ARCHAEOLOGICAL REPORT

Archaeological Recovery

of the

JAVA SEA WRECK

PACIFIC SEA RESOURCES

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Pacific Sea Resources
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THE JAVA SEA WRECK
ARCHAEOLOGICAL REPORT

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1.0 INTRODUCTION

1.1 Objectives and Results

In March 1996 Pacific Sea Resources (PSR) learned of a shipwreck in the Java Sea. The wreck had a cargo of iron and thirteenth-century Song dynasty Chinese ceramics. It became known as the Java Sea Wreck.

Through Indonesian partner PT Sulung Segarajaya, PSR was awarded a license to salvage the Java Sea Wreck in July 1996. During August a barge, tug, equipment and personnel were mobilized in Singapore. Departure was on 28 August, and after clearing in at Belitung the excavation vessel was anchored over the wreck site on 30 August 1996.

Excavation took two months. On 29 October the anchors were retrieved and the barge and finds returned to Singapore, arriving there on 4 November. In a conservation laboratory in Singapore, the ceramics cargo was cleaned, desalinated, and then systematically shelved for cataloguing and study.

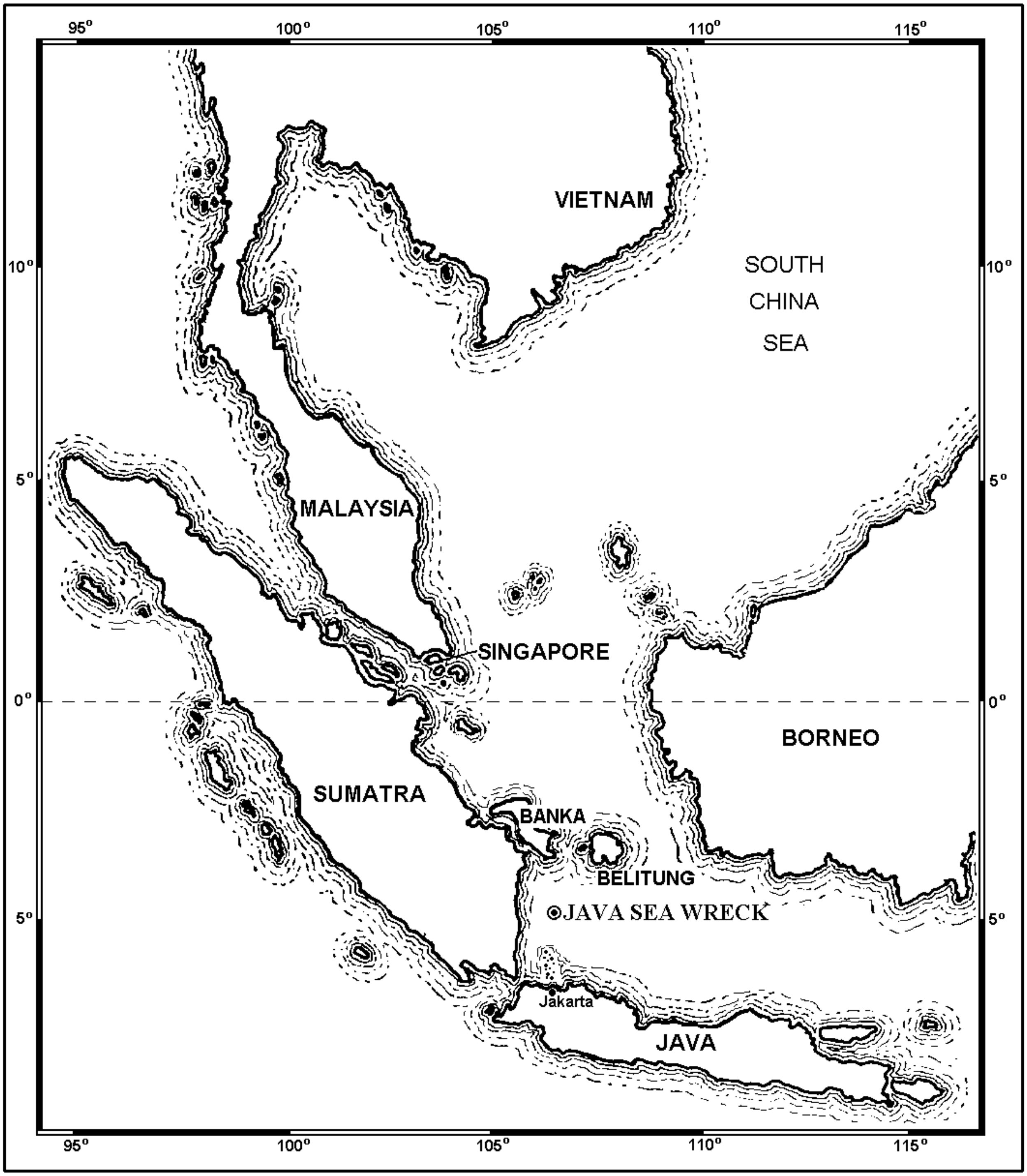
This Archaeological Report details the historical background at the time of the loss, describes the archaeological methods that were used to excavate and document the wreck, and discusses the site, the ship, and the likely wrecking process. It presents the artifacts and ceramics in inventory form and goes on to study the context of the finds in time and place. The iron cargo, the most extensive ever discovered on a ship of this era, is discussed in terms of the history and technology of iron production in Asia.

The ceramics present a wonderful cross section of export wares from southern China. Over half of the ceramics cargo consists of simple, utilitarian bowls and dishes, provincial ware for day-to-day use. At the other end of the spectrum are exquisitely molded *qingbai* (pale blue) ewers with dragon handles and rare Cizhou-type ewers and bowls, obviously meant for the elite. In between are dozens of varieties of fine bowls, dishes, vases, bottles, boxes, and jars, in all shades from white through green to blue.

None of the ship's structure has survived. However, from evidence gleaned from the iron concretions and fragments of wood, it seems that the ship was of Thai origin. The primary cargo of iron cauldrons and bars was loaded in holds the full length of the ship. Tens of thousands of ceramics from the kilns of southern China were stowed on top of the iron. The ship then made its way south along the coastal route, possibly stopping in Vietnam, Thailand, and Sumatra, where it traded for ivory, earthenware kendis, and aromatic resins. Having passed through the treacherous Banka Strait, it headed on towards eastern Java where the Majapahit empire was taking shape. But for reasons never to be discovered, it sank in the Java Sea, well short of its final destination.

1.2 Locating the Wreck

The wreck lies in the northwest region of the Java Sea. There is no land in sight. There is no bottom trawling. And yet fishermen found the shipwreck and can return to it again and again. It is thought to have been first discovered in the late 1980s. It is most likely that birds gave away the position that had remained a secret for over seven hundred years. Birds feed on schools of fish that are attracted to the wreck. On an otherwise featureless sandy seabed, a wreck provides food and shelter for huge schools of fish and large individuals - a place for corals, sponges, and oyster shells to thrive. Birds are always feeding on schools of fish, but most of the schools are pelagic and therefore move around. Fish over a wreck stay in more or less the same location. When fishermen observe birds feeding for a long time in one location, it is a very good sign that a wreck lies below.



Java Sea Wreck location map.

The fishermen are usually more interested in fish than the wreck itself. They keep the position to themselves, as it provides a continuous supply of red snapper and grouper. Their ability to relocate the site is remarkable, considering the birds are only there on the rare occasions that the schools of fish come to the surface. In the case of the Java Sea Wreck the closest navigation marker is an offshore oil-production platform more than thirty miles away. By steaming for, say, four hours at 10° from the platform, they come to the area using only a watch and a rudimentary compass as instruments. Sometimes they go straight to it and confirm the location by catching reef fish where normally there would only be pelagic species. Otherwise, they drop a marker buoy and do a slow search using a lead bar on a rope. When the bar hits an iron hull, a ballast stone, or a piece of porcelain, they can feel it and confirm it by fresh marks in the lead. In no time they are anchored over the site, pulling snapper in one after the other.

It is normally only a matter of time before a hook snags on the bottom and, when pulled free, comes to the surface with a lump of iron concretion or a ceramic shard. Many of the fishermen in the southern portion of the Java Sea live on a few islands in the Thousand Island Group just north of Jakarta. Several of them are also sea cucumber and aquarium fish divers and have small compressors rigged on their boats. These divers are also on the lookout for shipwrecks, which abound in the Indonesian archipelago. World War Two tin cargoes, Ming blue-and-white, and Song celadons are often recovered by these divers and disposed of very quietly. As soon as they heard that a ceramics shard had been fished up in the middle of the Java Sea, they headed for the site to salvage what they could.

As there is no bottom trawling in the area, there must have been large numbers of intact ceramics on the wreck mound that could be easily recovered without any excavation equipment, such as airlifts. It is now known that much of the surface material was removed by fishermen. As an aside, some fishermen have admitted to using explosives on the site to catch fish before and after ceramics were recovered. The shock waves from the explosion kill the fish and just about every other living organism in the near vicinity. About a third of the dead fish float to the surface, where they are quickly snatched up. The other two-thirds sink to the bottom, where they are left or collected by fishermen with primitive diving equipment. Entire coral reef ecosystems are destroyed by this very short-sighted technique.

The authorities are aware of the loss of national heritage caused by looting and dynamiting. Eventually, the navy got word of these activities and arrested the fishermen concerned. Aware that it was too risky to return to the site, the fishermen sold the position of the wreck to John Anderson, an American, who had been carrying out survey and salvage work in Indonesia for several years. Under contract to the Government, Anderson visited the location in a fishing boat in 1993 and recovered approximately 1,000 pieces during a preliminary investigation. The salvage company returned with a barge and excavation equipment in 1994 and in less than a month recovered an additional 7,000 ceramic items. The barge almost sank on the wreck and was towed back to Jakarta for major repairs. Shortly thereafter the company went into receivership for reasons unrelated to the shipwreck.

In March 1996 Pacific Sea Resources carried out a brief survey of the wreck site, which suggested that a significant amount of hull structure and undisturbed cargo remained. Anderson then sold the rights to Pacific Sea Resources and a joint venture was established. Unfortunately, it was only after excavation was under way that Anderson informed Pacific Sea Resources that the wreck had been looted previously by enterprising local interests who had recovered at least 4,000 intact ceramic pieces, and that no hull structure remained.

1.3 Political Considerations

In order to carry out shipwreck excavation work in Indonesia, a salvage license must be awarded to a local company, by the national shipwreck committee, Panitia Nasional. Pacific Sea Resources formed the Indonesian company, PT Sulung Segarajaya, through Indonesian partners to apply for a license.

With Pacific Sea Resources' record of the successful archaeological excavation of the Manila galleon *Nuestra Senora de la Concepcion* in Saipan, Panitia Nasional readily accepted the application. Before the license could be awarded, however, approval had to be obtained from twenty-two Government departments. As soon as these approvals were in hand, the license was issued and a deposit of Rps. 100,000,000 was paid to Panitia Nasional.

Before work could commence, security clearances had to be obtained for all personnel and vessels. Even Indonesian nationals, who made up the vast majority of the crew, had to be cleared before they could work on a wreck site in Indonesian waters.

A security officer representing Panitia Nasional was permanently posted on board the recovery vessel while excavation was under way. His role was to ensure that excavation was done in accordance with the license terms and to guard against outside interference, such as piracy. Every evening the ceramics finds for the day were inventoried and jointly signed off by the security officer and Pacific Sea Resources. When the excavation was completed and all export documentation was in order, the security officer accompanied the barge and cargo back to Singapore.

2.0 HISTORICAL BACKGROUND *by Dr. John Miksic*

2.1 China's Position in the Nan Hai Trade from 500 B.C. through the Tang Dynasty (A.D. 906)

2.1.1 Introduction

In the year A.D. 100, a distant observer of the Earth would have seen humankind on the verge of an explosion of commercial activity. Between the Mediterranean, where the Roman Empire under the Caesars was at its height, and China, stable and prosperous under the Han Dynasty, the kingdoms of South Asia were encouraging foreign traders to come to their shores. Ivory and incense from India were used in Roman palaces. Traders from the Graeco-Roman regions established outposts along the southern coasts of India, where Roman coins and pottery have since been found. The British archaeologist Sir Mortimer Wheeler, who excavated several of these sites, concluded that "it is fair to envisage Indo-European commerce of the first century A.D. pretty closely in terms of that of the seventeenth century" (Wheeler, 1954: 125). The Romans established trading companies with powers and procedures similar to those of the Dutch and British factory systems used in Asia over a thousand years later.

The Indians formed similar groups. The members of the Indian trading corporations were "related by a common interest in trade that had to pass through a particular center ...[T]hese traders were given royal charters" (Kosambi, 1959: 282). Indian trading guilds, engaged in the wholesale commerce of luxury goods, and maintained diplomatic relations with rulers of regions where those goods originated.

The Chinese, however, were not yet party to this communication. Indeed, the Chinese maintained an attitude of aloofness and official disinterest until much later, that is, until events during the early Song dynasty (960-1279) conspired to bring about a change in the policy toward trade. It was then that China finally integrated into the trading system of the Nanhai (the Chinese phrase designating the Indian Ocean and South China Sea). But the nature of China's participation in this ancient and sophisticated maritime trade network was unique. In order to understand the factors which shaped the trade of the South China Sea in the thirteenth century, it is necessary to understand the traditional Chinese perspective on trade in general, and on maritime commerce in particular.

2.1.2 Trade in the Indian Ocean, A.D. 100

Two major Mediterranean sources enable us to construct an outline of the early maritime trade system of Asia. One is a *Geography* written by the Alexandrian Greek astronomer, Claudius Ptolemaeus (Ptolemy), around the year A.D. 100. The second is an anonymous work entitled *Periplus Marae Erythraensis*, "Sailor's Guide to the Indian Ocean," written around the same time. These texts describe the commercial institutions of the Indian Ocean and show that commercial practices along the trade routes there had already been standardized.

The main commodities known to be shipped over these routes were high in value and low in bulk. They included such items as spices, various kinds of incense, gold and silver, special textiles including silk, and items that are now mainly considered oddities but commanded high prices in those days such items as rhinoceros horn and kingfisher feathers.

There were two basic sectors in the trade network: those in the Indian Ocean, lands "above the wind," and those in the South China Sea and Straits of Malacca, lands "below the wind." The traffic along these routes was governed by the regimen of the seasonal winds or monsoons.

It was not possible to sail from one end of the route, such as the Persian Gulf/Red Sea area, to the other end, in China, in one voyage. The normal practice was for Indian ships to sail within the Indian Ocean as far east as the Straits of Malacca. From there, the voyage to China was undertaken in Southeast Asian ships.

According to the normal rhythm of the winds, ships would sail from China to the Straits of Malacca area in January and February. The voyage from Southeast Asia to China could be undertaken between June and August. Sailors left India for the Straits between April and August with the southwest monsoon. It was technically possible to sail to India on the same wind, but most ships only departed from the Straits for India in December or in January. So just as the ships from China would be returning to Sumatra or Java with their cargoes of silks and metal, the other ships would be leaving those islands on their way to India.

Merchants from the two legs of the network would not meet unless they remained in the Straits for nearly a year. Ships did not usually stay over, but traders could. They changed from ship to ship in relays.

The third leg of the triangle involved what is now eastern Indonesia, the sources of some of the rarest spices, specifically cloves and nutmeg. The ships from the Moluccas and Sulawesi usually left between May or June and October, arriving in the Straits or north Java about two months later.

Until the Song dynasty, shipping in the South China Sea was a monopoly held by Southeast Asians, of whom the people of what is now Indonesia formed the majority. The people of Java and Sumatra were the ancient sailors of the world *par excellence*. Their relatives settled the lands from Hawaii to Madagascar, off the west coast of Africa. Huge ships known as *kolandiaphonta* came from the eastern seas; these seem to have been non-Indian, and were almost certainly from Java or Sumatra. Indian ships by contrast seem to have been largely coastal vessels.

2.1.3 Emporia: The Treaty Ports

The Graeco-Roman texts cited here use a precise word to designate an international trading port in the Indian Ocean: *emporion*, which of course has come down to us in modern English as *emporium*. The *Periplus* mentions 27 emporia in the Indian Ocean, divided into three classes: "designated," "lawful," and "authorized" (Miller, 1969: 19, Schoff, 1912: 51, n. 1; Warmington, 1928:53). The distinctions between these categories are unclear, but the general term means "a legal mart where foreign trade is allowed and taxed." Ptolemy, describing the India seas and non-Roman but well-known territory, intends *emporion* to mean an authorized coastal mart in the Orient where non-Roman dues were levied by non-Roman authorities (Warmington, 1928: 107). Ships calling at other ports might be escorted away under armed guard.

Emporia existed from the Red Sea to Southeast Asia. Graeco-Roman traders resided as far east as south India. Some Tamil kings even possessed bodyguards from "Yavana" (from "Ionia," an old name for part of Greece). Rome exported glass and wine to India, and grain was shipped from the Roman colony of Egypt, but most of the spices and silks had to be purchased with gold and other metallic money.

As previously mentioned, Roman coins are found in many sites of this first period of large-scale Asian trade in India. It is interesting to note that Roman emperors as early as Vespasian, A.D. 78, complained that the trade in luxury goods was draining currency out of the empire. The same problem arose many centuries later, when the British, in order to finance their imports of tea and porcelain, forced the Chinese to accept opium in lieu of metals.

A few Roman artifacts have even turned up in sites in Southeast Asia, especially at Oc-eo in southern Vietnam, apparently the major trading center in the South China Sea from the second through the fifth centuries.

The Roman trading stations in south India survived at the most for about 200 years. Then they fade out of history, as the empire began its long, slow decline. Even after Rome fell, however, the name "Rum" continued to shine with a bright luster in Asia. The Byzantine Empire was also known by this name, and coins from fifth-century Byzantium are common discoveries at sites of this period in Sri Lanka (Wolters, 1967: 80).

Europe forgot completely about its earlier involvement with Asia for a thousand years and sank back into the darkness of the Middle Ages, when all that remained of the early long-distance trade were a few legends of fabulous wealth in the distant East.

The story has an interesting postscript. In 1410, a Byzantine-era copy of Ptolemy's *Geography* was discovered in a library in Florence and was translated into Latin. This translation was studied at the Academy at Sagres established by Prince Henry the Navigator. The information it contained, although more than a thousand years old, provided a vital stimulus to the planning of the explorations of the south coast of Africa which culminated in the Portuguese discovery of the Cape of Good Hope and the route to India. This episode is one of the most intriguing examples of the use to which ancient classical literature was put upon its rediscovery during the Renaissance, and the clear connection between the beginnings of European commercial expansion into Asia (and accidentally into America) and the birth of European humanistic studies.

2.1.4 While Europe Slept

The period that concerns us here is that between the fall of Rome and the arrival in the Far East of their distant descendants, the Portuguese. During this thousand-year phase of development, only now attracting historians' attention, the Asian maritime trade fared extremely well without European involvement or, indeed, awareness. Very few Asian records of this long interim survive, and those that do tend to be written in archaic or extinct languages and deal mainly with ritual and politics. The principal exception is Marco Polo, who traveled the entire length of the Asian maritime trade route during his return from Yuan-dynasty China to Italy in 1292-93. Polo's descriptions of this world seemed so unbelievable to his contemporaries that for centuries his tales were thought to be imaginary. Only in the early twentieth century when archaeological discoveries begin to corroborate his reports did historians begin to take his account seriously. Although one author has recently challenged the current view that Polo was recounting a true story, the vast weight of evidence suggests that he was in fact attempting to do no more than record what he had actually seen and done.

The very earliest reports from the Graeco-Romans depict a system whose framework continued to exist right up to the twentieth century. This system was highly efficient, given the technology and communications of the time, in distributing goods over an enormous stretch of coastline. The main elements of the system included the designation of certain ports as open to foreign traders and others as closed, the Roman emporia. This characteristic was obviously designed to ensure that the benefits of the trade would accrue to certain people, namely the rulers of the regions concerned.

In traditional kingdoms the more distant parts of the realm could not be trusted to send the customs duties collected from foreign merchants to the central treasury. Furthermore, the wealth accumulated by merchants could well be used to mount a challenge to the established ruling clique. For these reasons, the main ports where foreign trade was allowed were those most closely supervised by the principal ruler, who might reside inland, in the center of the more fertile agricultural zones of the kingdom.

In the port zones, the foreign merchants usually had their own quarters. These would correspond to the foreign quarters of the treaty ports of nineteenth-century China. Within these quarters the foreign communities enjoyed more or less complete autonomy, as long as they did not interfere with the rest of the citizens of the kingdom. This arrangement suited both parties: the foreigners were allowed to follow their own customs and religion, and the local administration did not have to worry about trying to control motley groups of people with different languages and legal systems.

The trading system itself is difficult to define, but in essence there seem to have been two separate sets of exchange practices for different categories of merchandise. The "rare and precious" items (in the stock Chinese phrase) were coveted by the wealthy as status symbols, and the rulers often limited access to them. Some were claimed as monopolies of the ruler himself; in other cases, he claimed a duty of up to 30%, and the rest of the luxury goods could only be sold to a designated group of buyers.

The possession of such luxury goods obviously had political symbolism, and the rulers did all they could to control their distribution. This category of merchandise was usually not bought and sold in the usual fashion, by a process of haggling until a bargain was struck between buyer and seller. Instead, a customary or diplomatic procedure was used to negotiate a set of "equivalencies" between the items brought by the foreign merchants and those returned by the local inhabitants. The ideology of exchange was more of a generalized than a specific reciprocity, in anthropological terms. It was not seemly to perceive this kind of exchange as trade. In most instances the foreign items were presented to the local ruler in the guise of tribute or gifts, and the local ruler reciprocated by giving presents. The nature of the gifts returned by the rulers was, however, fixed by custom; a certain amount of foreign produce would elicit a specific quantity of "gifts." Thus the appearance of trade (and the use of money) were avoided.

The second category of exchange involved more utilitarian items. These are even less well documented than the luxury items, but stray references to the transport of bulk necessities such as rice and salt are found in the earliest sources. It seems that these found their way into markets where money was used. Many forms of currency were used in Asian markets, and coins in some areas were treated as just another form of metal which might be melted down and recast into other objects. In general, however, marketplaces in Asia were monetized at a very early period.

Indonesian inscriptions show that weights and measures had become standardized between A.D. 850 and 900. These weights were heavily influenced by Indian units and linguistic terminology, but there were some indigenous elements in both units and names.

By the year 900, silver and gold coins were minted in multiple denominations in Java. It is worth noting that the Javanese coins look nothing like those made in India. The Javanese word *wli* (modern Indonesia *beli*, "buy") first appears in an inscription dated 878. The word *pirak*, analogous to modern *perak*, "silver," was a synonym for money. Indian influence in the form of the Sanskrit word *wyaya*, modern Indonesian *biaya*, "expenses," also was current in 878. It seems that in addition to precious metal, other currency in the form of iron bars was used until the early tenth century (Wicks, 254-259).

An integral figure in the organization of ancient trade was the official who acted as the intermediary between the foreign merchant communities and the local ruler. This official had different designations in each area, but his duties and privileges were remarkably similar in all times and places. In the Southeast Asian realm he was called the shahbandar (from Persian "Lord of the Harbor"). In modern parlance this term is used to translate the English "harbormaster," but this gives only a pale reflection of his activities. In many cases he was chosen from the foreign community, and to ensure his loyalty he was frequently betrothed to a member of the local royalty. He supervised the collection of customs duties and the warehousing of the imported goods. He also acted as the manager for the local ruler's own commercial activities; many Asian rulers themselves invested in ships and cargoes. They settled disputes between the foreign merchants and rulers, and could act on their own initiative to make treaties with foreigners. Such people obviously had numerous opportunities to enrich themselves.

A good description of the system is given by Tome Pires, one of the first Europeans with an intimate knowledge of its working. He resided in Malacca from 1512 to 1515 and describes the shahbandars there, of which there were four, each with jurisdiction over merchants from different areas: "They are the men who receive the captains of the junks.... These men present them to the *Bemdara* (the royal treasurer), allot them warehouses, dispatch their merchandise, provide them with lodging if they have documents, and give orders for the elephants..."(Cortesao, 1944: II, 265).

These characteristics of the early ports of trade in Asia were already in existence when the veil of history lifts during a short period around two thousand years ago. One can even trace their origins further back in time; the oldest documents on trade, from Mesopotamia, already indicate the existence over 4,000 years ago of officials in charge of long-distance trade, officially designated trading ports, tributary trade in luxury items, and foreign quarters. This is not to suggest that these traits owe their existence to Mesopotamian influence; rather they simply reflect a logical approach to the similarity of conditions prevailing in these different times and places.

2.1.5 Early Chinese Trade

The Chinese were not among the original members of the Indian Ocean trading network. When the Graeco-Romans first entered the Asian world, the Chinese were still largely confined to the Yellow River area of northern China. The main route to China at this time was still overland, via the Silk Route. For many centuries China's northern frontier had been a zone of constant contention between the settled agrarian way of life and the nomadic adaptation of the steppes beyond. The nomads were always a military threat to the Chinese.

One of the tactics that the Chinese used to counteract the nomads' military superiority was to encourage exchanges of prestigious goods across the frontier. The Chinese produced numerous manufactured items that the nomads desired; by dangling exotic and rare commodities in front of the northern barbarians, it was sometimes possible to bribe them into maintaining peaceful relations. Domestically, the imperial dignity could be maintained by casting the gifts to the nomads in the form of a ruler-vassal relationship.

The nomad elite received imperial gifts in return for their tribute, recognition of political autonomy in their own territory, and permission to conduct limited private trade with the Chinese.

This gave the people of the steppes access to Chinese silk, tea, and porcelain. The Chinese obtained jade and, importantly for their military position, good horses.

The earliest evidence for foreign trade between Chinese and non-Chinese groups dates from the fifth century B.C. It involved exchanges between the Han people living in Shandung and the people occupying what is now southern China, known as the Yüeh. The carriers of the trade were Yüeh people living around mouth of Yangzi. China south of the Yangzi became Sinicized only after the fall of the Han, when many people from the north migrated south.

Between 500 and 221 B.C., the late Zhou Dynasty, demand increased among the (northern) Chinese for southern luxuries like ivory, pearls, tortoise shell, kingfisher feathers, rhinoceros horns, scented woods, and spices; "this demand may have been the strongest single motive for the southward expansion of Chinese political power" (Wang, 1958: 5). Qin Sihuang, the "first emperor," was the first ruler to extend northern Chinese control to parts of the south coast, bordering on the South China Sea. At this time the entire south coast was still populated by Yüeh people. "The few prehistoric sites along the coast which have so far been examined merely suggest that the people were quite different from the Chinese and had a different cultural pattern" (Wang, 1958: 7).

The Yüeh, unlike the northern Chinese, were expert sailors and already frequently traded with other regions. One kingdom, Nan Yüeh, with its capital near modern Guangzhou, was described in the first century B.C. by the contemporary author Su-ma Ch'ien as "the collecting-center of rhinoceros horns, elephant tusks, tortoise-shells, pearls, fruits and cloth (of hemp and other fibrous plants)" (Wang, 1958: 8). Lo Yüeh, another kingdom located in the Red River basin near modern Hanoi, was captured in 214 B.C., but not until Chinese troops had been defeated several times and reinforcements had been sent, consisting of "criminals, banished men, social parasites and merchants" (Wang, 1958: 10). This interesting set of associations for merchants shows the low esteem in which they were held. Who were these early merchants exiled to the southern colonies? No information exists.

According to Confucianism, merchants were the lowest rung on the social totem pole. The documentation of Chinese economic history is therefore extremely poor. Because Confucian scholars monopolized the bureaucracy, owing to an education system predicating access to high office on memorization of the Confucian classics, Chinese history was written by officials who considered trade a degrading subject, not worthy of notice. However, indirect references, usually complaints from ministers, show that by 178 B.C. Chinese people were becoming interested in making profit from the luxury goods trade. A rising class of merchants encouraged powerful nobles to invest in trade in salt, metals, and luxury goods. Meanwhile ministers praised rulers who "despised gold and jade" and wanted the emperor to make everyone return to farming.

The relationship between the governing elite of China and the mercantile classes has been marked by suspicion and hostility for over two thousand years. One of the main characteristics of Chinese history has been the tension between the culture of the north, the original center of Chinese culture, marked by militarism, austerity, isolationism, and centralized rule, and the culture of the originally non-Han Chinese south, marked by a spirit of free enterprise, commercialism, social mobility, and outward-lookingness.

Four military commanderies were set up to administer the newly conquered territory, corresponding to the regions of Fuzhou, Nanhai (Guangzhou), Guilin, and Xiang (Hanoi). "Very little is known of these commanderies" (Wang, 1958: 10) other than that they had a governor and military staff.

The commandery of Nan-hai soon split off and became a "miniature empire," Nan Yüeh, which ruled the coast from southern Fujian to Vietnam until 111 B.C., when the Han retook the area. In 196 B.C. the chief was made a feudal lord by the Han empire, and a regular trade with the Han developed, mainly based on the acquisition of iron in exchange for pearls, tortoise shell, ivory, and rhinoceros horn—commodities that were imported from the South Seas.

Han Wudi, an energetic emperor who died in 87 B.C., allowed trade, but after his death the ministers had their way and trade was restricted. The court debate on the morality of trade is preserved in a collection of essays entitled "Discourses on Salt and Iron." In 77 B.C. a Yüeh native who had become head of a commandery was executed for having earned more than one million cash in illegal trade.

The "rare and precious objects" from beyond China played an important part in the legitimization of the ruling dynasty. As Chinese civilization developed, so did the search for more unusual and exotic items from abroad, until something resembling a cult of imported rarities evolved. The imperial court formulated a policy of sending missions abroad in search of rare and precious goods. This duty often was assigned to eunuchs. An early text refers to "chief interpreters attached to the Yellow Gate [eunuchs serving in the palace] who go to sea with the men who answer their appeal [for a crew] to buy bright pearls, *pi-liu-li* (opaque glass), rare stones and strange things, taking with them gold and various fine silks to offer in exchange.... The merchant ships of the barbarians are used to transfer them [the Chinese] to their destination" (Wang, 1958: 19-20). These emissaries embarked from ports in western Guangdong, where few Chinese lived; they had already been active as centers for the pearl trade. The eunuchs may have been barbarians themselves.

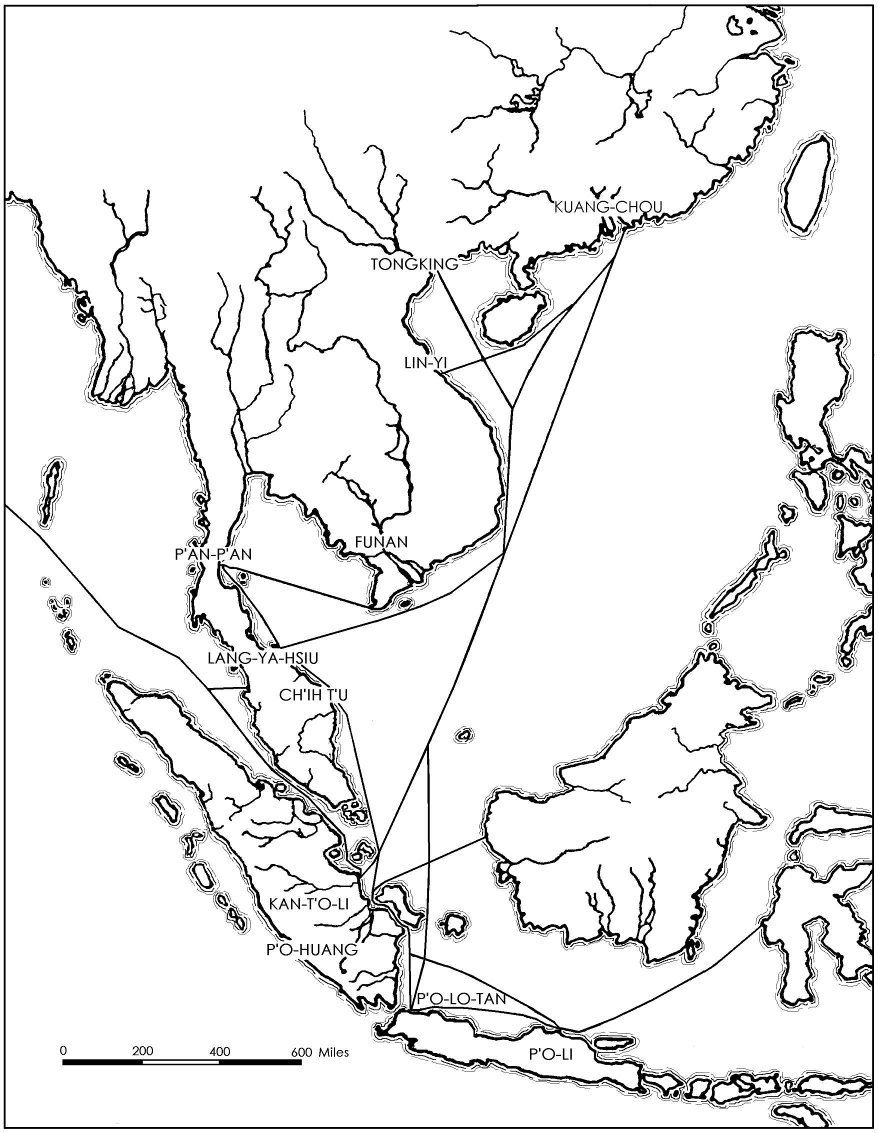
In the later Han Dynasty, in the second century, barbarians began sending their own seaborne missions to China. One supposedly from Daqin (Rome) came in the year 166, but was rejected by the Chinese as spurious. The envoys brought elephant tusks, rhinoceros horn, and tortoise shell as tribute; these were South Seas produce, not Roman. This record is, however, useful as the only account of what any missions brought to China at this time.

The Han collapsed in 220 and was succeeded by a period known in general as the Three Kingdoms, celebrated in Chinese literature. One of these three kingdoms, Wu, held the southern coast; the other two, Wei and Shu, held the north and west. The Wei therefore had to deal with the Wu in order to obtain southern luxuries. In 236 the Wei sent envoys to Wu to obtain pearls, kingfisher feathers, and tortoise shell in exchange for horses.

The Wu kept sending missions into the South Seas in search of these items. Two of these envoys, Kang Tai and Qu Ying, made a special mission to the South Seas in 245–250. They both wrote books, long lost, about their mission; some quotations from Kang Tai have been preserved in other texts. He mentioned Java/Sumatra, which he apparently visited, as well as Bangka, Belitung, and Borneo □ in all, ten places on the Malay Peninsula and in the Southeast Asian archipelago. During the Three Kingdoms period Chinese ships were apparently still incapable of sailing in the open sea; the emissaries traveled in foreign ships.

2.1.6 The Tribute Missions

The kingdom of Wu was conquered by Qin, A.D. 280. More men were sent to sea to acquire the standard South Seas luxuries, and foreign tribute missions to China accelerated. In the short period of 284–287 Funan, Linyi (Champa), and twenty other countries came to present tribute. An image of the wealth which this commerce generated found its way into the literature of the period. The Governor of Qing Zhou, on the route between south China and Loyang, the northern capital, was famous for flaunting his wealth, including coral trees, ivory, pearls, and scented woods. One account says that he had "powdered gharu-woods as fine as dust sprinkled over an ivory bed, and asked those that he specially loved to step on it" (Wang, 1958: 35).



Trade routes and tributary kingdoms of Southeast Asia in the fifth to seventh centuries A.D.

During the Wu and Qin dynasties, 226-405, China received missions from the following countries: Funan (7 missions), Champa (6), Daqin (the Eastern Roman Empire) (1), Sri Lanka (1), and Tangming(?) (1) (Wang, 1958: 120). Shortly thereafter, before the beginning of the next major historical phase, the famous Chinese Buddhist monk Faxien returned to China from India by sea rather than by the more common overland route. In 414 he called at *Yeh-po-ti*, a large trading port somewhere near the south end of the Straits of Malacca (quite possibly in northwest Java). From there he sailed directly to Guangzhou with over two hundred other people. During all his years in India he saw no Chinese, nor were there any among the merchants on the ship taking him to China. This is the first record of a sailing connection between India and China; all indications are that Chinese merchants were not participants in this trade.

The next period of important tributary activity occurred during the Southern Dynasties, 420–589, when a large mission visited China "to ensure safe and profitable trading for the foreign merchants and trading envoys" (Wang, 1958: 38). In all, 99 foreign tribute missions visited China between 420 and 589 (Wang, 1958: 51), a great increase over the previous period. The flow of tribute to China was not consistent, however; rather it came in spurts. The pattern of tribute exhibits two peaks, one during the years 420–460, the other in the period 502–540.

The Southeast Asian countries active in this tributary trade include the following:

Holodan, in Java, sent 6 between 430 and 440.
Pohuang, Tulangbawang, southeast Sumatra: 7 between 445 and 464.
Gantoli, probably south Sumatra, 455–564, 5.
Poli (Bali?): 3, 470–524. Poli's products were dominated by those obtained from the sea: tortoise shells, shell-fish, purple cowries, and corals.
Panpan, somewhere on Malay Peninsula, 455–589, 12.
Langkasuka, Malay Peninsula, 515–56, 3;
Champa, 420–589, 25. There is a record of the types of commodities brought by this most active tributary. These include metals: gold, silver, and copper (there were said to be lots of gold and silver articles produced there); also tortoise shell, cowries, gharu wood, grass mats, cotton cloth, rhinoceros horn, and ivory. On the whole, this list represents the common items sought by the early Chinese nobility.

Funan, 430–589, 17. Trade goods from Funan included some items for religious rituals like gharu wood (incense), ivory and sandalwood stupas and statues, and glass vessels used for temple rituals. The items meant for use by the nobility (as opposed to the temples) consisted of gold and silver articles, cowrie ornaments, scented woods, ivory, peacock feathers, tortoise shells, re-exports of items like gems, coral, opaque glass, cotton, and storax. Chinese "gifts" to these areas list only silk and brocade.

Although the Southern Dynasties were an active period of communication with the South Seas, the records of this time still exhibit no references to Chinese ships going overseas. There are, however, rare pieces of evidence which enable us to read between the lines and to conclude that certain Chinese were exhibiting a "modern" attitude toward the benefits of engaging in foreign trade. In the 479–502 period, there is a reference to a certain Zhang Qing-zhen who "calculated carefully the silks and brocades which he used to trade with the 'K'un-lun p'o'" (Wang, 1958: 60). The phrase "K'un-lun p'o" refers to the ships of the people who lived in the South Seas. Apparently there was a mercantile class in south China, but other than their bare existence, no other information regarding them survives.

Two other references are even more indirect, but betray something of the true nature of the trading activity and its importance for at least some sectors of Chinese society. In one reference to the Liu Sung Dynasty, one of the southern dynasties, the following note appears: "When the two Han dynasties had sent expeditions these [overland] routes had been found to be particularly difficult and merchandise, on which [China] depended, had come from Tongking; it had sailed on the waves of the sea.... Precious things come from the mountain and the sea by this way. There are articles such as rhinoceros' horn and kingfisher feathers and rarities such as serpent pearls and asbestos; there are thousands of varieties, all of which the rulers eagerly coveted.

Therefore ships came in a continuous stream, and merchants and envoys jostled with each other" (in Wolters, 1967: 77).

The history of the dynasty that succeeded the Liu Sung and ruled from 479 to 502 also refers to the active maritime trade of that time: "Of all the precious things in the world none are better than those of the southern barbarians. They are hidden in the mountains and in the seas. They are innumerable. Merchant ships arrive from afar and bring these things to the southern provinces. Thus it is that Tongking and Kuangtung are rich and well stocked. The goods are stored in the imperial treasury."

Very little information regarding the administration of the trade of this period survives. A mission from the Javanese kingdom of Holotan in 430 was partly intended to acquaint the Chinese emperor with the difficulties that the Javanese merchants sometimes experienced with corrupt port officials (Wolters, 1967: 165). This indicates that the collection of duties was not always properly supervised by the central government.

The Southern Dynasties came to an end with the reunification of China by the Sui Dynasty in 581. The emperor in 605 moved his capital and ordered the provinces to deliver such southern luxuries as rhinoceros horns, elephant tusks, furs and feathers, to adorn his new court (Wang, 1958: 63). The short-lived Sui recorded the following missions: <u>Champa</u> (2); <u>Dandan</u> (2); <u>Panpan</u> (1), <u>Red Earth Land</u> (3), <u>Cambodia</u> (1), <u>Jialoshi</u>(?) (1) (Wang, 1958: 122).

2.1.7 Trade During the Tang Dynasty

After the establishment of the Tang Dynasty in 618, the southern ocean trade expanded. In addition to luxuries for the court and goods of a religious nature, items used for medicinal purposes and condiments for food formed an increasing portion of the imports from the South Seas (if the sources are a true reflection of the situation). Yangzhou, at the junction of the Yangsi and the Grand Canal, became the main center of trade. A road built in 728 connected Guangzhou with Yangzhou. A source says that "the various countries from across the sea may now daily transport their merchandise, so that the wealth of tusks, hides, feathers and hairs, and that of fish, salt, clams and oysters can...meet the needs of the treasury and...satisfy the demands of the Qiang-Huai region" (Wang, 1958: 79).

Through the eighth and into the early ninth century, trade continued to expand under the energetic Tang rulers. Guangzhou in particular benefited from this expansion. As a source from 841 says, "Guangzhou enjoyed the profits of the barbarian ships where all the valuable goods were gathered.... Of all those who served at Guangzhou, not one returned without being fully laden [with the wealth they acquired]" (Wang, 1958: 83).

The missions which visited China more than once during the 278 years of the Tang Dynasty are as follows: <u>Champa</u> (26), <u>Holing</u>, Java (8), <u>Sri Vijaya</u> (6), Shih-tse (4), <u>Cambodia</u> (3), <u>Qulomi</u> (2), <u>Jambi</u> (2), <u>Doholo</u> (2), <u>Kanqifo</u> (India) (2), <u>Mola</u> (India) (2) (Wang, 1958: 122–123).

Even during the Tang, there are still no references to private Chinese traders voyaging overseas. The only descriptions we possess are the incidental references in court records, which tend to overlook commercial matters completely, and the record of another Buddhist monk-adventurer, Yijing. He voyaged from China to Srivijaya, south Sumatra, in 671, in a ship belonging to the ruler of Srivijaya. He remained in south Sumatra for 6 months, studying Sanskrit at a large monastery there; his experience was positive enough that he recommended it to other future

Buddhist travelers. He then took ship in another Srivijayan vessel and sailed to India via Malayu (Jambi) and Kedah.

After residing in India for 18 years, Yijing returned to Srivijaya, noting that in the interim it had absorbed both Malayu and Kedah. He intended to remain in Srivijaya for some time, but one day, while he was aboard a ship in the harbor in order to send a request to China for more paper and ink, the ship unexpectedly weighed anchor and sailed straight to China, leaving him no option but to go along and buy his own supplies. Nevertheless he so desired to spend more time in Sumatra that he returned there for some more years before finally returning for good to China in 695.

Yijing's account is useful because it mentions other Buddhists who made the pilgrimage to the Buddhist holy land, including a monk who sailed in a merchant vessel "heavily loaded with goods" from Guangzhou or Hanoi to Holing. The ship then went to Malayu, but after passing it sank in a storm because it was overloaded; the monk drowned. No doubt this incidental report represents the tip of the iceberg; voyaging between South Sumatra and China by Indonesian ships carrying a wide variety of goods from both Southeast Asia and the shores of the Indian Ocean was probably a common activity during the Tang period.

The report of Yijing is of utmost importance to the study of early Tang maritime trade, because it is the only description of the sea routes used before 750. He describes direct voyages in Indonesian ships from Guangzhou to Palembang or (less often) Java. From there the standard ports of call were Malaya (Jambi) and Kedah. Return voyages followed the same route in reverse.

In the late seventh or early eighth century, Srivijaya "sent several missions to the court to submit complaints about border officials seizing [their goods] and an edict was issued ordering [the officials at] Guangzhou to appease them [by making inquiries]" (Wang, 1958: 97, quoting the *Tang shu*). "This is the only mention in Tang records of any mission from the Nanhai successfully inducing the central government to act on behalf of the merchants at Canton. This is evidence that Srivijaya was the dominant trading power and had already earned the respect of the Chinese" (Wang, 1958: 98-99). Srivijayans were leaders of the foreign merchant community at Guangzhou until 742.

In 684 the governor of Guangzhou was killed in manner which suggests that the murderer was an Indonesian distressed by officials' misdeeds (Miller, 1969: 186). Some such incident may have been responsible for the remark of Tome Pires over 800 years later explaining why foreigners were not allowed to go to Guangzhou: "They say that the Chinese made this law about not being able to go to Canton for fear of the Javanese and Malays" (Cortesao, 1944: I, 122).

In 714 we first learn of the existence of a Chinese official called the Superintendent of Shipping Trade (alternatively called Superintendent of Barbarian Shipping). This is the first sign that an official like the shahbandar of the Indian Ocean was appointed in China. The office was rather independent of the provincial authorities, being administered directly from the central government, and was dominated by eunuchs. A record from the early ninth century gives some indication of this official's duties:

> When [the laden Nanhai ships] arrive, a report is sent to the Court and announcements are made in all the cities. The captains who command them [or chief merchants] are made to register with the Superintendent of the Shipping Trade their names and their cargo. [The Superintendent] collects the duties on the goods and sees that there are no [prohibited] precious and rare goods [of which the government had a monopoly]. There were some foreign merchants who were imprisoned for trying to deceive [him]" (Wang, 1958: 101). Another source says that

> head of the office "dealt with the translation of languages, the offering of valuable gifts, and every year conducted the sending of tributes (either sending those due from the province itself or arranging for foreign tribute missions to go to the capital).

After the last ship of the season arrived, 30% of the non-monopolized goods would be taken as duty, and the rest would be given back to the envoys to dispose of themselves (Hirth and Rockhill, 1911: 15).

Provincial authorities continued to have some duties too in regard to the supervision of maritime trade. A governor of Lingnan in 820 was cited for halting smuggling: "When the foreign ships arrive and are docking, they are charged a lowering-anchor-tax. There is an examination of the merchandise. Rhinoceros (horns) and pearls were so numerous that bribes were offered to the servants and retainers; the Governor stopped this" (Wang, 1958: 101).

The same record says, "Far across the sea in the South, there were those who died in the countries there. The officials held their goods. And if their wives or their sons did not come within three months to claim them, these would be confiscated. The governor [stopping this practice] said 'The sea journey back and forth is calculated in years; why fix the time in months? If anyone has proof, no matter whether he comes early or late, let him have all" (Wang, 1958: 101-102).

In the ninth century another port of trade was opened to foreigners: Quanzhou (also called Zaitun, an indication of the large number of Muslim traders who frequented it).

In the time of the succeeding Song Dynasty (960–1279), similar practices apparently existed:

> Concerning foreign ships and merchants, the Superintendent examines the boats entering the harbour for 'prohibited goods,' takes into the godowns all the legal imports, collects the taxes due on these goods, buys on behalf of the government those goods of which it has the monopoly, and examines the boats leaving the harbour for 'prohibited goods'. He further protects the foreign merchants while they are at the port.
>
> Concerning Chinese ships and merchants, the Superintendent examines the cargo of the ships when they leave for the Nanhai and when they return, and collects the taxes due on their goods.

In 878 this period of prosperity came to an end. Guangzhou was pillaged during the Huang Zhao rebellion, foreign merchants were murdered, and all trade there ended for a century. Foreign merchants then established a rendezvous at a place known to the Arabs as Kalah (which appears in the *Arabian Nights* as a place visited by Sinbad). Archaeological sites at both Takuapa, on the west coast of South Thailand, and Laem Pho, on the east coast, contain abundant evidence of trade with the Near East and China at this time and may correspond to this toponym.

Wang, (1958: 113) divides early maritime trade with China into three phases:

> Phase One: 200 B.C.–A.D. 300. Precious things desired by courts.
> Phase two: A.D. 300–600. Holy things.
> Phase three: A.D. 600–900. Drugs and spices.

The brief Five Dynasties period (907–959) saw little commercial activity. Only four missions to China are recorded: three from Janzheng and one from Srivijaya. The foundation of the Song

Dynasty in 960 ushered in a new and even more prosperous period of trade, when many more parties became involved, including for the first time Chinese merchants voyaging into the Nanhai.

2.1.8 Early Southeast Asian Ships

The oldest known boat yet discovered in Southeast Asia has been carbon dated to A.D. 260–430 (Manguin, 1993: 236). It was discovered in Pontian, on the east coast of the Malay Peninsula. This date agrees with that estimated in 1926 by I.H.N. Evans based on ceramics found on the site with the boat, which are similar to those discovered at the contemporary port of Oc-eo in south Vietnam. The origin of the boat cannot be determined, but its lashed-lug design marks it as Southeast Asian rather than Chinese. It seems to have been a trading vessel, as its cargo suggests. The ship is estimated to have been about 12 meters long.

Few other early boats have been discovered in Southeast Asia. One other, which has not been scientifically dated but which resembles the boat from Pontian, was discovered near Khuan Luk Pad, in south Thailand, a site of A.D. 1–500 that has been systematically looted because of the huge quantity of early trade beads discovered there.

Two important finds, although found in disturbed condition, were both made near Palembang, Sambirejo, carbon dated to A.D. 610–775; and Kolam Pinisi, Palembang, A.D. 434–631. The Sambirejo ship is estimated to have been 26 meters long. From a later period, probably the late Song, is a fragmentary vessel from Paya Pasir, near Kota Cina, northeast Sumatra. This too was a relatively large vessel like the Sambirejo ship. Finally, the only other important vessel of the pre-Ming period to be discovered and studied was found at Butuan, Mindanao, south Philippines, and dated to the period A.D. 1270–1410; its original length is estimated to have been 20 meters (Manguin, 1993).

These ships can only be partially reconstructed, so no detailed comparisons are possible. But some basic construction techniques can be discerned. One of the most important traits of these early Southeast Asian ships is that no iron was ever used in their construction. Instead their planks were lashed together with vegetable fibers. The use of outriggers would seem to have been another important early characteristic; large seagoing ships of this type are depicted on the Javanese monument of Borobudur, carved around 800. Dr. Manguin (1993: 264) does not think the largest ships would have used them. The use of quarter rudders such as these reliefs indicate is highly probable, but some early Chinese ships may have used them too.

A fourth-century Chinese text on medicinal plants refers to foreign ships called *bo*, analogous to the *K'un-lun po* of other writers. The word *po* would seem to be a transliteration of the Malay *perahu*, "boat." These ships were over 50 meters long, carried four masts, and had a capacity of 600–700 people and about 600 tons of cargo (Li, 1979: 90).

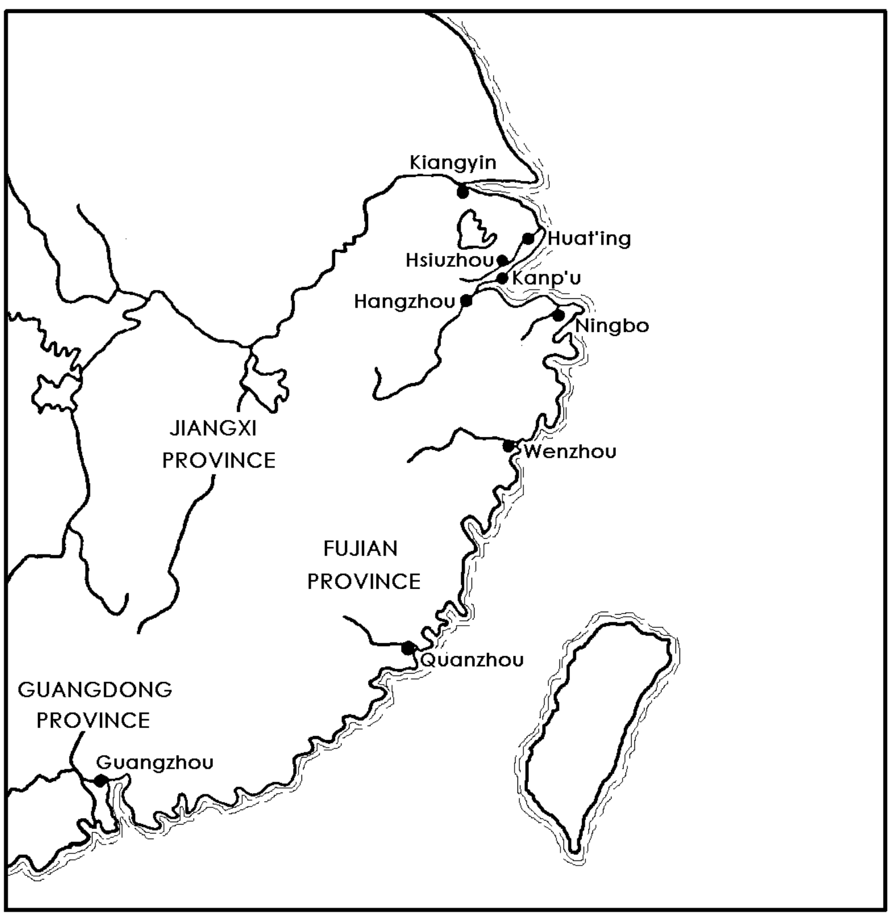
Chinese influence, such as the use of iron nails, seems to have become common in Southeast Asia in the fourteenth through the sixteenth centuries. The shipwreck at Bukit Jakas, Bintan Island, Riau, Indonesia, carbon dated to between 1400 and 1460, is an early example of the hybrid Chinese-Southeast Asian variants that became standard in the period after the Chinese began to participate as shippers in Southeast Asian maritime commerce. It is significant that this influence only appears after the end of the Song Dynasty; it is another strong piece of evidence supporting the inference that Chinese shippers did not participate in the trade until after the year 1000.

2.2 Trade Interaction During the Song Dynasty (A.D. 960 - 1260)

2.2.1 Introduction

In 960 the Song Dynasty reunified China after a period of civil war, and commerce in the ports where foreign trade was allowed quickly recovered. A decade later the Department of Foreign Trade at Guangzhou was reorganized as commerce was expanding at a rapid pace. The Song helped to stimulate this recovery by sending four missions abroad in 987. These missions "consisted of eight court officials, who carried with them imperial edicts, gold, and cloth, to various barbarian countries in the South Seas to induce the import trade of aromatics, rhinoceros horns, pearls, and Baroos camphor (so-called after Barus, north Sumatra, source of the highest quality camphor)" (Ma, 1971: 33).

The Northern Song opened new ports, equivalent to the "treaty ports" persisting into the nineteenth century. The first alternative port to Guangzhou was Quanzhou, in 1087. Other Offices of the Maritime Trade Superintendency (Shih-po Si) were located at Hangzhou and Ningbo. Later, Offices of the Maritime Trade Bureau (Shih-po Wu) were located at Suzhou, Wenzhou, and Jiang-yin Chun. Although little quantitative data exists to make a firm judgment, enough anecdotal information has been preserved to support the conclusion that "by the Song period, the scale of maritime trade had become so large that it may be deemed the first period of great oceanic trade in the history of the world" (Ma, 1971: 23).



Port cities of Song dynasty China.

It was still a criminal offense for individual Chinese to engage in direct trade with foreigners, however, and the system of hoarding all foreign incense and other luxury goods in government warehouses was still maintained. Thus for the period between 960 and 1126, known as the Northern Song, foreign commerce was continuing to expand, but still within the mold cast by the Confucianists a thousand years earlier.

Merchants who induced foreigners to bring cargoes that yielded duties of over 50,000 strings of cash were offered official rank. In 1115 the Chinese government established a hotel at Quanzhou for foreigners, which cost the government 300 strings a year. In 1132 another hotel was founded at Guangzhou. A welfare service was set up for shipwrecked seamen, with an allowance of 50 cash and 2 pecks of rice a day.

As early as the late Tang Dynasty, the government had begun to invest in maritime trade infrastructure by developing a harbor near Fuzhou. The Guangzhou harbor was dredged at government expense in the early eleventh century (Wheatley, 1959: 26-27).

2.2.2 The Song Government Trade Monopoly

Imports via maritime trade in the Northern Song still consisted of two main categories: the less expensive, consisting of textiles (mostly cotton), spices, and drugs, and the much more valuable: jewels, ivory, rhinoceros horn, ebony, amber, coral, aromatic products and perfumes. The sale of the luxury goods was still a government monopoly; only licensed dealers could buy them at government warehouses in Quanzhou, and to a lesser extent at Guangzhou, in fixed quantities and at fixed prices.

Licensed goods were acquired by the government as import duty (all duties were paid in kind, not in cash) or through purchase by the superintendent of merchant shipping. For this purpose he was allocated about 100,000 strings of cash a year in the late eleventh century, and 300,000 strings in the early twelfth century. Interestingly, the capital for this activity was obtained by taxing priests' diplomas. The returns on this investment were substantial; the Quanzhou office between 1128 and 1134 made a profit of 980,000 strings (Rockhill,1914: 421, n. 1.)

The government attempted to enforce an imperial monopoly over the import and possession of eight items: tortoise shell, elephant tusk, rhinoceros horn, a special kind of steel used for weapons, skin of a lizard used for making drums, coral, agate, and frankincense (Ma, 1971: 37-38). Nevertheless, indirect references suggest that the reality did not correspond very closely to the ideal which the laws sought to impose. Again, the records that were preserved obviously show a very inaccurate picture of what was actually going on.

2.2.3 The Currency Drain

Already in 1074 an official named Chang Fang-p'ing mentioned seagoing junks that were leaving China on their return voyage with full cargoes of cash, so that "the currency was drained off like the waters of the sea into the wei-lu" [literally, rear gate] (Rockhill, 1914: 422). By the mid-twelfth century, illicit trade in expensive merchandise was so great that Chinese smugglers were paying for all goods with gold, silver, iron, and especially copper cash, and this drain was causing the Chinese government serious concern. By 1159 only one-tenth of the money intended to be coined was actually cast. This discrepancy was generally attributed by official accounts of the time to illegal foreign sea trade.

In 1194 the governor of a military district in Fujian refused to allow people under his jurisdiction to go abroad to trade with foreign people "whose many ships coming from abroad laden with aromatics, rhinoceros horns, ivory and king-fishers' feathers were already draining all the copper cash out of the land." Sumptuary laws were passed repeatedly (in 1107, 1157, 1201, and 1214) against use of kingfisher feathers and gold for ornaments, but to no avail. In 1248, a "Censor, Ch'en Ch'iu-lu, attributed the drain of cash out of China to the extravagance of its people in purchasing such luxuries as perfumes, ivory, and rhinoceros horns, and to the sea-trade generally" (Rockhill, 1914: 423).

Thus sea trade was a double-edged sword; rather than providing additional resources for the state coffers, it seems to have had the opposite effect. This did not, however, prevent the rulers from dreaming that maritime trade might provide a solution to their serious financial problems.

2.2.4 The Southern Song Dynasty: Trade for Revenue

The ancient strictures on foreign trade maintained by the Chinese government began to weaken when, in 1126, the Song rulers were defeated by the Khitan nomads. When the northern heartland of China was lost to the invaders, the Chinese court escaped and moved south, to Hangzhou. The port of Quanzhou, the nearest to Hangzhou, eventually surpassed Guangzhou as the largest entrepot in China. Not only was the court now cut off from the overland route to the west, and conversely nearer to the centers of maritime trade with the South Seas; now the potential capacity of maritime commerce to augment the coffers of the kingdom—in order to defend the remnants of the Song lands against the northern invaders—became a matter of significant moment to the empire.

Thus official trade expanded, partly by design, in order to secure additional revenue. The Emperor Gao-zong in 1137 issued an edict on the subject, stating, "The profits from maritime commerce are very great. If properly managed, they can bring a million (strings of cash). Is this not better than taxing the people?" (Ma, 1971: 34).

In fact Gao-zong's projections were based on available statistics; in 1128 maritime trade had already yielded customs duties of 2 million strings of cash, which was 20% of the government's entire revenue.

With the establishment of the Southern Song Dynasty, there came a revolutionary development: for the first time in history, private Chinese were allowed, even encouraged, to go overseas to trade. The entire structure of the maritime trade system of the South Seas underwent fundamental changes as a result of this new policy. Status as an official tribute-bearing country was no longer a prerequisite for conducting commercial relations with China. Trade was freed from its link to diplomacy. The tribute system which had regulated contacts between Southeast Asians and Chinese declined significantly in importance.

Even the ostensibly aloof attitude of the nobility toward trade, behind which often lay a very different code of conduct, eroded significantly. "In the late Southern Song period, the relatives of the Song royal family were vying with private enterprises in Quanzhou.... They used their political status to toy with the maritime trade rules to earn much profit from maritime trade. Hence they were very unpopular with the merchant community" (Kwee, 1997: n 35).

The decline of the tribute system probably contributed significantly to political changes in the South Seas. In particular, the advent of Chinese merchants and shippers in Southeast

Asian waters broke down barriers that had fostered the prosperity of a few centralized trading ports. The empire of Srivijaya, based in south Sumatra, had received a severe blow from the Cola invasion of 1025; the appearance of Chinese ships in Southeast Asian waters probably sounded the old thallasocracy's death knell.

The upsurge in Chinese shipping activity did not, of course, mean that Southeast Asian society suffered economically as a whole; in fact the converse is almost certainly true. Numerous new port sites, marked by abundant shards of Song ceramics, date from this time, suggesting that prosperity probably increased for the Southeast Asians as commerce grew. Moreover, the new wealth was probably more widely distributed. New ports gave traders direct access to Chinese merchants, bypassing the Srivijayan rulers who would have raked off most of the goods in dues and fees.

The complexity of maritime trade in the early Southern Song is well indicated by an enormously varied inventory, dated 1141, which included 339 types of imports. The most important in terms of value as well as volume were still aromatics and drugs: frankincense, ambergris, liquid storax (a kind of resin), gardenia flowers, pucuk , myrrh, cloves, nutmeg, and sandalwood. These were not trivial commodities; they were commonly used for a wide range of purposes. In addition to their religious uses, various kinds of aromatics were needed in the household to perfume clothes and bathwater and serve as wall decorations and in the preparation of food. One of four imperial warehouses was used solely to store incense and aromatics.

By late Song times, traders had to file official forms specifying destinations and needed guarantors "who assumed full responsibility in case the traders violated the trade laws." Crew members of trading ships usually engaged in small-scale maritime trading. They were organized into 5-member units, and had some sort of "papers" issued for them (Kwee, 1997: 16).

Some Chinese had probably been residing in Southeast Asia before 1126, but it is unlikely that any accurate accounting of them will ever be made. Since it was potentially a capital offense to disobey the laws against private overseas trade, those who flouted the law would try to ensure that their acts would not be recorded. One of the earliest pieces of evidence that Chinese were living overseas for long periods appears in 1150, when a Chinese and some "dark natives" were shipwrecked, apparently while trying to sneak back into China. The Chinese had lived in Indonesia for a long time and had an Indonesian wife (Hirth, 1917: 76).

As might be expected from the clandestine nature of the early trade and the intensity of the smuggling practiced even after private trade was no longer an offense, little documentary information exists to illuminate the conditions under which early Chinese shipping was conducted.

2.2.5 Chinese Ships of the Song Dynasty

Of the few details that can be adduced, one is that ship captains were given a *qu-qi* ,or "vermillion pass", on which was written his name and that of his first mate, the number of passengers, and the size and type of his ship. Ships had about ten oars, each worked by four men, as well as sails. The sailors were armed against pirates, with bows and arrows. Ships had two anchors at the bows. There were no cabins; each passenger was allotted a certain amount of deck space. Zhu Yu of the Song period described merchant ships at Guangzhou:

> The ships were several hundred feet long, and wide. Merchants divided space in the ships for stowing goods, each getting several square feet of floor space, while they slept above. Most of the goods were ceramic vessels, one placed within another according to size with little space between...." (Quoted in Li Zhiyan and Cheng Wen, 1989: 102).

The main vessels towed behind them a small boat used when landing. In the early twelfth century the magnetic compass began to be used, but texts describe another method of navigation which made use of a hook on a long rope to bring up mud from the sea bottom, which captains used to smell and inspect to determine their position (Wang, 1958).

Maritime archaeology is just beginning to contribute new insights into the physical conditions of the early Chinese maritime trade activity. In May–July 1995, an expedition based on preliminary work in 1990 investigated a shipwreck just north of Fuzhou, in the Dinghai area. The majority of artifacts recovered (69%) were porcelains. There were also two concretions of iron. Remains of ship timbers still existed; more excavations are planned, which may shed much more light on the subject.

A shipwreck at Ningbo, contemporaneous with Bai Jiao, has also been discovered. Another ship dating from the Song dynasty was found at Quanzhou and excavated in 1974. It had a deep v-shaped bottom, a true keel, and a stern rudder. The Quanzhou ship was 34.6 meters long, 9.82 meters wide, and displaced 374.4 tons, making it as large as any merchant vessel then known in the West.

2.2.6 Southeast Asian Markets

As has been noted earlier, some Southeast Asian societies had already become accustomed to the use of currency before the end of the first millennium. Of these societies, the most comprehensive data indicating a highly monetized economy comes from Java. Taxes in Java were expressed as money, not as a proportion of the harvest as was still current practice in India, for example. Irrigated rice land, orchards, and houses were privately owned and could be sold, although rights to land not under continuous cultivation were still vested in the village as a corporate body.

Most villages had periodic markets. Market officials are mentioned in the oldest Javanese inscriptions from the eighth century (Christie, 1992). The inscriptions also describe two levels of economic activity: one level was part-time (probably); activities in this category included dye-making, dyeing, weaving, some pottery making, sugar making, and bamboo mat making. These occupations were probably conducted as sidelines when the agricultural cycle or local resources made them feasible.

The second level of activities concerned specialized traders and craftsmen, who could choose where to live for economic reasons; they were mobile. These people were termed *masamwyawahara*, "those who carry on commerce." Some were middlemen somehow connected to an international network, dealing in imported produce, including tin and other metals, but they also sold rice. This suggests that there was a relatively large number of people who bought food on the market.

How did the long-distance maritime trade network interact with the local distribution system? Sadly, the Javanese sources are no more helpful in answering such questions than the Chinese. Once more we must turn to archaeology, and once more we find that very little data has been collected. The only important class of Chinese artifact for which distributional data has been collected in Java is porcelain, and only one regional study has so far been conducted: in north-central Java. In a study conducted by a Dutch scholar in the 1940s, Song pottery was found at over 20 sites in Rembang, and in more than a hundred sites in the neighboring regencies of Semarang, Grobogan, Demak, Jepara, Pati, Kudus, and Blora. The distribution pattern seems to be correlated with settlement areas and transport routes.

The data indicates that, by the eleventh century, pottery in the area of north-central Java surveyed by Orsoy de Flines (2,500 square kilometers) was distributed by some sort of integrated marketing system. The north-central pattern contrasts with the pattern so far detected in a haphazard fashion for the Tang dynasty ceramics found in south-central Java; most of the finds of Chinese porcelain there are associated with temple sites. There are, however, several different variables that might account for this, including different functions for the pottery, lesser importance attached to ceramics in the Tang, different geographical areas, and different settlement patterns, and so on. So much more information on the distribution of Chinese imports in Southeast Asian sites must be collected before the possible effects of changing Chinese involvement in maritime trade on the Southeast Asian society and economy can be observed and disentangled from other subsystems evolving at the same time.

2.3 Trade Interaction During the Yuan Dynasty (A.D. 1260-1367)

2.3.1 Introduction

Although a fugitive Song court managed to survive for another 19 years, until 1279, for all practical purposes the Yuan Dynasty began in 1260, when the Mongols largely completed the conquest of China. If Chinese economic history can be said to be neglected, the economic history of the Yuan has been positively ignored. Only one English-language study has been devoted to the foreign trade of the Yuan, and that work, Schurmann's *Economic Structure of the Yuan Dynasty* (1956), contains only one chapter on maritime trade. Yuan trade has also been largely neglected in Chinese-language sources. A 1955 study by Fang Hao is still the main work, though its conclusions are now outdated (Kwee, 1997).

Chinese sources tend to conflate the Song and Yuan, so that details about the Yuan are often obscure or contradictory. Fang Hao, studying Sino-Western interaction in general, argued that foreign trade during the Yuan was stunted by monopolizing acts of the Yuan government, that big merchants were suppressed, but that nevertheless trade increased compared to the Song!

Chen Gao-hua has suggested that Yuan foreign trade was conducted mainly by sea rather than overland (Kwee, 1997: 2, n. 3), a view that contradicts Reid's generalization (1993:10). He makes the assertion, briefly treated, that the maritime trade reached a peak in Yuan; so does Schurmann, also without substantiation. Li Donghua (1984) argued that maritime trade in Quanzhou during the Yuan was more prosperous than in the Song, but, once again, offered no evidence (Kwee, 1997: 2, n. 4).

However, anecdotes indicating the wealth of Quanzhou are plentiful. We know, for instance, that the son-in-law of the superintendent of trade at Quanzhou, who died in 1293, had 80 seagoing ships and 130 pikuls of pearls (Wheatley, 1959: 29).

Such indirect evidence does support the idea that the trade expansion characteristic of Song times continued to accelerate during the Yuan Dynasty. Moreover, Yuan sources show clearer distinctions among various maritime territories. Such terms as East and West Seas (*Dong-xi-yang*), Bigger East Sea (*Da-dong-yang*), Little East Sea (*Xiao-dong-yang*), and Little West Sea (*Xiao-xi-yang*) first appeared. These are obvious signs of increasing Chinese familiarity with the maritime world.

Other sources of indirect evidence must suffice to estimate the nature of the expansion of Yuan trade, no statistics having survived. Schurmann (1956: viii; cited in Kwee, 1997: 5-6, n. 13) observes that "not all the important economic institutions of the Yuan are covered [in the *shi-huo-zhi* section of the *Yuan shih*]...nothing on tenancy, private commerce, stores, pawnshops, and manufacturing. None of these institutions directly concerned the government, although they are important in the economic history of China; only those of direct interest to the government such as taxes, land survey, maritime grain transport, and monopoly taxes are treated."

One text, the *Da-de-nan-hai-zhi*, states that there were "many treasures" in the Yuan Dynasty, many times more than previous dynasties (Kwee, 1997: 3, n. 7). According to Chen Gao-hua (1991), there were more than 160 types of maritime goods in the Southern Song, but more than 220 types in the Yuan (Kwee, 1997: 4, n. 9). The number of foreign polities trading with China, as well as the variety of produce in China, increased during the Yuan.

By way of interest, a rare instance of the use of maritime trade as a poetic theme occurs in the work of Sung Pen in the early fourteenth century. "The foreign ships have sailed away from their anchorage. Year after year they come as if the seas were always tranquil...In the sixth month when the south wind blows they come, and we greet them with wine and music. Is it not a joyful occasion?" (Wheatley, 1959:3).

2.3.2 Yuan Government Interests in Maritime Trade

The Yuan established their first maritime trade office in 1277 at Quanzhou, the most prosperous port of the late Song. "Every year, an invitation was to be extended to foreign traders to trade in China" (*Yuan shih, juan* 94; Kwee, 1997). Three more were established shortly thereafter: at Ningpo (King-yuan), Shanghai, and Kanfu (near Hangchou, Polo's Ganfu). By 1293 there were seven. "So much emphasis was placed on revenue from maritime trade that even monks, who were often granted privileges, were not exempted from taxes."

The Yuan, being Mongols, lacked the ancient Confucian prejudice against trade. Thus it is not surprising that they liberalized the system even further than the Song emperors had done. Official veneration of Ma-zu, Goddess of the Sea, increased. In 1278 "officials memorialized the throne's calling attention to the importance of encouraging trade relations with the peoples of the south-eastern [or southern and eastern] islands, all of whom, the writers declared, were filled with the most loyal devotion to China" (Rockhill, 1914: 429). In 1279 an envoy was sent to Java. In 1282 an envoy from Java came to China with a shrine of gold as tribute.

The Yuan in 1284 actually instituted a policy of government investment in maritime trade. The prefects of Hangzhou and Quanzhou chose certain persons to go abroad to conduct trade, providing them with ships and capital. Net profit was distributed according to a formula of 70% for the government, 30% for the trader. Seagoers and families were exempted from corvée. This policy was resented by big merchants; its main objective seems not to have been to stimulate trade but to prevent a few large mercantile families from becoming dangerously powerful by making it possible for more small operators to compete with them. This new form of government involvement in maritime trade may reflect the traditional symbiotic relationship between the *ortogh* and the Mongolians in their original homeland in the steppes. *Ortogh* ("partners" in Turkic) were commercial groups, consisting largely of central Asiatic Muslim merchants, who became a leading class under the Yuan; extensive government funds were loaned to them for commerce and usury (Kwee, 1997: n. 41). Under the Yuan government, more Muslim tombstones were erected in Quangzhou than during the Song.

The government even went so far as to forbid the use of private capital in foreign trade (Rockhill, 1914: 425). However, "The efforts of the government to prevent private trading must have failed signally, for in 1303 we learn that the prohibition against private sea-trading was repealed..." (Rockhill, 1914). By then the Yuan government had instituted a maritime trade tax, in 1292 (Kwee, 1997: 15, n. 46), and by 1295 smuggling to avoid the tax and to export forbidden goods such as bronze coinage was so rampant that officials were sent out to sea to examine ships.

In the late Yuan period the pendulum of official attitudes toward commerce swung back and forth. The offices of maritime trade were closed in 1294, but reopened later the same year; closed in 1303, reopened in 1308; closed in 1311, reopened in 1314; closed in 1320, reopened in 1322. The reasons for these closures are never given in the sources. Scholars have suggested that political reasons, such as the fear that rich merchants might turn against the state, were responsible, but it is also possible that these actions were meant to penalize private traders who violated trading laws. There are references to "22 rules of Yuan trade." In an interesting theory, Chen Gao-hua has argued that the prohibitions may not have been all that significant, for there is evidence to suggest that foreign traders still came to Shanghai when the office of maritime trade there was closed.

2.3.3 The End of Tributary Trade

In 1326 the Tai-ding emperor renounced tributary trade. "In 1329 the presenting for transmission to Court of expensive and useless objects, all of which had to be paid for at regulated prices and which were now held to be but a canker devouring the riches of the state was strictly forbidden."

The Yuan were more expansionist than the traditional Chinese empires had been. They fought numerous battles on the Southeast Asian mainland, with Vietnam, Champa, Cambodia, and Burma, often to attempt to force the Southeast Asians to accept a more formal degree of submission to their overlordship than the Chinese had ever required in the context of the "tributary trade."

In 1292 the emperor, Khublai Khan, decided to send a large expedition to Java to avenge a mutilation of his envoy. The naval expedition was placed under the governor of Fujian, using ships requisitioned from private traders, there being no formal Chinese navy. In 1293 the fleet sailed from Quanzhou, but the expedition became embroiled in a confused political situation in Java, was ultimately betrayed by an erstwhile Javanese ally, and sailed back the same year. Khublai Khan died in 1293, and relations with Java soon returned to normal; Javanese missions arrived at court in 1298 and again in 1300.

2.3.4 Chinese Trade in the Moluccas

One of the more interesting questions about Southeast Asian commerce in the Yuan period concerns the breadth of the area over which Chinese sailors actually ranged. One of the prizes of the maritime trade—one which attracted such early explorers as Columbus—was access to the mace and cloves of the Spice Islands, the Moluccas. Some authors have argued that the Chinese actually reached the Moluccas as early as the Yuan Dynasty, while others have rejected this idea.

The Yuan dynasty author Wang Dayuan (Rockhill, 1914: 259–60) and early Portuguese sources say that Chinese traders once visited Ternate and Tidore to buy cloves.

Barros held that the Moluccans lived like savages until Chinese junks began to arrive to buy their cloves, providing in exchange the Chinese cash that became their major currency. Eventually "the Javanese also responded to their commerce, and the Chinese stopped coming" [Joao de Barros, *Da Asia*, 1563, Dec. 3, livro 1, 576–79]. Other Portuguese, Spanish, and Dutch sources report similar stories circulating among the Ternatans. Galvao, one of the earliest and most careful of these, concedes that the Ternatans differed as to whether the first junks arriving for cloves were Chinese, Malay, or Javanese. "Most of them incline towards the view that it was the Chinese, and that seems to be the truth" (Galvao, *A Treatise on the Moluccas* [c. 1544] in Reid, 1996, n. 20).

But by the early fifteenth-century Ming period, there is no indication of direct Chinese sailing to the Moluccas. What happened?

Reid (1996) suggests that Majapahit incorporated the Chinese sailors, by then largely resident in Southeast Asia and in the process of becoming absorbed into the local populations, into the Javanese shipping industry. "'Chinese' merchants may no longer have been reported as making the voyage between Java and Maluku because they ceased to be identified as such. The confusion of Ternatans as to whether the early traders were Chinese, Malays, or Javanese was probably justified." This is plausible, but not completely convincing. The early fifteenth-century Ming voyages under Zheng He were Muslim-led, so it seems likely that some knowledge of this ancestry would have been communicated to them. It also creates the implication that the Javanese were less aware than Chinese of the routes to eastern Indonesia. Another possibility is that the early Ming prohibition against foreign trade severed the China-Moluccas connection.

2.3.5 Chinese Communities in Southeast Asia

Our first written confirmation that some permanent communities of Chinese in Southeast Asia had formed comes from the author Wang Dayuan, a trader who spent a number of years in Southeast Asia in the late Yuan period. He mentions two such communities but does so in such an offhand manner as to suggest that they were so common that they did not deserve special attention. In one case, he reports that some Chinese from the Yuan dynasty fleet, on its way to attack Java, were shipwrecked, fell ill, and had been left behind on Goulan Shan (possibly the island of Gelam, off southwest Borneo). In his day, 40 years later, some men (or their descendants; "over 100") "live mixed up with the native families" (Rockhill, 1914: 261). A second reference to overseas Chinese appears in the context of his description of the Longya men, at "Dragon's Tooth Strait," the western entrance to Keppel Harbor, Singapore. That location was known as a particularly dangerous pirate lair. From his account some Chinese lived there, although it would seem more likely that they were resident at Pancur, his name for the settlement on the Singapore River, about 8 kilometers away. By the early fifteenth century, several other communities existed in Sumatra and Java; it is likely that their roots go back at least to the end of the Yuan, for the installation of the Ming Dynasty in 1368 was accompanied by a total ban on Chinese emigration.

2.4 Trade Commodities

2.4.1 Historical Sources

There are few sources which contain usable information on China/Southeast Asia trade of this period, largely due to the official prejudice against commerce even during the relatively free atmosphere of the Song and Yuan Dynasty. The *Ling Wai Dai Da, "Information on What is Beyond the Passes,"* by Zhou Qufei (1178), has been lost but was quoted by later sources. The oldest well-preserved text was written by the harbormaster of Guangzhou, Zhao Rugua, *Zhu Fan Zhi, "Records of Foreign Peoples,"* in 1225. He did not leave China, but accumulated his information by interviewing sailors. The most interesting text is the *Dao Yi Zhi Lue* [DYZL], the "Description of the Barbarians of the Isles" written by Wang Dayuan, cognomen Huan-chang, a native of Nanchang in Jiangsi, in 1349. This is the first in-depth account of Southeast Asian trade written by an eyewitness. Another important Chinese reference work on Southeast Asian commerce was written by Ma Guan, entitled *Ying-Yai Sheng-Lan* [YYSL], "A Comprehensive Survey of the Shores of the Ocean," probably written between 1425-1432, by an otherwise unknown Chinese Muslim who knew foreign languages and went as interpreter and recorder with the 1413 expedition of Zheng He. The *Xing Cha Sheng Lan [* [XCSL] or "Description of the Starry Raft," was written by Fei Xin in 1436; he made several voyages with Zheng He, in an unknown capacity.

Before the Southern Song, aromatic woods and resins were the most sought-after Nanhai products. During the Southern Song and Yuan, demand expanded to include bulk commodities such as pepper and a wide range of other commodities listed in the texts referenced above. The lists cannot be taken as comprehensive, however. In Wang, for example, the equivalent of “et cetera” appears at the end of the lists of trade goods. Some ports, e.g., Hua-mien, associated with the Batak area of north Sumatra, are identified as stops for provisioning only, not as trading ports. Here the ships would purchase cattle, sheep, fowls, ducks, betel nuts, sugarcane, sirih leaves, and cotton. The shippers would barter iron bars, blue cotton cloth, coarse bowls, and Quzhoufu porcelain.

The Chinese authors sometimes were mistaken about which products were local and which were re-exports. Zhao, for example, knew that Srivijaya was a great source of Arab products such as pearls, frankincense, rosewater, gardenia flowers, myrrh, aloes, asa-oetida, etc. (Hirth and Rockhill, 1911: 61). In other cases errors due to the inability to distinguish between exports and re-exports have crept in.

2.4.2 Commodities Traded Within Southeast Asia

Following is a list of commodities traded between various ports in Southeast Asia as noted in the above-mentioned sources. Some are Chinese products, while others are goods carried by traders from outside the region.

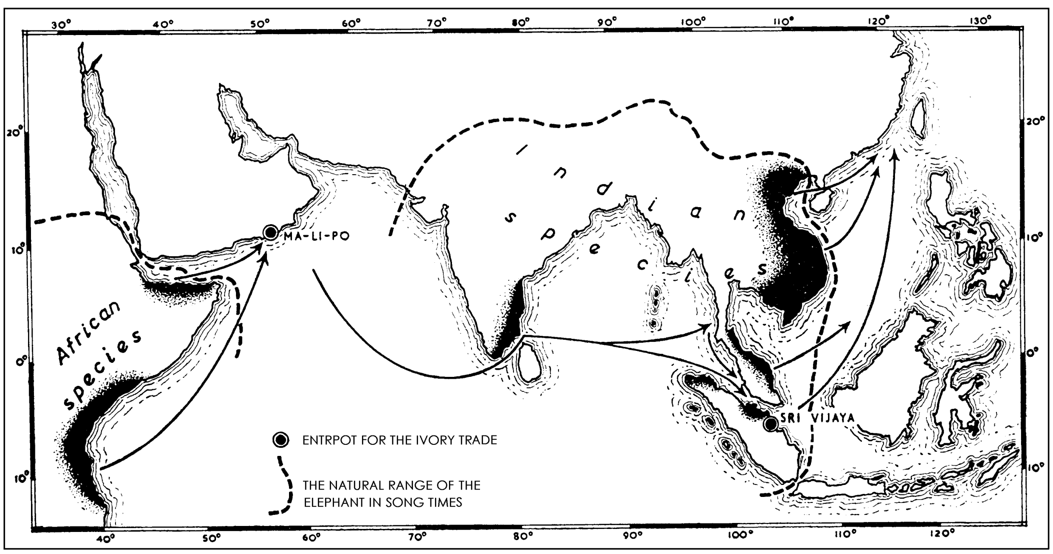
Glass beads	Coral beads	Cotton
Taffetas	Damask	Chintz
Silk	Satin	Patola cloth
Brocades	Muslin	Gold
Silver	Mercury	Borax
Tin	Betel nuts	Cowrie shells
Salt	Spirits	Lacquerware
Musical instruments	Wooden combs	Pepper

Rosewater	Camphor	Gypsum
Alum	Brimstone	Sulphur
Rhinoceros horns	Hides	Ivory
Tortoise shell	Iron	Laka wood
Sapan wood	Gharu wood	Rosewood
Sandal wood	Calambac wood	Cardamon
Kingfishers' feathers	Dragon's blood	Gems
Rattan	Beeswax	Ambergris
Pearls	Coconuts	Nutmeg
Cloves	Mace	Pandanus
Mats		

2.4.3 Commodities on the Java Sea Wreck

The two main commodities, iron and ceramics, are treated in Sections 8.0 and 9.0, respectively.

2.4.3.1 Ivory



Sources of ivory and routes for the ivory trade during the Song dynasty.

Wild elephants were still found in south Fujian until A.D. 1050, and in Yunnan until A.D. 1388 (Arasaratnam, 1991). However, ivory was imported to China from at least as early as the tenth century as a major item of tributary trade. Northern Vietnam sent large quantities on nearly every mission. In the year 980, "100 tusks of ivory" were sent; in 1164, "30 pieces of ivory tusks"; and in 1177, "70 ivory tusks." In 1173, 11 domestic elephants were sent to China as tribute. Champa (central Vietnam) sent 168 ivory tusks in 1155. The Srivijaya empire of southern Sumatra sent 87 tusks weighing 4,065 katis in 1156, and a further 60 tusks in 1178. Ivory was sent from as far as Africa via Arab traders. The Abbasid dynasty of Arabia sent "209 pieces of big ivory tusks" in 1131 (Wong, 1979). Ivory, according to Zhao, came from Annam, Red River, Cambodia, the east coast of the Malay Peninsula, Sumatra, and Java (the latter lies outside the elephant's range and in reality must have re-exported ivory).

Whilst the primary cargo on the Java Sea Wreck was iron and ceramics from China, the ivory cargo strongly suggests that the ship stopped at a port, or ports, along the route from China to Java for secondary trade. The ivory may have come from Vietnam, Thailand or Sumatra.

2.4.3.2 Resin

Damar is the Malay name for a wide range of resins. The resin recovered from the Java Sea Wreck has not been identified. There are, in fact, over a thousand species of resin-producing plants in Southeast Asia, so identification is problematic. The most commonly traded resin was *Styrax benzoin*, which is tapped from a species of tree that occurs in Sumatra, Malaysia and western Java, but it was only cultivated in Sumatra. Ibn Battuta mentions it as a product of Sumatra in the fourteenth century. Wheatly (1959: 55-59) mentions that benzoin was being traded north to China by the eighth or ninth centuries A.D. Zhao says it was imported from Cambodia, and shipped to China in porcelain [stoneware?] vessels. Wang surprisingly does not mention it at all. The YYSL lists it only as a product of Malacca.

Throughout Asia, resin was burnt as an offering, or as a way of calling certain spirits to the aid of a healer. In Malay culture it was important for rice planting and reaping rituals in which the supplicant is trying to coax the rice spirit to stay and allow an abundant harvest.

The presence of resin as an item of cargo on the Java Sea Wreck is very clear evidence of secondary trade during the voyage from China. And a port in Sumatra is the most probable candidate, possibly the same port at which the ivory was loaded.

2.4.3.3 Glass

This material was mentioned as an import to China in A.D. 80 in the *Han Shu*; collected by "chief interpreters attached to the Yellow Gate [eunuchs serving in the palace] who go to sea with the men who answer their appeal [for a crew] to buy bright pearls, *pi-liu-li* [opaque glass], rare stones and strange things, taking with them gold and various fine silks to offer in exchange." (Wang, p. 19).

Zhao found Arab glassware better than Chinese glass because it was heat resistant, less brittle, and sometimes decorated with engravings. He says (p. 227) "Liu-li [glass] comes from several of the countries of the Ta-shï. The method followed in melting it is the same as that of China, that is to say, it is made by burning oxide of lead, nitrate of potash, and gypsum. To these materials the Ta-shï add southern borax, which causes the glass to be elastic without being brittle, and indifferent to temperature, so that one may put it in water for a long time without spoiling it. It is, therefore, more valuable than the Chinese product." A seventh-century source says that Funan ships brought glass mirrors to China (Hirth and Rockhill, 1911: 228). Idrisi the Arab mentions the manufacture of glass in China, at Khanfu, Hangzhou.

A tributary mission to China in 1156 brought West Asian ceramics, 4 glass vessels of Arabian sugar, and 16 glass vessels of Arabian dates. In 1178, 4 glass vessels of foreign sugar, 3 glass vessels of foreign dates, and 4 glass vessels of gardenia flowers were brought (Ho Chuimei, 1994).

X-ray florescence analysis of the few glass objects found on the Java Sea shipwreck indicate that they came from two origins. A dimpled glass base of a vessel, similar to a

European onion bottle, is clearly of Chinese manufacture (see Section 7.10). There is only one reference in Zhao to Chinese glass exports: beads and bottles were sent to Borneo. In the DYZL, only glass beads are listed as having been exported. A large quantity of Chinese glass fragments of bottles and other containers has been found in a fourteenth-century site in Singapore. A very few intact examples of the same period have been recovered from burial sites in Riau. It seems that other than beads, however, Chinese glass was not a common export during the Song-Yuan era. In a recent study by a Chinese scholar (An, 1996), the author only discusses the trade of glass into China, and does not mention any exports.

Analysis of a fragment of crumbly green and yellow glass from the wreck indicates that it is almost certainly not of Chinese origin (see Section 7.10). While there is no firm evidence of glass manufacturing from primary materials anywhere in Southeast Asia during the pre-modern period, it is strongly suspected that the Javanese in the late first millennium A.D. engaged in this activity. If this fragment was not from India or the Middle East, it may have been made in Java.

2.5 The Monetary System

2.5.1 The Monetization of China

The economy of China began to be monetized after the An Lu-shan Rebellion in A.D. 755. For making bronze, China had to import tin, but domestic deposits of copper were relatively numerous. Of China's copper producing districts, five or six were located in the Khitan (northern) area, 26 in the southern Song area. The Khitan and Xixia kingdoms used Song coins rather than minting their own. During the northern Song period there were over 100 Chinese copper mines in production. A gradual shift of copper mining centers from Fujian and Guangdong to Hunan can be observed; this is probably due to the exhaustion of the earlier mines (Ch'en, 1965: 615).

In China, copper was used for two competing purposes: to cast ceremonial and household goods; and as money. The government tried to restrict the private use of copper; an edict of A.D. 960 by the last emperor of Later Zhou stated that "apart from ceremonial objects and weapons and such articles as bells, cymbals, and handbells used in temples, other copper ware and statuettes must be surrendered to local officials within 50 days at an estimated price. Those who fail to obey will be punished by death if the amount of copper secretly kept at home exceeds five catties." The same proclamation was repeated in 969 and again in 977.

"Because of the acute shortage of the metal, in the 976–83 period people were digging up copper articles from ancient tombs or destroying Buddhist statues in order to obtain copper for illicit minting" (Ch'en, 1965: 617), and an edict issued in 991 "forbidding people from melting down coins for manufacturing purposes" acknowledges the problem.

After a period of relative balance between supply and demand for copper, the problem arose again in the mid-twelfth century. To set an example, the emperor in 1154 gave the mint 1,500 bronze articles from his palace collection to melt down. In addition, 2,000,000 catties of bronze items were procured from the people. Brass and bronze items used in temples had to be registered and were subject to tax (Ch'en, 1965: 618).

The issue of coins in China can be plotted for some years. The following table (from Ch'en, 1965: 619, table 3) gives some data for the numbers of coins minted in particular periods.

Tang Dynasty:		Northern Song:		Southern Song:	
742–56:	327,000	995-8:	800,000	1131:	80,000
804–05:	135,000	1000-1:	1,350,000	1132-3:	100,000
820–21:	150,000	1007-08:	1,830,000	1155:	140,000
834–5:	100,000	1016-17:	1,250,000	1156:	220,000
		1021-2:	1,050,000	1157:	230,000
		1023-32:	1,000,000		
		1041-9:	3,000,000		
		1049-54:	1,400,000		
		1064-8:	1,700,000		
		1073-4:	6,000,000		
		1080-1:	5,949,234		
		1106-7:	2,890,000		
		1124-5:	3,000,000		

"The Southern Song suffered almost continuous inflation. The smallness of the figures is due to the exclusion of 'big coins', iron coins, and paper notes. In a period of serious copper shortage the standard cash could have been issued only in small quantities" (Ch'en, 1965: 619-620). A process of debasement can also be detected in Song coins (Ch'en, 1965):

Copper content of Song cash:		
	976:	65.5%
	1019:	64.5%
	1035:	60%
	1135:	60%
	post-1135:	54%

An alloy known as dan-tung, essentially a copper sulphate solution, was also used to copper-plate iron coins.

For Southeast Asians before the twelfth century, Chinese coins represented no more than a convenient source of bronze. As early as 1074 an official complained that cartloads of coins were crossing China's frontiers. The Song tried to push the export of silk as a way of offsetting the unfavorable balance of trade. Between 1160 and 1265 the export of cash was forbidden ten times, Java being specifically mentioned once. In addition to repeated injunctions against the export of coins, in 1293 private trade in gold, silver, ironware, military equipment, and so on was forbidden. In 1296 the export of gold and silver was again forbidden.

Another instructive set of quantitative data concerns the edicts that sought to stem the hemorrhage of coinage from China. The list shows that during the Song Dynasty the main sources of the leak shifted from the north to the south border.

Locations cited in injunctions against coin exports issued during the Song Dynasty (Ch'en, 1965: 621):

<u>Year/Prohibited area</u>
960 - north of Great Wall, southern barbarian regions
970 - all barbarian regions
1041 - outside the empire
1085 - outside the empire
1091 - outside the empire

1165 - outside the empire
1178 - outside the empire
1182 - Guangzhou, Quanzhou, Mingzhou, Suzhou
1198 - all seaports
1212 - all Yangzi ports
1216 - only iron coins allowed in frontier area
1234 - all seaports
1244 - all seaports
1250 - all seaports
1252 - all seaports
1253 - all seaports

The Southern Song began issuing paper money in 1121, but because it was not secured by metallic reserves it became greatly depreciated. Khublai Khan also began to issue paper money in 1260. This paper money made its way to such distant places as Wutieh in India, according to Wang Dayuan.

2.5.2 The Monetization of Indonesia

The economy of Java began to be monetized around the same time as that of China. Silver coins with a design based on the sandalwood flower motif originated in central Java, perhaps around A.D. 800, and spread from there to Sumatra and the isthmian area of the Malay Peninsula. At least one example has been found as far away as Fostat, Egypt, in a twelfth-century context. It is not known when Srivijaya in south Sumatra began to issue coinage; no specimens of native coinage have been reported from the vicinity of Palembang, but Palembang has been very cursorily excavated. Three gold sandalwood-flower coins were found at a temple site at Muara Jambi, as part of a foundation deposit that probably dates from the eleventh or twelfth century.

According to the DYZL, in Java they cast coins of an alloy of silver, tin, lead, and copper, "the size of a section of a small conch shell. They are called 'silver coins,' and are used in business transactions in exchange for [Chinese] copper cash" (Rockhill, 1914: 237).

Silver coins are rare in Sumatra, in contrast to Java. The only significant discovery of silver coins is a cache of 79 found at Krui, Bengkulu, in 1904 (Wicks, 1985: 219). Other major finds of sandalwood flower coins, at Barus and Bengkulu, have been of gold.

Tin coins were used in Sumendala, Aceh (YYSL). The tin coins were the main currency used in trading, but they also cast gold coins called dinar. The Hsi Yang Chao Kung Tien Lu says in a note that "They cast a coin of pale gold an inch and 5 tenths in diameter and on both sides of which there are designs. It weighs 3 candareens 5 li. One authority says that 48 of them is equal to one tael four candareens in gold." (Rockhill, 1914: 154, n. 1.)

In 1079, a Srivijayan embassy was given 64,000 strings of cash. These do not seem to have found their way into circulation, however; they were probably melted down and used for some other purpose.

Sometime within a few years of 1300, the Javanese adopted Chinese copper coinage as an official medium of exchange, a landmark in the interaction between the internal economy of Indonesia and its links with China. Chinese coins had already been in use as money in a few ports in Sumatra and elsewhere in Southeast Asia as much as a century earlier, but the conversion of the Javanese economy can be viewed as a significant watershed in the evolution of Southeast Asian society.

Monetization had perhaps reached a stage beyond which it could not evolve further without an efficient base-metal coinage, which Chinese money was able to provide. The amount of Chinese coinage in Southeast Asia must have been considerable. The Javanese inscriptions shift almost overnight from quoting monetary amounts in Javanese currency to Chinese picis. Nevertheless, Wang Dayuan in the late Yuan mentioned that, in his day, Chinese coins were routinely exchanged with native coins (Rockhill, 1914: 236), so native coins must still have been in circulation.

The coming of Islam to Sumatra in the early fourteenth century introduced a new form of coinage. "By the early fifteenth century this coinage would become the commercial and accounting standard throughout island Southeast Asia, a position it maintained for more than two hundred years" (Wicks, 1993). Chinese coins no longer formed the basis of trade.

3. ARCHAEOLOGICAL PROGRAM *by Michael Flecker*

3.1 Archaeological Objectives

The primary archaeological objectives of this project were to document as much of the wreck site as possible, commensurate with actual site conditions, and then to use that documentation and follow-up research to assign the shipwreck a place in history.

A preliminary investigation of the wreck site indicated a primary cargo of iron and Song Dynasty ceramics. Before the excavation commenced, research was undertaken to discover more about thirteenth-century trade throughout Asia, as well as Chinese and Southeast Asian shipbuilding techniques at the time. By knowing what to expect in terms of artifacts and hull structure, excavation, documentation, conservation, and storage could be planned with specifics in mind. Actual finds always differ to some extent from expectations, but it is a worthwhile exercise to find out as much as possible about a site before it is disturbed.

Once a wreck site is excavated, there is no going back. Any information not recorded is lost forever. The two most important details to record before an artifact or structural element is moved are position and context. With these, and a good understanding of site conditions, the site can be reconstructed on paper, with a computer, or by modeling to determine cargo stowage patterns, vessel layout, construction techniques, crew and passenger dispositions, and the wrecking process.

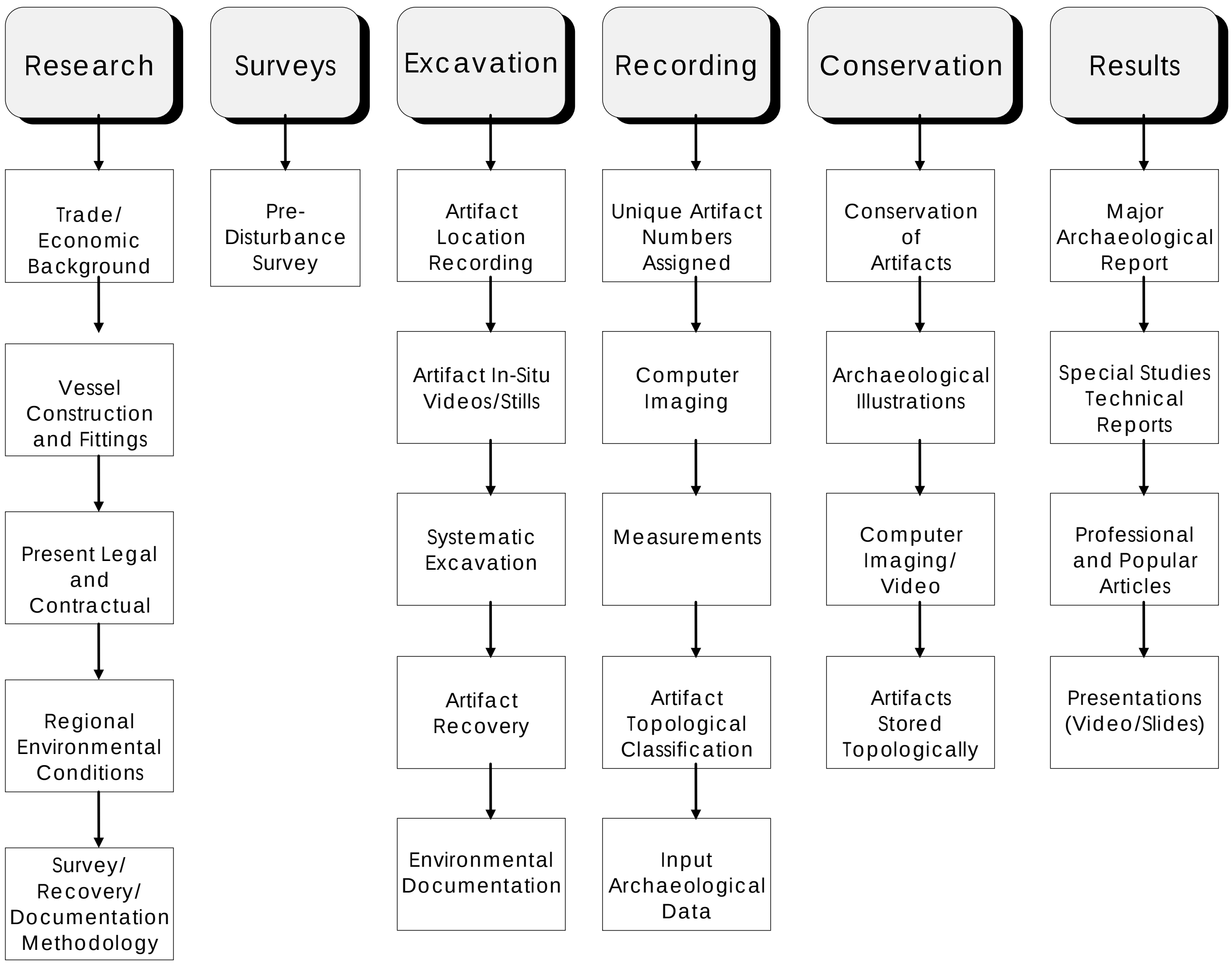
On a well-defined and undisturbed site it is desirable and often feasible to plot precise positions for all significant artifacts. Unfortunately, the Java Sea Wreck site was highly disturbed, largely by the natural wrecking process, as described in Section 5.0. It would have been an impossible task to record the individual positions of tens of thousands of ceramics spread over an area of 70 x 55 m. Instead, the area was divided into 5 x 5 m grid-squares (134 in total) and ceramics positions were recorded by grid-square.

Apart from a few fist-sized chunks of eroded wood, nothing whatsoever remained of the ship itself. In its place were massive iron concretions that concreted together before the hull disintegrated. All that could be learned of the ship's layout had to be gleaned from the configuration of the iron concretions. As a result, they were photographed, videotaped, measured, and (in very small areas) carefully dissected. A photomosaic was also constructed, but due to changes in vertical relief and mediocre visibilty, it cannot be interpreted quantitatively.

Scatter of ceramics on the seabed prior to excavation.

The artifacts themselves must be stabilized and conserved. It is the artifacts that provide so much information on trade patterns, ancient technology, cultural interactions, life on board, and life in general at the time of the loss. The artifacts and their constituent materials were studied in detail. Follow-up research was undertaken. Much was learned, as detailed in the following sections.

TABLE 3.1 ARCHAEOLOGICAL PROCEDURE FLOW CHART

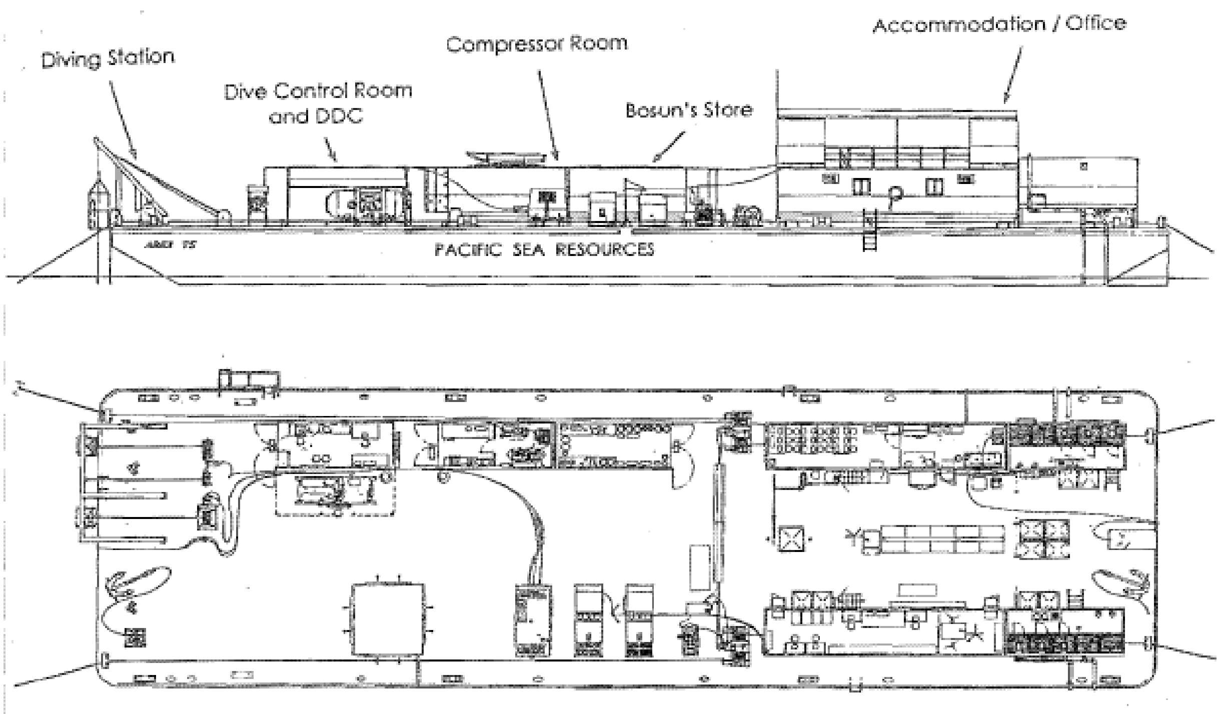


Pacific Sea Resources

3.2 Recovery Vessel and Diving Systems

3.2.1 Recovery Vessel

The 53 m long accommodation/dive support barge, *ABEX TS*, was hired for the excavation. This barge with its spacious covered accommodation area, ample deck space, and high-capacity water and fuel tanks was an excellent work platform for a two- to three-month project with minimal shore support.



General arrangement of DSB, ABEX TS.

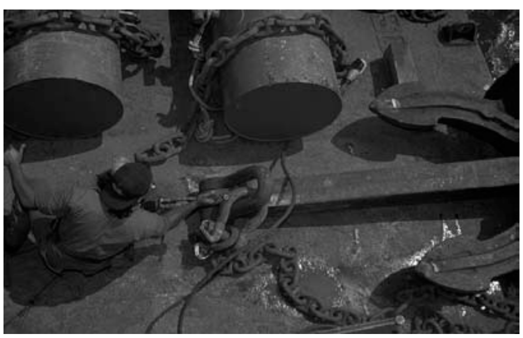
The accommodation area consisted of sleeping quarters for up to thirty personnel, two ablution cabins, a galley and mess, a dry-store container, and a large office. The office housed the computer and video systems used for data recording, together with the charts and drawings needed for the day-to-day monitoring of excavation work. An SSB radio installed in the upper-level accommodation provided a worldwide communications link via Jakarta and Singapore Radio. Forward of the accommodation were the permanently installed bosun's store container, compressor/workshop container, dive chamber/control panel container, and bow-mounted A-frame.

ABEX TS *moored over the site.*

ABEX TS *accommodation.*

All onboard facilities were powered by a 195 KVA and a 125 KVA generator, which were rotated on a twelve-hour basis, the smaller unit being used for the night supply. Two 390 cfm low-pressure industrial compressors were installed near the bow to run the air lifts and three air-tugger winches, 1 x 1 ton, 1 x 2 ton, and 1 x 5 ton. One compressor was sufficient to run all systems, while the second provided full backup. They were alternated on a three-day cycle.

A four-point mooring system, run off two hydraulic double-drum winches, enabled the barge to be maneuvered precisely over the grid being worked. The ground tackle for each mooring point consisted of a three-ton stockless anchor connected to a pennant buoy by 27 m of stud-link chain and 40 m of 25 mm pennant wire. The barge's 25 mm mooring wire ran through fairleads to the pennant buoy. The anchor pattern required a very wide spread, so that the barge could be moved anywhere over the 70 m long wreck site without having to redeploy anchors.



Three-ton anchor ready for deployment.

Anchor pennant buoy.

Taking up slack on a mooring winch.

Five containers were loaded onto the forward deck, two of them double stacked. Three contained packing material for the ceramics from the wreck; one was for packing and storing the ceramics; and one was an artifact store and conservation area. Before departing from Singapore, 300 tons of potable water, 100 tons of washing water, and 80 tons of diesel fuel were loaded into the four designated tanks, sufficient for an extended operation without resupply from shore.

Loading stores onto the barge.

The *ABEX TS* was towed between Singapore and the wreck site in the Java Sea by the 660 BHP tug *ATSA I*. A steady five knots was achieved both ways in moderate weather conditions. The *ATSA I* assisted with anchor handling and remained on standby throughout the project.

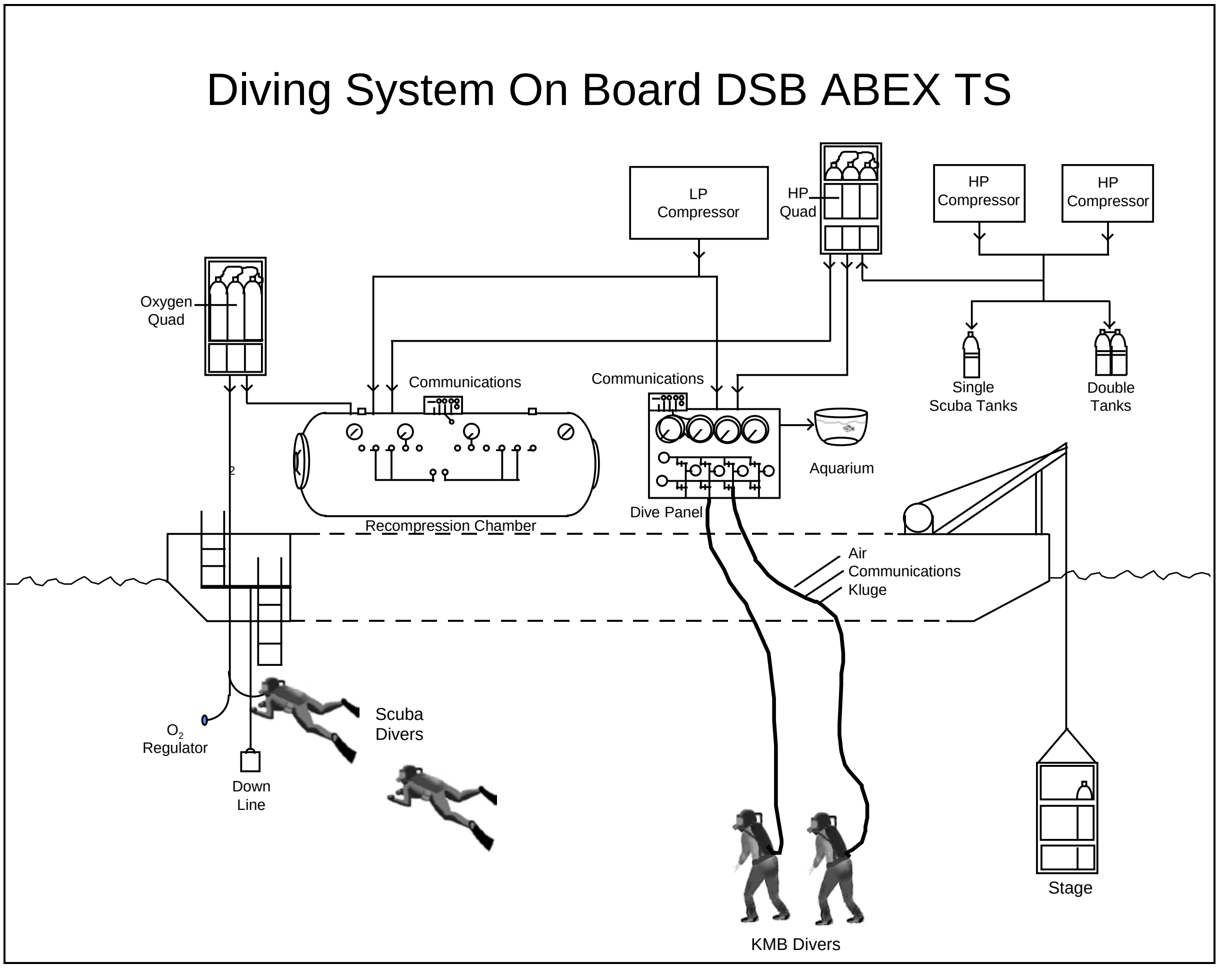
Engine room of ATSA I.

Tug and anchor handler, ATSA I.

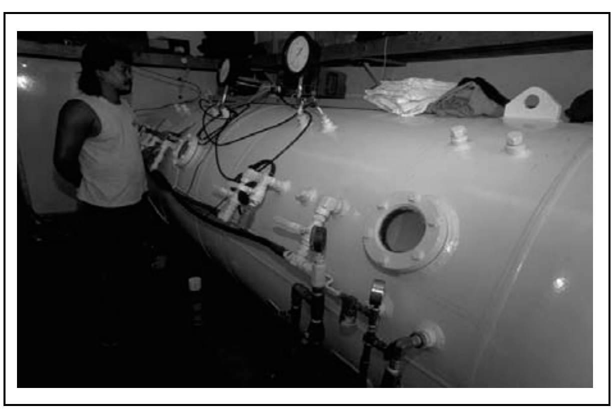
An Indonesian fishing boat used for resupply.

A 10 m long Indonesian fishing boat was hired to ferry temporary personnel to and from Jakarta, 115 nautical miles to the south, and to supply fresh fruit, vegetables and spare parts. The trip typically took 19 hours and occurred on average once every ten days.

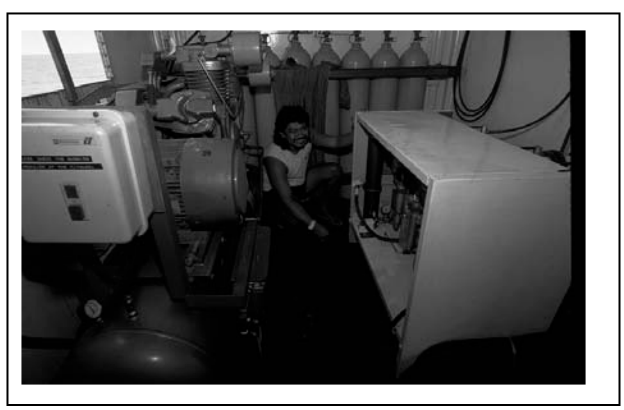
3.2.2 Diving Systems



The wreck lay in 26 m of water, an ideal depth for surface-supplied-air diving with surface decompression on oxygen. With a core of twelve surface supply divers, the first pair leaving the surface the moment the sun crept above the horizon and the last pair leaving the decompression chamber just after dark, twenty diver hours of bottom time were achieved on a daily basis.



Decompression chamber operations.



The compression room.

The diving spread was mounted at the bow of the barge, so the barge was moored with the stern facing the prevailing weather in order to put the bow in the lee. The main equipment was installed in two 20 ft containers. The forward container, with a clear view of the working deck, housed a two-diver air-control panel and a 48 in double lock Deck Decompression Chamber (DDC). The second container housed an 86 cfm low-pressure compressor, a 9 cfm high-pressure compressor, an 8-cylinder emergency air bank, and workshop and storage space. In a row alongside both containers were nine 16-bottle racks of medical oxygen needed for surface decompression.

Oxygen racks for surface decompression.

Adjusting a KMB mask.

Kirby Morgan Band Masks (KMB) – and occasionally a Superlite helmet – were used for the surface-supplied diving. They were connected to the air control panel by umbilicals that incorporated an air hose, pneumofathometer hose for determining the diver's depth, communications cable, and a rope-strengthening member. The Superlite could be used with a helmet-mounted videocamera and a light; however, the Indonesian divers found the KMB more comfortable.

Two-diver control panel.

Checking the emergency air supply prior to a dive.

Diving operations were controlled from the forward container at the air control panel. Air was supplied to the two-diver panel from both the low-pressure compressor and the emergency air bank. Pneumofathometers built into the panel allowed accurate monitoring of the depth of each diver, and a radio mounted just below the panel provided two-way communications.

Divers were deployed in a two-man staging operated from an A-frame permanently mounted off the bow of the barge. A 2-ton air-tugger winch was used to lower the staging from the deck to the seabed and to lift it back to the deck at the end of the dive. The advantages of using a staging are that ascent and decent rates can be carefully controlled from the surface, and umbilicals can be tied off at the bottom to drastically reduce current drag on the diver. A clump weight, consisting of a solid 7 cm bar of steel, was rigged such that the staging could be lowered down to it on two guide wires, thus preventing the staging from twisting and fouling the umbilicals. The clump weight could be raised and lowered by an 1-ton tugger in order to keep the staging a meter or two above the seabed, where it could not foul the grid ropes. In heavy seas this clearance was increased.

Divers about to leave surface.

The staging on the way to the seabed.

Surface decompression on oxygen at the depth of this site has three main advantages. First, the divers can be removed from the water and complete their decompression in a carefully controlled environment. Second, decompression time is reduced by breathing oxygen rather than air. Lastly, by transferring the divers into the DDC, it frees up the diving equipment, allowing the next pair of divers to immediately enter the water.

Decompression schedules were taken from the US Navy Surface-Decompression-on-Oxygen tables and modified according to standard offshore diving practice. Bottom times ranged between 100 and 105 minutes at a depth of 85 ft (26 m). Instead of using a 110/90' table, the 130/90' table was chosen (an increase of two tables) to take into account the nitrogen build-up due to many consecutive days of diving. The US Navy procedure is to travel directly to the surface without any in-water stops, enter the chamber, and be pressured down to 40 ft for 48 minutes, breathing oxygen. On completion the diver travels to the surface at 25 ft per minute. Modifications to this procedure included a 3 minute water stop at a depth of 30 ft, pressuring the chamber down to 50 ft while breathing oxygen for 10 minutes before ascending to 40 ft, and then slowing down the ascent to the surface such that it took 10 minutes rather than 1 minute, 40 seconds. An air break of 5 minutes was also taken for every 20 minutes on oxygen to minimize the chances of suffering from oxygen toxicity. These modifications greatly reduced the risk of decompression sickness.

While surface-supply diving was used for excavation work, scuba was used for setting up the rope grid, video and photography, measuring and recording, and supervision. Up to four divers used scuba, the numbers fluctuating to ensure a full team of twelve surface supply divers. A special scuba platform was rigged on the side of the barge, with a ladder and a heavily weighted decompression line. A guide line ran from the bottom of the decompression line out to a buoyed down line. The down line led to one of the grid stakes, well away from the working surface supply divers, so that there was no interference between the two. Normally, twin tanks were used and dives were kept to 30 to 40 minutes for a first dive and 20 to 30 minutes for a repetitive dive. All decompression was done in water, using standard US Navy tables. However, as an added safety precaution, oxygen was breathed at the 10 ft stop via low-pressure hoses fitted with second stage regulators.

In all, 880 dives were made during the project, totaling 1,190 diver hours bottom time, without any serious mishap.

Company at the scuba decompression staging.

A scuba diver leaves the barge.

3.3 Excavation Techniques

Before excavation could commence, a grid system had to be set up over the wreck site. A longitudinal gap ran between the rows of iron concretions that protruded from the center of the site. This gap was the only remaining evidence of a longitudinal bulkhead that must have run the full length of the wrecked ship. It provided a very convenient center-line orientation.

A 12 mm polypropylene rope was run over the concretions parallel to the gap rather than through it, as there were obstructions at both ends. It was extended in both directions to several meters beyond the surface scatter of ceramics, where 1.5 m-long pipe stakes were hammered through the soft sediment into the stiff clay below. The rope was stretched taut and tied off to the stakes. The center-line rope was 70 m long.

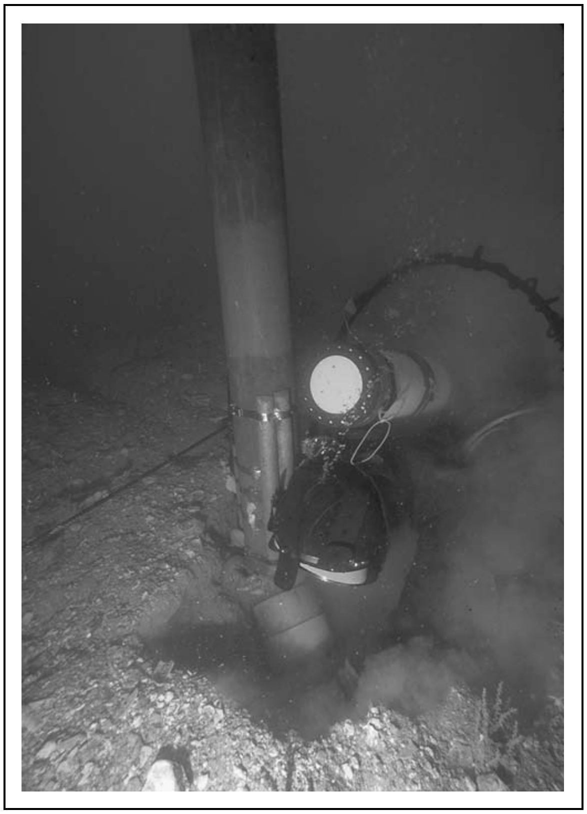
Using a fiberglass tape and the 3,4,5-pythagorus-right-angle technique, more stakes were driven in perpendicular to the center line and 5 m on either side. Having installed the longitudinal ropes between these new stakes, the procedure was repeated until six lines were established. By measuring 5 m along the lines from the outer stakes, perpendicular transverse grid lines could be installed. Initially three transverse grid lines were put in, and more followed as the excavation progressed.

Longitudinal lines were initially numbered 1 to 7. As the site widened, additional longitudinal lines had to be installed until numbers ranged from -1 to 9. Transverse lines started at A and eventually reached N, being 55 m long at the widest point. Large plastic grid tags were tied in to the grid lines to the front and to the right of each grid in the direction of progression for easy reference by divers. The tags were painted gray/blue to prevent flaring from the camera strobe and video light.

Grid rope and tag in an unexcavated area.

Divers worked in pairs, with each diver being allocated one grid square. If it were possible, adjacent grids were not worked simultaneously to prevent sediments stirred up by one diver from reducing the visibility of the other. Each diver used a 15 cm diameter airlift fitted with a 45- degree elbow at the base to prevent it from digging itself into the seabed. One airlift was painted red and the other white to minimize confusion on the bottom in times of low visibility. By placing the airlift away from the work face, divers could fan sediments into it to expose ceramics and artifacts. In areas with a heavy concentration of broken ceramics and poor visibility, it was often more efficient to dig up through the work face with both hands, so that artifacts and intact ceramics could be felt as well as seen.

Each grid had a plastic basket, color-coded in the same manner as the airlifts and numbered with a small tag that matched the grid being worked. Artifacts and intact ceramics were placed directly into these baskets, so that their point of origin could be recorded on the surface. Large broken pieces were placed in another unmarked plastic basket that was emptied 5 m behind the work face whenever full.



KMB diver excavating within a grid square.

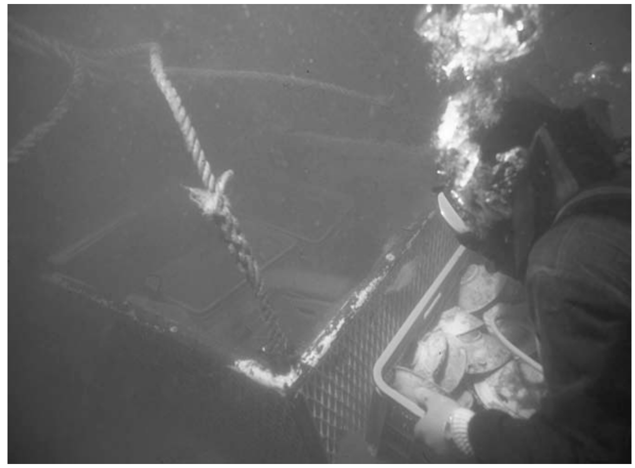
Surface signs of airlifts at work.

Artifact basket close at hand.

Filled basket awaiting recovery.

At the end of a dive each diver would place his working basket in a steel lift basket, regardless of how much was in it. There were always spare labeled plastic baskets in the steel basket in case the first one was filled. The steel basket was winched to the surface at the end of each dive. Working baskets were removed, and new ones put in and lowered to the bottom for the next pair of divers.

Ceramics were recorded by grid-square, due to the huge quantities involved. Artifacts such as the stone anchors and the iron concretions were plotted with reference to the grid lines. The concretions were more thoroughly recorded by means of a photomosaic, which will be discussed in more detail in Section 3.4.4.



Artifact basket being placed in the steel lift basket.

The lift basket breaks the surface.

Site cross sections and concretion heights were determined by taking soundings with a decompression meter that was accurate to 0.1 m. A reference point on a grid stake ensured that soundings could be corrected for tidal variations.

Excavation progressed across the full width of the site before moving forward to the next grid, up to the iron concretions. At this point, work was restricted to the south of the concretions to prevent equipment being dragged over them during barge moves, and because the site had become so wide that it took too long to shift the barge transversely as well as longitudinally as work progressed. Having passed the concretions, work continued on the south side of the site until reaching the end of the grids. Then excavation moved up and back along the grids on the north side of the concretions.

3.4 Photographic Procedures

Every step of the project was documented on still film and on videotape.

3.4.1 Still Photography

All still photographs, including those shot underwater, were taken with Nikon cameras, mainly the F90, N90S and F801 models, and occasionally with an F90X. A selection of Nikon lenses was used for surface photography. Zoom lenses included a 28-70 mm f3.5-4.5 D, and a 35-105 mm f3.5-4.5, both D and non-D series. A 105 mm f2.8 D macro lens was used for photographs of small objects, and a 20 mm f2.8 D was used for wide-angle shots in confined spaces. Occasionally, a Sigma 75-300 mm f4-5.6 zoom lens was used for distant subjects.

Fully-equipped underwater photographer, Anthony Holley.

Nikon SB-25 and SB-26 flashes were used extensively, being particularly effective for fill-in light on faces where there was a bright background.

Sixty-five rolls of Fuji Provia 100 ASA slide film were exposed during the project, along with several rolls of Fuji Super HGV 100 ASA print film and a few rolls of Fuji Sensia 100 ASA slide film. One roll of Provia 400 ASA slide film was also used, rated at 800 ASA, with 500 watt lights underwater. All rolls were 36 exposures giving a total of over 2,600 photographs taken during mobilization and on site. Additional film was taken of the conservation of ceramics and other follow-up work in Singapore.

3.4.2 Underwater Still Photography

Both archaeological and aesthetic shots were taken underwater. A black and yellow 30 cm scale rule was included in most of the archaeological photographs. A black and white rule was not used, as the high contrast causes halation, where the white is overexposed and distorts the apparent size of the scale divisions.

An F90 camera with a 20 mm lens and an SB-25 flash were sealed in a Subal Miniflex aluminum underwater housing for the documentation of large fixed objects, such as the concretions. Concretions of particular note were photographed from many different angles and exposures. As the concretions were too heavy to recover, and were too degraded to respond to normal conservation treatments, the photographic documentation was that much more important. Special attention was paid to certain blocks for interpretation purposes, such as Concretion 19, which was thought to be molded to the shape of the bow. Others clearly showed the packing of the cauldrons and bundles of iron bars.

Airlifting work on the seabed was also photographed many times with this setup from varying viewpoints and with different lighting angles. The very wide angle of the lens behind the dome port allowed these shots to be taken at close range in poor visibility. The flash was usually held out at full arm's length on its long jointed arms to reduce the reflection of the light off the suspended matter in the water (back scatter). Normally the main flash was above and to the left of the subject, but this was varied according to the subject's orientation. An Isotechnics Isotender slave flash, fired by a sensor detecting the main flash and aimed from the right-hand side, provided additional lighting many times. For the concretions it was placed on the seabed to light up overhanging portions.

A pair of Nova 500 watt tungsten halogen lights was used for different lighting effects. These were mounted on an aluminum bar with a power supply cable from the surface. The arrangement was made less cumbersome with a small lift bag, but still had to be maneuvered by an assistant diver. For the standard 100 ASA film the exposure required was 1/8th of a second, wide open at f2.8. With the damping effects of the water and by lying on the bottom, slow shutter speeds can be used underwater, but the movements of the airlifting would be blurred. Therefore, 400 ASA film was used, upgraded to 800 ASA, to give reasonable speeds of 1/60th of a second.

The photographer was always on standby to record one-off events, such as the recovery of a large stone anchor and the excavation of unique ceramics. The wide-angle lens was used when a diver was required to fill the frame, and the zoom lens was invaluable for shooting smaller items, such as the ewers, in detail.

Marine life photographs were taken with the wide-angle lens for schools of fish, and the zoom for individuals, corals and sponges. Many of the groupers that had taken up residence between the concretions were very cooperative, enabling close-ups of an eye or a gaping mouth. The 105 mm macro lens was ideal for small creatures, as it could focus down to life size, equal to the 24 x 36 mm film. Waiting for the right moment and the right angle for a shoveler shrimp and attendant goby required great patience, but could be well rewarded with the results produced with this lens. Details of sea slugs and sea snakes were also recorded.

3.4.3 Video Photography

The new Sony DCR-VX 1000 Handycam Digital 3CCD videocamera was used for surface and underwater video work. The Mini DV digital videocassettes give no loss in quality on repeated playing or on digital copying, thus giving excellent results in the final edited version. Sony DVM60 cassettes were used exclusively. In most instances, the videocamera was tripod mounted for surface use. An Amphibico VH1000 aluminum housing provided the necessary protection for the camera for underwater filming.

Digital videocamera in action.

A Sony Marine Pack HVL-80DA 80-watt light provided illumination for close range filming of fish and corals and sponges, but was not powerful enough for longer range work. The pair of Nova 500 watt tungsten halogen lights described above improved the range, but required great coordination between the cameraman and the lighting diver. These lights provided the necessary illumination for filming airlifting operations and for colorful shots of the undisturbed ceramics field. They could also be used for artistic background illumination.

Like still photography, video was used for archaeological recording as well as aesthetic work. The ability to freeze-frame the digital video, with no loss of picture quality or flickering, made the video a powerful tool for quick analysis of various aspects of the site. Details could be studied immediately after a dive. There was no need to wait for film developing.

Before excavation work began, pre-disturbance runs were made over the ceramics fields and along the central axis of the wreck, following several of the longitudinal grid lines. Many shots were taken of the concretions to study their interrelationship and their individual composition.

3.4.4 Photomosaic

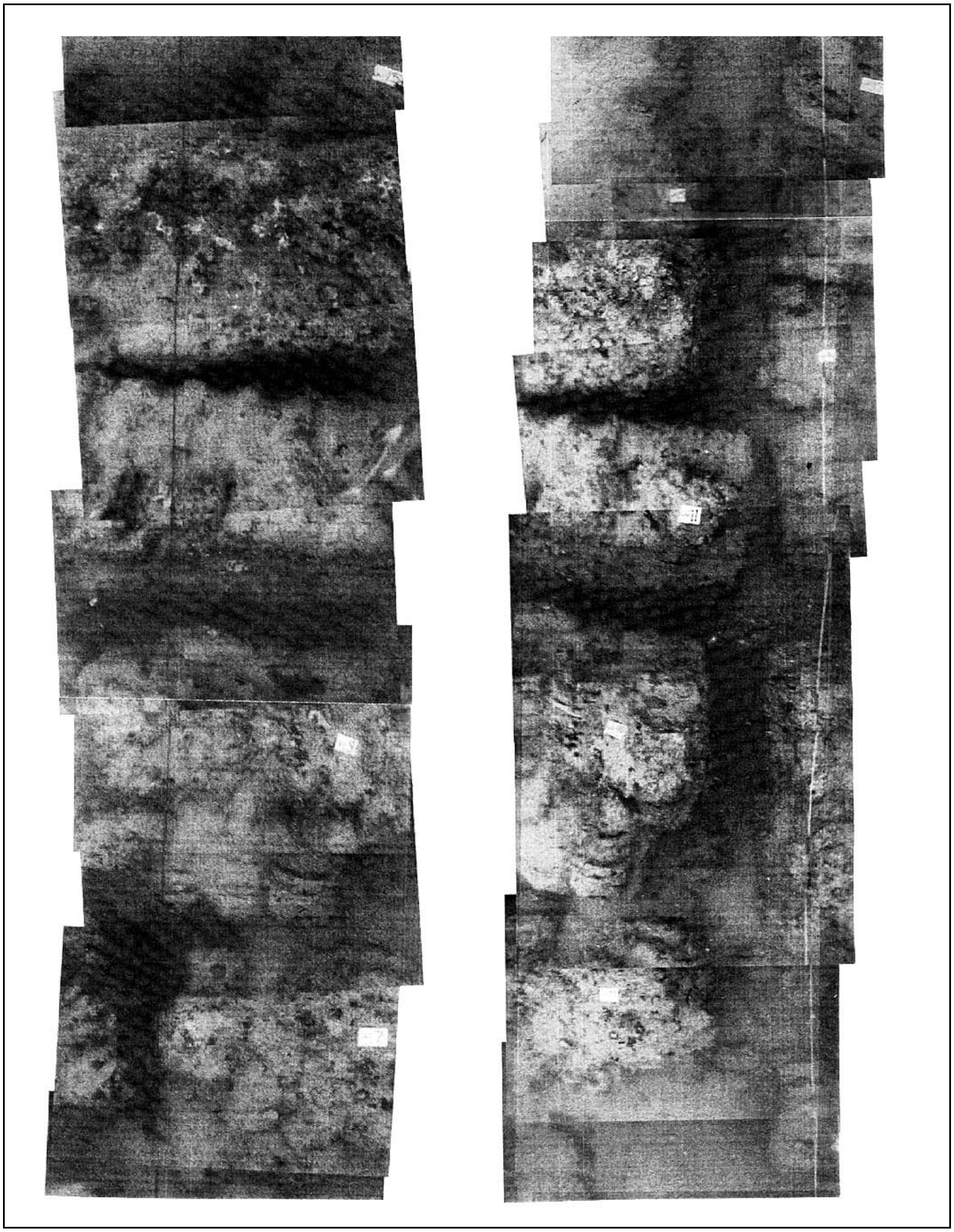
The mediocre visibility over the site made it impossible to get an overall view of the concretions while diving. As no hull structure survived at all, it became imperative to fully record the concretion layout. The individual blocks depicted the configuration of the no longer existent hull. Unfortunately, they presented the worst possible photomosaic situation with sheer vertical relief changes of up to 1.6 m. Accepting that it would be impossible to get a meaningful scale out of the mosaic, it was decided to compile it by means of digital video and computer manipulation.

Three parallel rope lines were installed at the same level across the concretions, the center one being clearly marked with one meter divisions. The camera was held vertically with the assistance of a small bubble level glued onto the housing. Planar alignment was achieved by keeping one of the rope lines parallel with the edge of the viewfinder. And a constant level was achieved by maintaining a constant depth reading. Of course, it was impossible to watch all three indicators at the same time, but results were reasonably consistent nonetheless. A long lead-in swim gave time to adjust and stabilize. Lines were swum, or rather drifted, with the current in an east to west direction. In all, eight lines were filmed, and six of those were used for the mosaic.

No artificial lighting was used for the photomosaic runs over the concretions, due to their rapidly varying heights from the seabed. This would cause the camera to constantly alter exposure levels and result in harsh shadows and glare. The camera is more light sensitive than the human eye, so reasonable results were achieved without artificial lighting.

The video runs were played back at very slow speed, and individual frames were selected to give more than 50% overlap. Having selected a frame, it was stored as a bitmap file on the computer via a digital image capture system called Snappy (see Section 3.5, Registration Systems). The images for each run were then recalled one by one into a image manipulation program called Fauve Matisse. First the edges of each image were cropped, where distortion is greatest. Then the scale and alignment were slightly adjusted to match as closely as possible the previous image. When the best fit had been achieved, the new combined image was saved and the steps repeated until the complete line (typically 20 images) was laid out.

In theory, successive lines could have been combined with the first to provide a complete mosaic of the concretions. In actuality, the PC (see Section 3.5, Registration Systems) did not have the power to do this and suffered memory overload. Instead, each run was processed and printed out as a mosaic strip. These strips were then cut and pasted to form the complete mosaic. This was used in conjunction with actual measurements to sketch the concretion field.



Two digitally produced mosaic strips.

3.5 Registration System

Three databases were required for the project: ceramics registration with grid location as the pivotal data; artifact registration with the same emphasis; and a packing inventory for Government monitoring. Instead of a conventional card registration system, all information including images was recorded on computer.

Jeff Nicklason at his artifact imaging and registration station.

Microsoft Access was chosen as the most appropriate database due to its widespread acceptance, compatibility with other software programs, ease of operation, and ability to incorporate digital images. Imaging was done with an 8-mm videocamera linked to the computer by an off-the-shelf digital imaging package called "Snappy," a cigarette packet-sized device with accompanying software. The main computer was a Compaq Presario 7222 (Pentium) PC, and the deck registration computer was a Toshiba Satellite 115CS (110 Pentium) notebook.

3.5.1 Ceramics Registration Database

The ceramics registration database is the primary tool for determining ceramics distribution over the wreck site, and hence the likely stowage pattern for the different wares. It contains 21 fields, 4 of them being for images of the piece taken from different angles and scales. Many of the fields had a pull-down list of the data most frequently input. Of course, new data could always be typed in. The input fields with associated pull-down lists are included as Table 3.2.

3.5.2 Artifact Registration Database

The artifact registration database contains all information on the artifacts and can be updated as the artifacts are cleaned and conserved, which often reveals details not apparent when they are first recovered. The database contains 12 fields, including 2 for images. The fields and associated pull down-lists are included as Table 3.3.

3.5.3 Ceramics Packing Inventory

The ceramics packing inventory is a simplified version of the ceramics registration database. It was required to keep track of the contents of each box that was packed and to monitor the quantities being recovered on a daily basis. Only six fields were necessary, and the pull-down lists are identical to those in the ceramics registration database.

Table 3.2: Ceramics Registration Database

Grid

Recovery Information

Material

Earthenware	Stoneware	Porcelain

Form

Box with cover	Jar	Basin
Box cover	Jarlet	Bottle
Box base	Kendi	Vase
Ewer	Lid	Dish

Size

Very Small	Small	Medium	Large	Very Large

Trait

Fine	Provincial	No Footring	Unglazed Ring	Octagonal	Round

Glaze

Green	Qingbai	Brown
Pale Green	Gray	Burnished
Olive	White	Cizhou

Decoration Method

Combed	Appliqué	Molded/Painted
Molded	Painted	None
Incised	Incised/Painted	

Internal & External Decoration

Combed	Plain	Wavy	Zigzag
Floral	Swept	Striated	Scrolls
Lotus	Ribbed	Ringed	

Description

Body Condition

Poor	Marginal	Good	Excellent

Glaze Condition

Poor	Marginal	Good	Excellent

Table 3.3: Artifact Registration Database

Artifact Number

Location/Grid

Recovery Information

Material

Cu Alloy	Ferrous	Wood	Glass	Rock	Organic	Unidentified

Form

Figurine	Ivory	Resin	Gong
Balance Weight	Ballast Stone	Sharpening Stone	Tray
Ingot	Scales Bar	Finial	Unidentified

Features

Condition	Dimensions	Description

Classification

Cargo	Personal Possessions	Ship's Stores	Ship's Fitting
Ship Structure	Intrusive	Unidentified	

Stored Images

3.5.4 Data Analysis and Display

Access is a powerful database program that allows filtering, sorting, and summing on many levels. Thus the ceramics database can be analyzed in great detail and in many ways. The main use, however, is to determine the distribution of ceramics over the site. This was first done for ceramics as a whole by summing the ceramics found in each grid. In order to graphically display the results, the new data was transferred to Microsoft Excel, a spreadsheet program with more powerful graphics than Access. The results were printed out both on 2-D and 3-D color-coded plots that depict the grid layout of the wreck site. Just a glance at the plots is enough to picture the unusual distribution that has taken place.

Similarly, the sum of the different types of ceramics was determined for each grid. By plotting this in the same manner, it is very easy to see which types were stowed in which part of the ship.

By using the form function in Access, excellent-quality catalogs with color images could be produced for both the ceramics and the artifact databases.

3.6 Ceramics and Artifact Handling Procedure

3.6.1 Ceramics Handling Procedure

At the end of each dive the foam-padded steel basket containing the plastic grid baskets was winched to the surface. The grid baskets were carefully removed and taken directly to the ceramics washing table, which was located on the port bow of the barge under an awning. A submersible pump supplied a continuous flow of sea water via piping and four discharge hoses attached to the back of the table. A foam mattress was fixed to the steel grating table top. Here the ceramics were cleaned of mud, sponges, oyster shells and coral with scrubbing brushes and plastic chop sticks. The more tenacious marine growth, and there was a lot of it, was left for removal in the conservation laboratory. Ceramics from each grid basket were kept completely separate.

Unloading ceramics onto the washing table.

Ceramics cleaning in full swing.

After washing, the ceramics were rinsed in fresh water, then sorted according to form, size, glaze, and condition in preparation for registering. The sorted ceramics were stacked on the shaded deck in separate areas designated by grid tags. Except for periods of inclement weather, all ceramics registration took place on deck immediately after washing. One person would examine the sorted ceramics and call out the pertinent information to another for data entry into a notebook computer. Information on each piece included the following: grid square, quantity of pieces with the same attributes, ware, material, form, size, glaze type, decoration method, internal decoration, external decoration, body condition, and glaze condition. One additional field was provided to record general traits, such as “no footring” or “unglazed ring,” and another for any further description unique to the piece being registered, such as “spout broken” or “distorted rim.” A small rotating staff of three people was used for calling and data entry in order to maintain the consistency of logged information. Unique or exceptional pieces and representative examples of each ceramics type were set aside for digital imaging.

Ceramics segregated by grid-square.

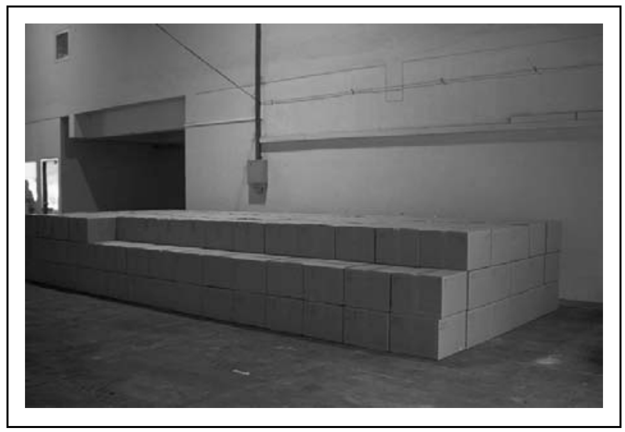
Logging each find on computer.

Only after registration was completed were ceramics from different grids mixed together in preparation for packing. Pieces that could be stacked, such as bowls and dishes, were placed one inside the other with 10 mm bubble plastic between each piece. Large or odd shaped pieces, such as ewers and kendis, were wrapped in 25 mm bubble plastic. Stacks or individual large pieces were then sealed in heavy gauge plastic bags containing small amounts of fresh water to prevent them from drying out while awaiting transport to the conservation laboratory. The bags were then placed in double-wall cardboard boxes that were lined on all sides with 20 mm polystyrene sheeting and divided into quadrants with a cardboard partition. The partition kept the stacks of ceramics separate and increased the vertical strength of the box to prevent crushing when stacked. In order to prevent shifting, all remaining space in the box was packed with loose fill polystyrene. Each box was finally taped shut, numbered on all sides, and stacked in sequence in a secure storage container.

A separate database was used to keep track of each box's contents, based on form, size, condition, and quantity. Daily packing lists were printed out each evening for joint signing by the Indonesian Government Representative and by Pacific Sea Resources.

On arrival at the conservation laboratory in Singapore, the boxes were unloaded from the container and stacked in the laboratory in sequence, such that processing could start with the first box that was packed and progress in order. The main priority was to complete cleaning and commence desalination without allowing the ceramics to dry out. Boxes were unpacked one at a time, the next one not being opened until the first had been processed. As much of the marine growth as possible was carefully chipped off with small chisels and chopsticks. Several pieces were only held together by the marine growth. When the shell and coral were removed, they fell apart, revealing yellow stained broken edges, a sign that they had been that way for some time.

Logging the ceramics for packing.



The ceramics cargo on arrival in Singapore.

On completion of mechanical cleaning, pieces that required more work were left overnight in a very dilute hydrochloric acid solution. After this treatment the pieces were scrubbed clean in fresh water, then carefully stacked in freshwater baths for desalination, the details of which are given in Section 3.7, Conservation. Plastic sheeting was placed over the baths to prevent evaporation and the breeding of mosquitoes.

After desalination the pieces were removed from the baths in the same order in which they had been placed there, dried, and sorted for cataloging in accordance with all the criteria recorded in the original ceramics database. They were then stacked in designated groupings on secure shelving in an air-conditioned storeroom.

The ceramic cleaning and desalination process.

3.6.2 Artifact Handling Procedure

The procedure for registering non-ceramic artifacts was similar to that for ceramics, although the numbers were far less. As each basket arrived on the surface, artifacts were removed, labeled according to grid, and placed directly into an appropriate storage medium. Registration of artifacts generally took place in the evening and was carried out at the PC work station in the barge office. The artifact database recorded the following fields: artifact number; grid square; date recovered; quantity; material (ferrous, copper alloy, etc.); form (gong, balance weight, etc.); classification (cargo, ship's structure, etc.); dimensions; condition; and description. Digital images were usually taken during the same registration session for inclusion in the database.

3.7 Conservation

3.7.1 Conservation of Ceramics

Conservation of ceramics is fairly straightforward. After cleaning off the marine growth, it is essential to leach out the salts that have entered the glaze and body of the piece during the hundreds of years that it rested on the seabed. If this is not done, the pressure created by salt crystalizing out of solution, particularly between the glaze and the body of an imperfectly glazed piece, can result in exfoliation and cracking.

To achieve this, the ceramics were placed in desalination baths 2 m in diameter and 0.3 m deep. A few drops of Algaetrene were added to prevent algae growth. The salinity of the water was indirectly measured with a conductivity probe, and the result graphed over time. As soon as the conductivity started to level out, the water was changed. The first wash increased in salinity very quickly, particularly the bath containing stoneware jars, which are more porous than the glazed ceramics. Subsequent washes were typically changed once every 10 days or so. The total desalination period was typically 3 months.

3.7.2 Conservation of Artifacts

Stable storage and conservation treatment are determined largely by material type. The different materials that had to be treated on this wreck included iron, copper alloy, glass, ivory, and wood.

The iron was in the form of concretions, a matrix of iron corrosion products, sand, and calcareous marine growth that forms around an iron artifact and often grows to several centimeters thick. In actual fact, there was no iron base metal left after 750 years or so. Some concretions contained a black material that was quite solid in places, but could readily be picked out, and other concretions contained slush. Some concretions that were not totally enclosed were completely hollow. Obviously nothing can be done to save the contents, but the concretions have become a mold of the original object. They were stored in water, as they very quickly expand and crack open if allowed to dry.

Selected concretions were cut open with a grinding disk and cleaned out so that a cast could be taken. The casting material used was Silastic J RTV silicone rubber, a low-shrink, room-temperature vulcanizing compound that gives highly detailed reproductions.

Copper alloy artifacts tend to be fairly stable after prolonged immersion in seawater. They can certainly be badly corroded and worn, but do not rapidly deteriorate when removed from their marine environment. The long-term problem is bronze disease, caused by absorbed salts. A good storage medium that also removes chloride irons from the artifact is sodium sesquicarbonate. The copper alloy artifacts were immediately placed in a 3 percent solution on board the recovery vessel. At the end of the excavation it was impractical for transport in the solution, so the artifacts were rinsed with fresh water and allowed to dry before being placed in plastic bags with silica gel to remove any remaining moisture.

In the conservation laboratory in Singapore the large items were put back in sodium sesquicarbonate for several more weeks of treatment. After that they were dried out as above and coated with Incralac.

Glass artifacts were treated in the same way as the ceramics. They were simply desalinated in fresh water. When the increase in solution salinity became minimal, the artifacts were placed in plastic bags for controlled drying.

The ivory artifacts posed a bit of a problem. The largest piece measures 620 mm long and 130 mm in diameter, while the smallest piece is a 100 mm long tip of a tusk. All of the pieces were badly deteriorated and exfoliating. The ivory was soaked in fresh water to remove the salt. One small piece was put in several acetone baths to remove the water, then in a 40% acetone/rosin solution in order to bind the layers. The results were quite satisfactory; however, it is not practical to use this treatment on larger pieces due to the large amount of acetone that is required. Instead, the larger pieces were simply bound in pantyhose to reduce the risk of exfoliation, and slowly dried out in plastic bags. So far this simple method seems to have worked.

Only a few pieces of highly degraded wood were recovered. Two of these had a dowel hole in them and hence were conserved. As they were only fist sized, the acetone/rosin method, as described for ivory above, was used. Apart from a few small shrinkage cracks, the method seems to have worked well.

4.0 SITE CONDITIONS ***by Michael Flecker***

4.1 Site Description

The wreck lies in the Java Sea in Indonesia in latitude 4° 14' S and longitude 106° 40' E. The southeast coast of Sumatra lies 50 nautical miles to the west. The islands of Banka and Belitung are some 70 miles to the north, and the northernmost island of the Thousand Island Group is situated approximately 60 miles to the south. There are no islands, reefs or sand banks within 40 miles. The ship sank in the middle of nowhere.

At night the southern horizon is disturbed by a flickering orange glow that marks the northernmost production platform of the Maxis Oilfield. Fishing boats and ships navigating through the Banka Straits pass by at regular intervals, but from time to time the sea presents 360 degrees of uninterrupted horizon.

Twenty-six meters below, the seabed is also bleak. A gently undulating silty sandy bottom stretches for miles in all directions. This loose and mobile sedimentary layer, varying from 0.5 to 1.0 m thick, overlies a stiff marine clay. Environmental and biological weathering have reduced the clay surface to undulations, holes, and loose chunks.

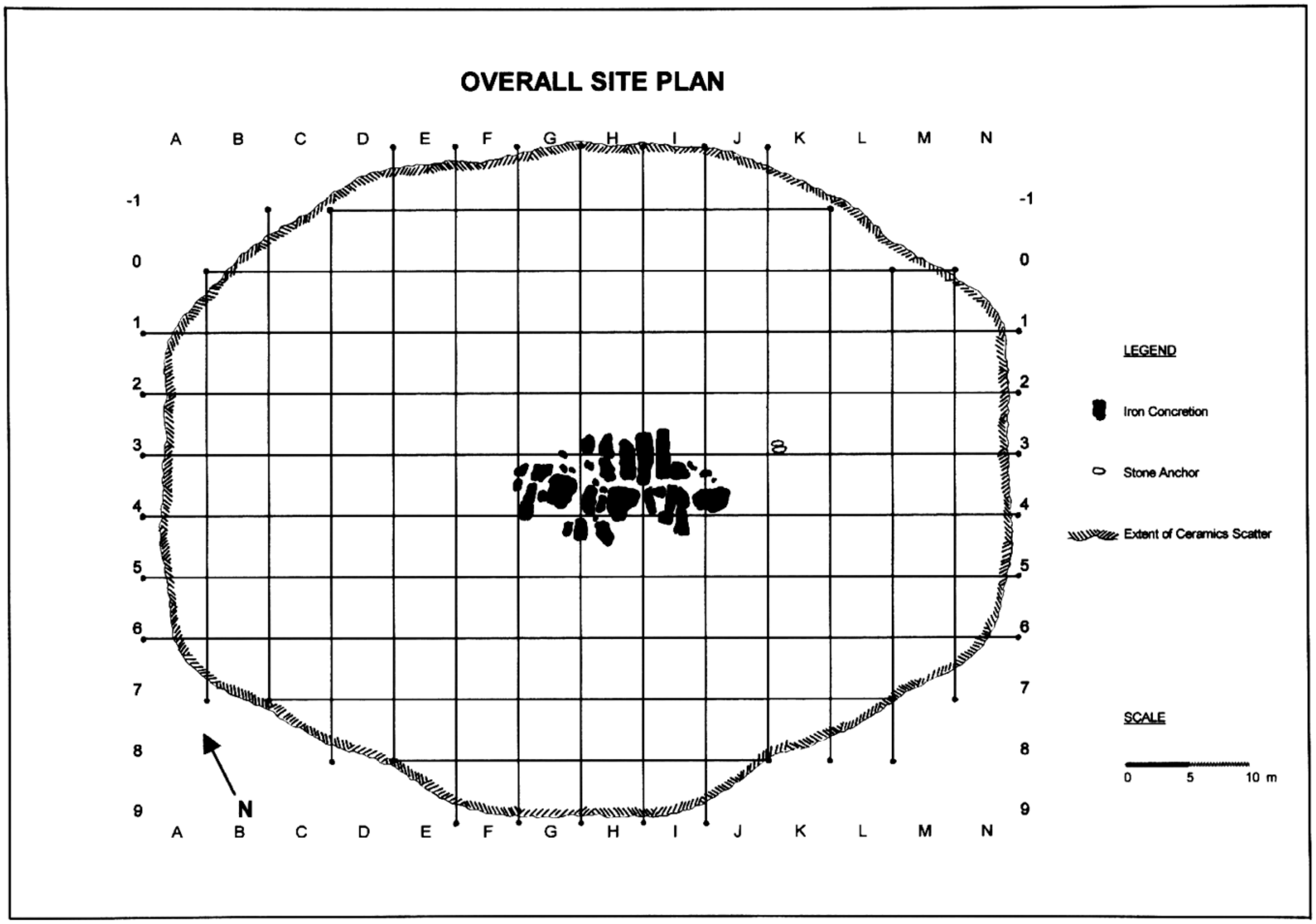
Projecting some 1.5 to 2.0 m above the surrounding sediments, the wreck mound forms a significant feature on an otherwise featureless seabed. A series of massive iron concretions protrudes a further 1.5 m above the mound, creating a thriving artificial reef, an oasis in an aqueous desert.

There is a pattern to the concretions. The iron cargo evidently concreted together before the ship completely disintegrated. Compartments and bulkhead locations can be readily discerned from the present concretion disposition. A long-gone longitudinal bulkhead or partition has divided the concretions into two rows. Small concretion chunks lie scattered around the main blocks, possibly the result of fishermen's explosives.

It is the longitudinal partitioning of the concentrations that provides the orientation of the wreck, 300°/120°, or WNW/ESE. For convenience, "wreck north" is taken as 30°, or NNE, and all future references to bearings are with respect to "wreck north."

Apart from a few scattered shards and some tube worms, the seabed immediately surrounding the concretions is barren. In fact, there is a relatively clear band of 10 to 15 m before substantial quantities of surface shards become evident. The outer limits of the wreck are marked by a carpet of silt-covered, encrusted shards. Again, these form a wide band around the central concretions, a band with a remarkably well defined outer edge. The oval-shaped area thus formed is 70 m long and 55 m wide.

To the south, west, and much of the north, the slope of the wreck mound is barely discernible. However, the eastern slope and some parts to the north are very distinct, as can be seen in the illustrations of the cross sections (Section 5.0). In various places around the site, mainly to the north and northeast, there are large holes. They are the result of previous excavations, reportedly well into the clay, to determine whether any remains or artifacts lay beneath the clay layer. During the two years since the last excavation, these holes have accumulated over half a meter of fine silt.



4.2 Oceanographic and Meteorological Conditions

The Java Sea is subject to the typical monsoonal weather system of the southern hemisphere tropics. The southeast monsoon prevails from May through September. The northwest monsoon blows from November through March and tends to have stronger, more consistent winds than the southeast monsoon. April and October/November tend to be periods of transition with variable winds and calms.

Monsoon-induced currents tend to set in a month or so prior to the true onset of the monsoon, flowing west to northwest during the southeast monsoon and east to southeast during the northwest monsoon. These currents are weak and are usually overridden by tidal currents. According to Admiralty weather charts the monsoon currents rarely exceed half a knot.

The tidal current regime in such an exposed location, where there is relatively little boundary influence, is very complex. The interplay of the monsoon current, tidal movement, and local meteorological conditions result in currents from all directions. When all factors contribute to a current in one particular direction, it may reach a velocity of 2 knots. But this is rare, and currents at the wreck location never exceeded 1 knot during the excavation.

One unusual phenomenon observed during the excavation, which was undertaken from the beginning of September to the end of October 1996, was that currents tended to be stronger during the half-moon phase than during full or new moon, a contrast to the norm. Current shifts were typically diurnal with at least an hour of slack water between shifts and were rarely diametrically opposed.

The actual weather conditions observed on the site during the excavation were somewhat different from the expected monsoon pattern. During the first two weeks of September the wind blew predictably from the southeast through to northeast with moderate velocity and some heavy rains early on. There were also occasional squalls, the worst gusting to 25 knots for a full day in mid-September. Winds were then consistently light from the southeast with no rain until the last week of the month, when they swung south and southwest and blew hard for four days, creating short 2 m seas. A southerly swell preceded this blow by a full day. The first three weeks of October were typical of the monsoonal transition period, with winds generally blowing lightly from south to east, and occasional squalls and rain from the south. Only one day was flat calm. From 20 October there were frequent squalls with very heavy rain from the south and southwest, lasting four days. Thereafter, winds were light from the south to east. Only once did the wind blow from the northwest, and that was due to a short-lived local thunderstorm.

Underwater visibility was moderate, typically ranging from 3 to 6 m. Very fine sediments on the bottom were easily stirred up by diver activity, and in times of low current, could result in zero visibility. Moderate currents from the east resulted in an unusually localized milky layer over the northeast quadrant of the site. Swells formed by the southerly blows also caused reduced visibility for several days.

4.3 Environmental Monitoring and Marine Life

First, it is interesting to note that the abundant life observed is restricted almost entirely to the wreck mound. Fifty-meter swim surveys undertaken in the four cardinal directions from the outer limits of the mound revealed the occasional shoveler shrimp with its attendant goby and a few worm holes. Otherwise, the gently undulating sandy seabed appeared lifeless.

The shoveler shrimp and goby were also a common sight on the wreck mound. Holes in the sediment with cleared paths in front indicated their presence. Ceramic shards often formed the roofs of these burrows. It is very easy to swim over them and see nothing, as the goby acts as lookout and darts into the hole when danger is near. Shrimp could sometimes be observed cleaning out the entrance. They are also known as bulldozer shrimp, as they can effectively push debris forward with their two claws clasped together. They are nearly blind and maintain contact with the goby through their long antennae. When a goby senses danger, it waggles its tail and the shrimp waits, retreating if the signal continues. Finally, the goby itself vanishes into the hole. This is an effective symbiotic relationship with the goby getting a clean home and the shrimp a forewarning of predators.

Sea snakes were regularly sighted and often caused some alarm by swimming between the divers' legs. Several went for a ride up the airlifts. They are very poisonous, their venom being much more potent than the most venomous land snake's, but they are docile and were never any threat. Being reptiles, they need to surface regularly to breath air which resulted in many sightings from the barge.

Live corals were scarce. There were a few small areas of encrusting corals on the concretions and several soft whip corals of different color, which often grew on shards scattered about.

Several species of sponges also grow on the concretions, and on the shards. They include small tube, barrel, and encrusting sponges.

Live mollusks were relatively scarce, although dead shells were found in and on the recovered ceramics. Only live sightings were noted. Similarly, only a few live crabs were actually spotted. No worms were seen although their holes and their casts were evident on the ceramics.

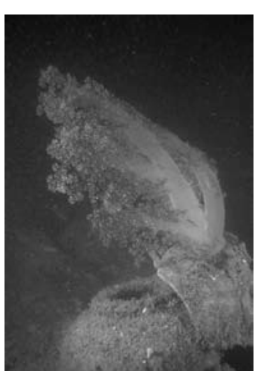
The concretions provided the main focus for fish life in the area. Rising up to 1.5 m from an otherwise flat bottom, they served as a refuge for resident fish and a hunting ground for the predatory fish. The barge also attracted pelagic fish. Large schools of jacks were often sighted beneath the barge, intermingled with batfish, rainbow runners, and fusiliers. Scuba divers decompressing on a line under the barge provided a convenient refuge for fry, but fusiliers and jacks often disregarded the sanctuary of the diver and attacked anyway. Constant dodging kept the diver's blood circulating.

Large groupers up to a meter in length were a common sight around the airlifting. They watched the divers and waited for any food disturbed from the sediments. They also made themselves comfortable in the lifting basket and in the diver staging. On days of poor visibility it was easy to come upon a large grouper unexpectedly, surprising both parties.

A giant stingray measuring 2 m across made its home among the concretions. There was only one, but he had many large ancestors, evidenced by spines over 200 mm long lying on the bottom.

One angelfish species was observed, the blue lined angel (*Pomocanthus annularis*). A pair of these was always around the concretions, nibbling on the algae. No butterfly fish, parrot fish, or similar common reef fish, were observed. Other fish observed on the site are listed in Appendix E.

Far from having a detrimental effect on the marine life, the excavation caused a temporary increase in activity, largely brought about by the stirring up of food from the sediments. Sediment from the airlift discharge blanketed corals and sponges on the concretions at times, but moderate currents prevented significant accumulation. The concretions were not disturbed, so resident marine organisms were not displaced.



Soft coral (Dendronephthya sp.)

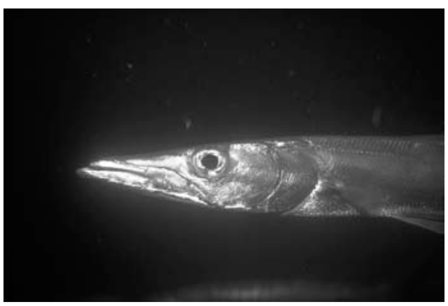
Soft coral (Dendronephthya sp.)

Nurse shark (Nebrius ferrugineus)

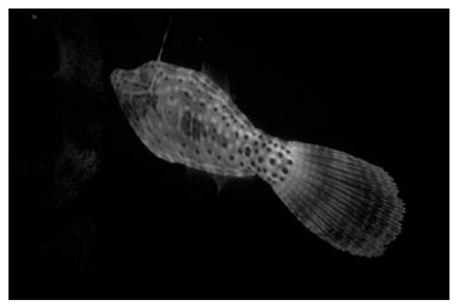
Marbled grouper (Epinephelus polyphekadion)

Blue lined angelfish (Pomocanthus annularis)

Marbled grouper (Epinephelus polyphekadion)



Yellow tail barracuda (Sphyraena jello)

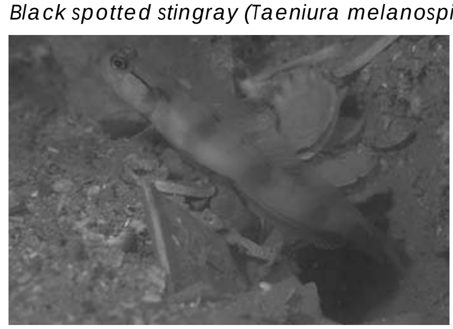


Scrawled filefish (Aluterus scripta)

Hawksbill turtle (Eretmochelys imbricata)

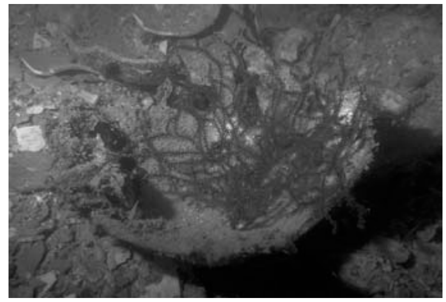
Black spotted stingray (Taeniura melanospilos)

Sea snake (Unidentified species)



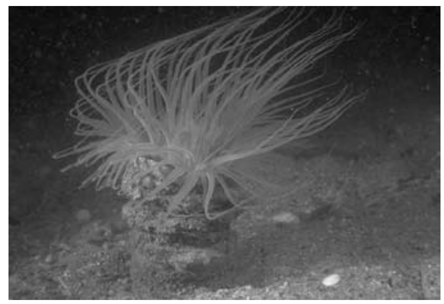
Shrimp goby (Amblyeleotris sp.)

Nudibranch (Bornella sp.)

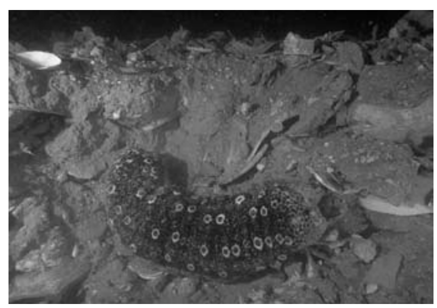


Purple tube sponge (Cribochalina sp.)

Feather star on rim (Unidentified species)



Nudibranch (Chromodoris sp.)



Sea cucumber (Stichopus variegatus)

Pair of flatworms (Thysanozoon sp.)

Yellow whip coral (Ellisella sp.)

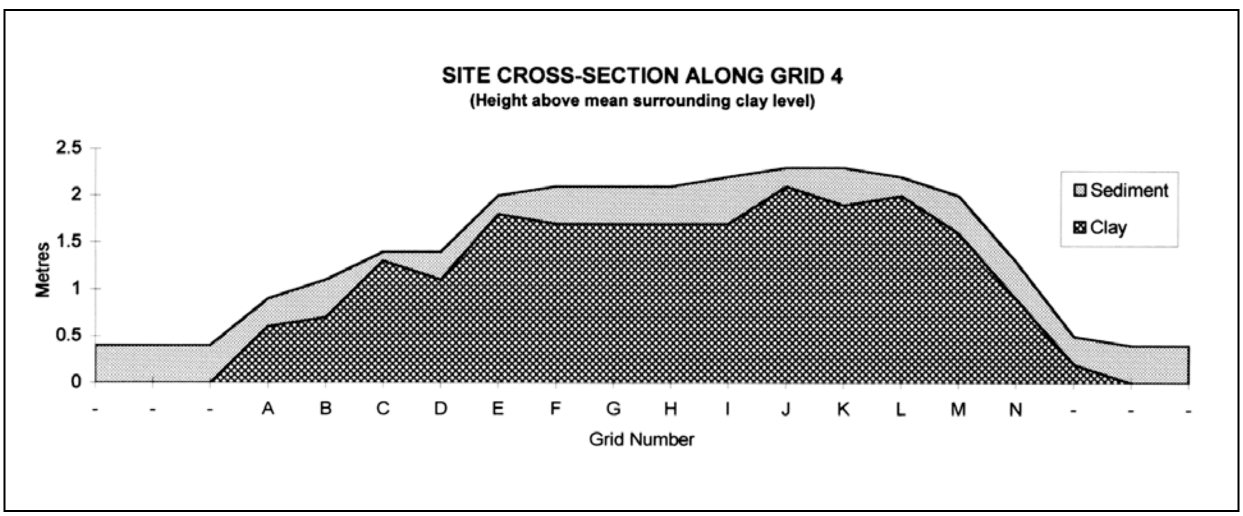
5.0 THE WRECKING PROCESS

by Michael Flecker

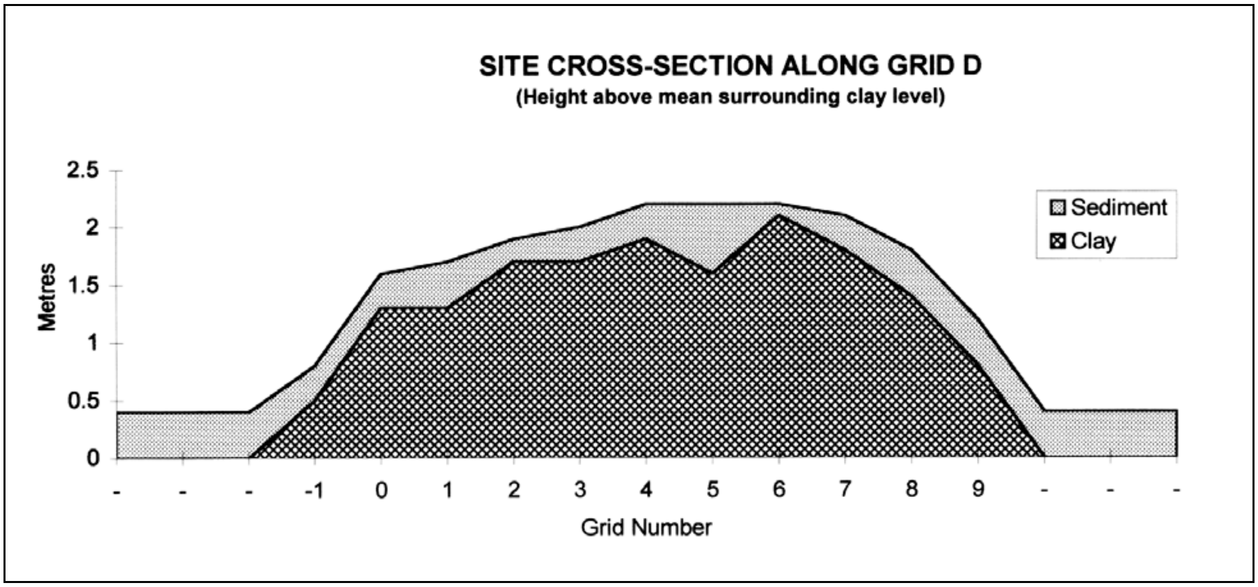
A description of the site prior to excavation is given in Section 4.1, Site Description. To recapitulate, the surface ceramics scatter occurs over an oval-shaped area approximately 70 m long by 55 m wide, which is slightly less than the extent of the so-called wreck mound. The highest point on the mound projects nearly 2 m above the surrounding seabed. In the center of the mound are two rows of iron concretions that assumed the shape of the compartments in which the iron cargo was stored before the ship disintegrated. The concretions cover an area of approximately 18 m by 10 m in the same alignment as the mound and project a further 1.5 m above the sediments.

A wreck mound is normally formed by sediment building up over hull and cargo remains. Typically, sediment carrying currents drop part of their burden in the lee of an obstruction. If currents travel in several directions, this can lead to a rapid burial of the site, with the result that hull timbers are protected from marine borers and ceramics are protected from abrasion and marine growth. Consequently, this vast site was initially viewed with great optimism.

Very early in the excavation, however, a stiff clay was found to underlie a layer of sediment and ceramics. The elevation of the clay was higher than the surrounding seabed. This lead to speculation that the clay was part of the cargo, but there was far too much and it was spread far too wide for this. Then it was suggested that the mound was completely surrounded by a scour trench, but sounding runs swum for 50 m from the outer limit of the ceramics scatter in four directions indicated that there was no scour trench at all. The height of the clay relative to the surrounding seabed is vividly depicted in the longitudinal and transverse cross sections of the wreck site.



Another puzzling discovery was that absolutely none of the hull had survived intact, not even under the iron concretions. The only wood that was found was in fist-sized eroded chunks, and there were only a few dozen of those.



Furthermore, every ceramic item that was recovered, without exception, had some marine growth on it, whether oyster shells, coral or sponges. So every piece has been completely exposed for at least some of its life on the seabed.

Therefore, it has been deduced that the ship came to rest upright on a clay seabed with little or no sedimentary overburden. Over several decades the hull timbers were eroded by currents and eaten by toredo worms. As the uppermost timbers collapsed, the ceramics cargo, which was stowed on top of the iron cargo, started to spill out in all directions. With no sediment covering the timbers they were eventually completely consumed. The iron cargo, consisting of stacks of woks and bundles of bars, was well concreted together before the wooden compartments disappeared. Those massive lumps of concreted iron have essentially remained in their original location ever since and clearly depict the long-gone bulkheads and outline of the ship.

As the containers holding the ceramics (possibly wooden barrels or bundles of straw) rotted away, the ceramics spilled out over a wider area. There then followed an erosion regime, or perhaps it was ongoing. The entire seabed in the region of the shipwreck has been eroded away by as much as 2 m. But the wide scatter of ceramics protected the clay under the wreck from erosion. As a slope began to form around the evolving mound, more ceramics would slide down, increasing the scatter and the resultant protected area. Eventually the entire ceramics cargo lay in a ring around an essentially bare hill. Perched on top of the hill were the rows of iron concretions.

Looking at samples of the stiff clay, it is hard to believe that so much could have been eroded. Two core samples were analyzed by Dr. Tan Thiam Soon of the National University of Singapore Civil Engineering Department. A core taken from the top of the mound indicates that the clay is very stiff. Six centimeters from the clay surface, it has a vane shear strength of 63 kN/m^2, and 14 cm down it gets as high as 107 kN/m^2 (see Appendix F). But when the overburden is removed to expose the clay surface, extensive weathering and biological degradation become evident. Rather than a smooth surface, it is pockmarked with holes that have been created by tube worms and is covered in small chunks of clay. On a larger scale, there are holes and trenches in the clay well over a meter deep and several meters in extent, possibly where the clay was less stiff and hence more easily eroded (these are not to be mistaken for the holes dug by earlier salvors). These holes have become traps for ceramics.

It is interesting to note that the clay of the surrounding seabed, and presumably that underlying the mound, is significantly different to the clay in the mound. The mound clay is streaked with red. When kneaded it becomes a uniform ochre color. The seabed clay is generally gray with some brown inclusions, and it is considerably softer, having a vane shear of 25 kN/m^2 10 cm below the clay surface. This is similar to the clay found 24 cm below the clay surface on the mound and implies that most of the 2 m or so that has eroded away was a soft clay. It was also a fairly silty clay, as indicated by a particle size distribution test, with up to 36% silt.

In more recent times, with greatly increased agriculture and deforestation, the seabed in the region of the shipwreck has become a depository environment. Around the mound there is typically a 0.3 m sediment layer over the clay. On the mound the sediment surface is fairly uniform. It is the undulations in the underlying clay that cause considerable variation in the thickness of the layer. In a deep hole there may be more than 1.5 m of sediment, whereas within the barren band around the concretions it can be as little as 0.1 m thick. There is 0.5 to 0.9 m of sediment around the concretions.

There were virtually no ceramics between the concretions, and very few within a 10 to 15 m radius. The lack of ceramics between the concretions is understandable if the wooden bulkheads survived until after the ceramics were swept off the iron, thus leaving no gap for them to enter. It remains a mystery why there were so few ceramics in the immediate vicinity of the concretions. Given the shallow nature of the overburden, it is possible that fishermen salvors with no excavation equipment concentrated their efforts here. But there are not many shards in this area, either, and it is unlikely that fishermen bothered to recover or move the shards.

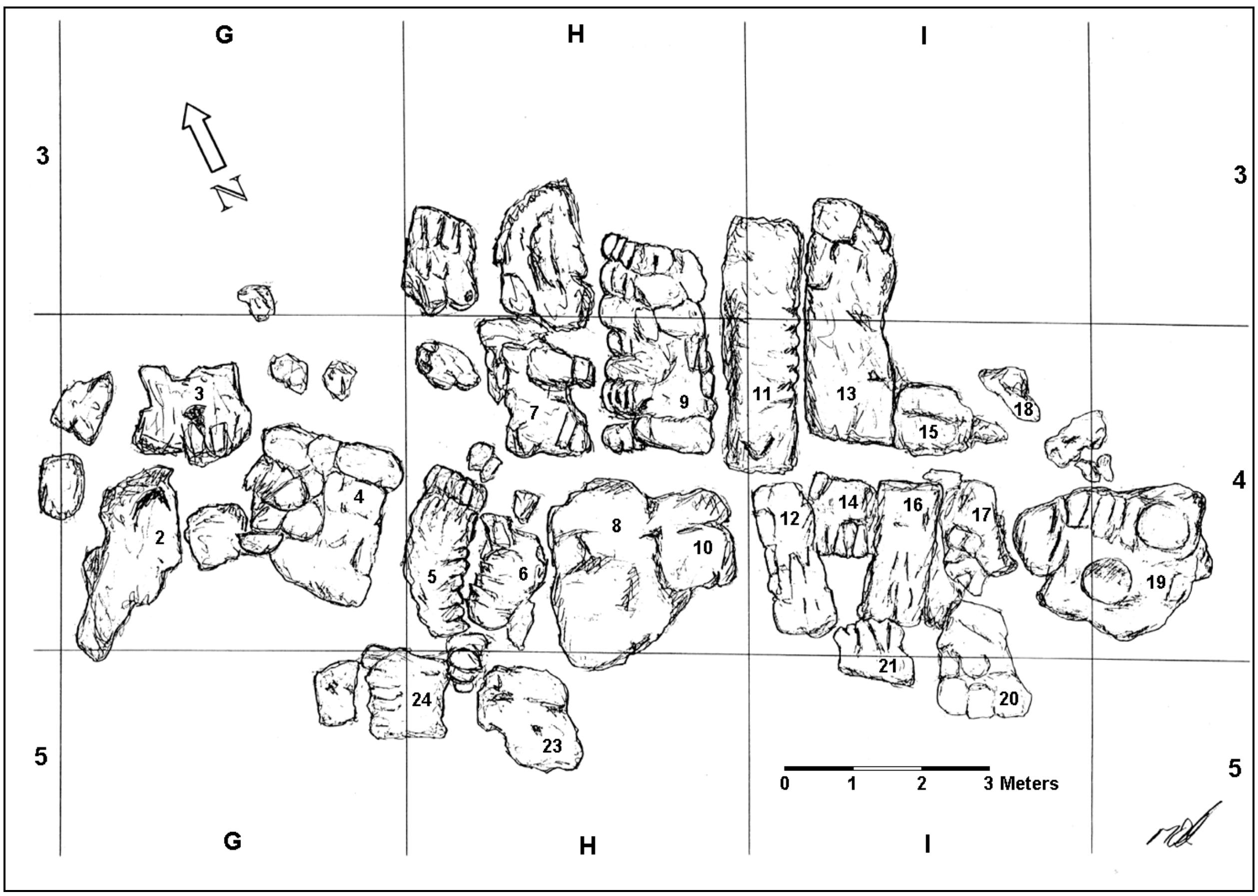
So, rather than an intact hull filled with iron and ceramics still in their original packing, the site disclosed a huge scatter of broken ceramics. It is estimated that at least 80% of the ceramics cargo was broken. Given the distance pieces have traveled from the original wreck location, this is not too surprising. As if this was not enough, it seems that explosives have been used on the site for fishing. There is evidence to support this. In isolated areas there is nearly 100% breakage, and the shards are smaller than usual. The stiff clay layer would act as a wall and bounce the shock waves back, so there was little chance for the ceramics near ground zero.

6.0 INTERPRETING THE SHIP *by Michael Flecker*

6.1 Hull Structure

There is no surviving hull structure, only a few fist-sized pieces of wood scattered about the site. As discussed in Section 5.0, The Wrecking Process, the hull and cargo have been completely exposed to the elements for prolonged periods. There was no layer of fine sediments to afford protection. Consequently, every piece of the ceramics cargo was encrusted to some extent with marine growth, and all of the ship's timbers have been eaten away by marine borers and current erosion.

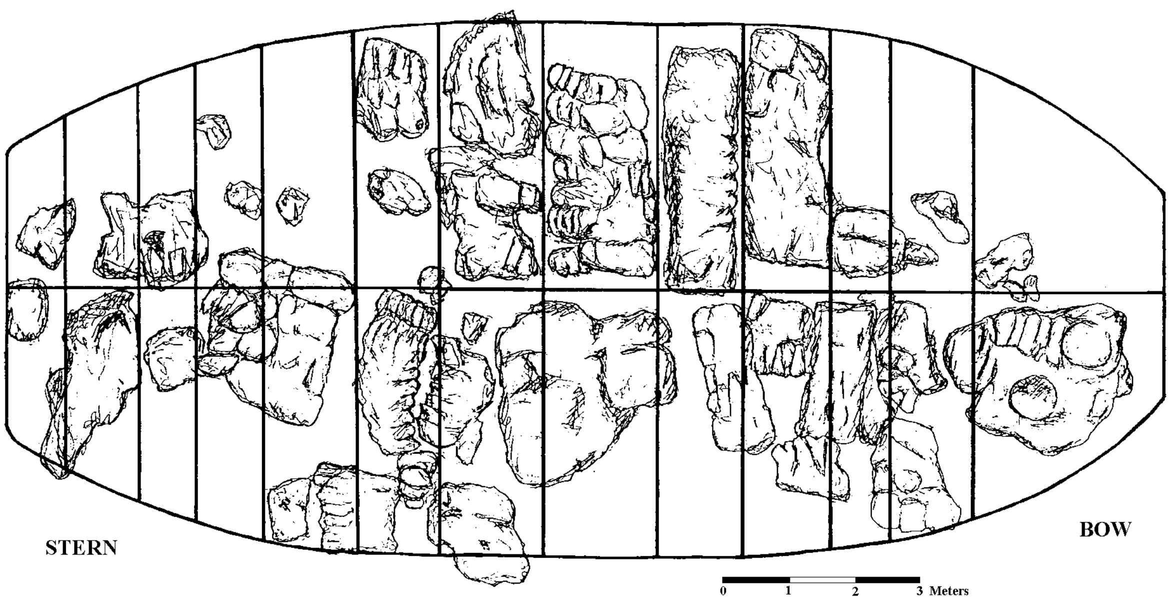
To learn something of the ship, we must instead study the massive blocks of iron concretion that dominate the site. The iron cargo was stowed in the lower holds and fused together before the ship disintegrated. The blocks have hardly moved from their original resting place due to their great weight. It is the shape of the concretions and their disposition that hints at the vessel layout.



Iron Concretion Plan

When studying the Concretion Plan, the orderly layout of the blocks is immediately apparent. They are divided longitudinally into two rows by a long narrow gap, and transversely they are similarly separated. These gaps are the positions of bulkheads that rotted away long ago.

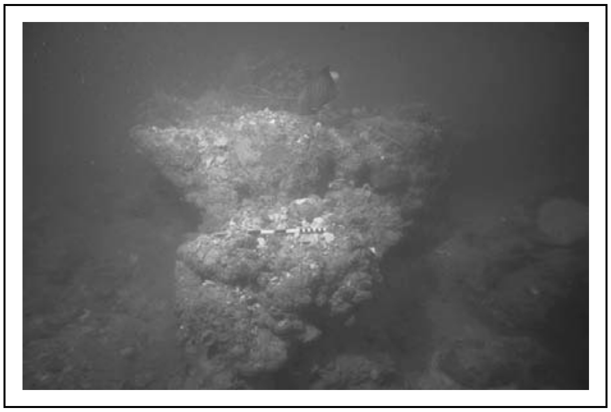
A longitudinal bulkhead is an unusual feature. In fact, to the author's knowledge such a structural element has never before been recorded on a ship of this era. It is feasible that when the hull collapsed, the consolidated iron cargo, packed across the full width of the ship, broke at the keel, but such a uniform break in every compartment makes this highly unlikely. Another possibility is that there was a nonstructural partition running the length of the ship, but the width of the gap suggests a substantial structural element.



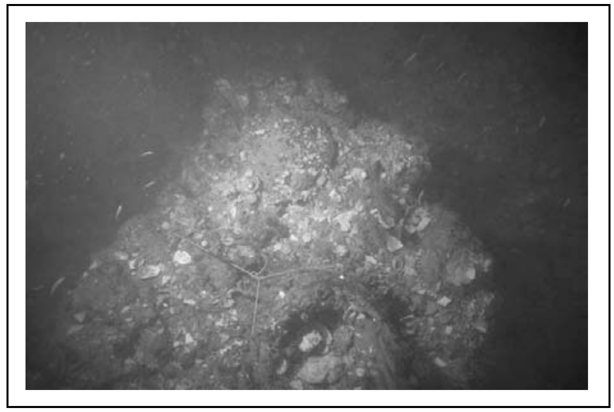
Conjectural Bulkhead Layout

Transverse gaps suggest a minimum of twelve bulkheads, dividing the ship into thirteen compartments. The compartment widths varied from 1.2 to 1.5 m in the central portion of the ship.

Two stone anchors were found lying side by side in Grid K3, a strong indicator that the bow of the ship is facing east. This supposition is supported by the shape of Concretion 19, the easternmost block. Looking at this concretion from the northeast at seabed level, one can clearly see the deep V section of the bow. The block seems to have skewed 45 degrees when the hull collapsed. In the original configuration the lower levels of the forward hold must have been filled with iron bars and cauldrons. The longitudinal bulkhead appears to have stopped at the foremost bulkhead and not continued all the way to the bow. Looking down on Concretion 19, it can be seen that the bow flared out very quickly from a fine prow. The bow compartment was approximately 2.7 m in longitudinal extent.



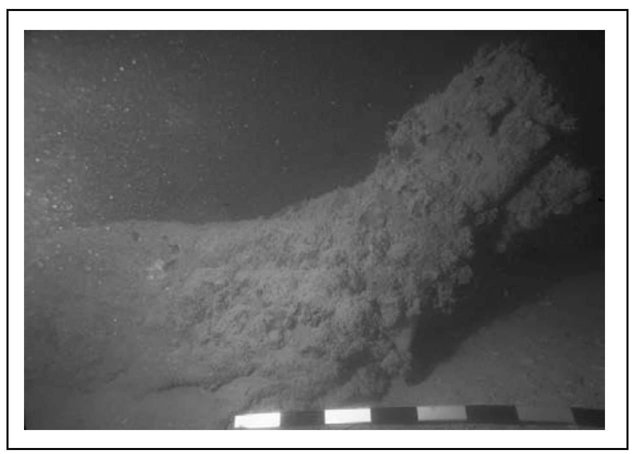
End view of the “bow” concretion.



Plan view of the “bow” concretion (the bottom left is the “bow”).

Towards the stern the concretions are broken into smaller blocks and are more scattered. This may partly be the work of fishermen’s dynamite. But it is also probably due to the iron being stowed in the raised stern, which must have collapsed before the lower hull. At Concretion 4 the pattern becomes asymmetric. There is nothing on the port side to balance the weight of Concretion 4. Either the port side was loaded with another cargo, such as ceramics, or Concretion 4 has fallen to one side and originally was amidships. If the latter, then the longitudinal bulkhead stopped short at this compartment.

Concretion 12 has a very interesting cross section. The outer portion of this concretion turns up abruptly from the horizontal, suggesting that it is a molding of the turn-of-the-bilge. If it is, then the vessel must have been flat bottomed and hard chined. Concretion 12, however, is only half as long as concretions on the port side, so it could not have extended to the turn of the bilge. An explanation is that the iron was stacked up on another form of cargo at this point, a cargo that has long since disappeared, such as wood.



Cross sectional view of Concretion 12.

The shape of Concretion 19 indicates that iron was stowed all the way up to the bow. From the symmetry of the ceramics spread about the centrally located concretion assembly, it is reasonable to assume that iron was loaded along the full length of the ship. This indicates a keel length in the order of 18 m. The well consolidated Concretion 11 is 3.8 m long, giving a minimum hull width of 7.6 m. The stone anchors are 3.2 m east of Concretion 19. Assuming they were stowed right on the forepeak and did not move far laterally when the ship collapsed, the bow overhang was approximately 4 m. If the stern overhang was of the same order, the length overall would have been approximately 26 m, giving an aspect ratio of 1:3.4.

Dowel hole in a wood fragment.

Although very few pieces of wood survived, two small chunks did have identifiable dowel holes. One was only a cross section with a dowel diameter of 15 mm. The other encased the entire hole with a dowel diameter of 27 mm.

6.2 Stowage Pattern and Cargo Capacity

Iron and ceramics made up the bulk of the cargo. Other items, such as ivory and copper alloy ware, were also present, but the stowage of these less significant trade goods is discussed in Section 7.0, Artifacts.

Iron was stowed first and appears to have been placed in the lower portion of every hold. It is very difficult to make out the individual components of the massive concretion blocks, but in some places it is clear. Many are made up entirely of bundles of iron bars lashed together in a cone shape. The cones have been stacked end-for-end in a longitudinal direction. Cauldrons are stacked one inside the other in a longitudinal direction as well, often on top of the iron bars. One exception is Concretion 6, which is made up of larger cauldrons stacked athwartships.

By calculating the volume of the iron concretions, making a 30 % allowance for expansion and packing interstices and using a specific gravity of 7.2 for cast iron, the total weight can be estimated at 340 tons.

To get an idea of the stowage of the ceramics, it is worth looking at the Overall Site Plan (Section 4.1) and the Overall Ceramics Distribution Plot (Appendix C). The ceramics have spread out 20 to 25 m in all directions from the iron concretions. The Ceramics Distribution Plot must be interpreted with caution since as many as 12,000 pieces were recovered in earlier excavations. It does, however, indicate trends. There is a dearth of pieces in the southeast quadrant, but this is

Bundles of iron bars concreted together.

offset by an abundance to the northeast. Overall, the distribution of ceramics is fairly even along the whole length of the site, suggesting that ceramics were loaded in every hold of the vessel. They must have been loaded on top of the iron cargo, probably in straw cylinders and wooden barrels. Nothing remains of the packing material.

It is interesting to study the distribution of the various types of ceramics to determine in which part of the ship they were stowed (see Appendix D, Ceramics Distribution Plots). Earthenware kendis were stowed throughout the ship, although there are much higher concentrations just forward of midships and at the bow. As the kendis are probably not from China, but rather were picked up at a port en route to Java, it is reasonable to conclude that they were loaded on top of the Chinese ceramics cargo along the length of the ship wherever there was remaining hold space. In fact, some of the Chinese ceramics may have been bartered for the kendis which were very popular in Indonesia.

Octagonal covered boxes appear to have been stowed throughout the vessel. So too were provincial dishes, but there were more in the bow area. Glazed provincial bowls with no decoration were essentially stowed from midships aft; whereas provincial bowls with an unglazed ring in the well were stowed in the stern and in the bow, but not amidships. Fine bowls with an incised decoration were also primarily stowed in the stern and in the bow with only a small quantity just forward of midships. Small qingbai vases were stowed from midships forward with the vast majority right up in the bow compartments. Small dishes with an incised decoration, on the other hand, were stowed everywhere except in the bow. Small conical bowls with an incised decoration were stowed amidships and perhaps in a few compartments just aft of that.

Merchants were generally allotted compartments or portions of compartments for their trade goods. Unfortunately, the huge scatter of ceramics makes it impossible to determine the stowage pattern by compartment. So it is difficult to say whether the different types of ceramics loaded throughout the ship were determined by the preference of individual merchants or were governed by a few individuals shipping a large consignment.

A very rough estimate can be made of the weight of the ceramics cargo. Based on at least 100,000 pieces of typical rice bowl size (many pieces are larger and many smaller), the ceramics cargo weighed between 25 and 30 tons.

The massive iron cargo and huge spread of ceramics strongly indicates that the ship was loaded to capacity. From the estimated weight of the cargo and from deduced ship's dimensions, it is estimated that the loaded displacement of the ship was 400 to 500 tons.

6.3 Wood Identification

Two wood samples were identified by Dr. Ian Godfrey of the Department of Materials Conservation at the Western Australian Maritime Museum (Appendix G). These samples, from their size and appearance, were from structural timbers. Other wood samples were collected; however, they were mostly in the form of branches. Such material could have been cargo (i.e. aromatic woods) or dunnage, but it could also be intrusive to the site. Branch wood is also difficult to positively identify.

Most of the small pieces of wood recovered were of the same species, judging from macroscopic examination. They included the two pieces with dowel holes alluded to earlier. The species is thought to be *Parastemon*, with the features of *P. Urophyllus* (common name

Mandailas) best matching the samples. *Parastemon* species are native to Southeast Asia and neighboring regions, being found in Western Iran, Papua New Guinea, Soloman Islands, Myanmar, Indonesia, and the Malay Peninsula, as well as some adjacent countries and islands.

Another possible match for this timber, although less likely than *Parastemon*, is *Parinari*. This is found throughout Southeast Asia and in southern China to some extent. The drawback on both of these species is that the trees are not particularly large and the timber is more difficult to work.

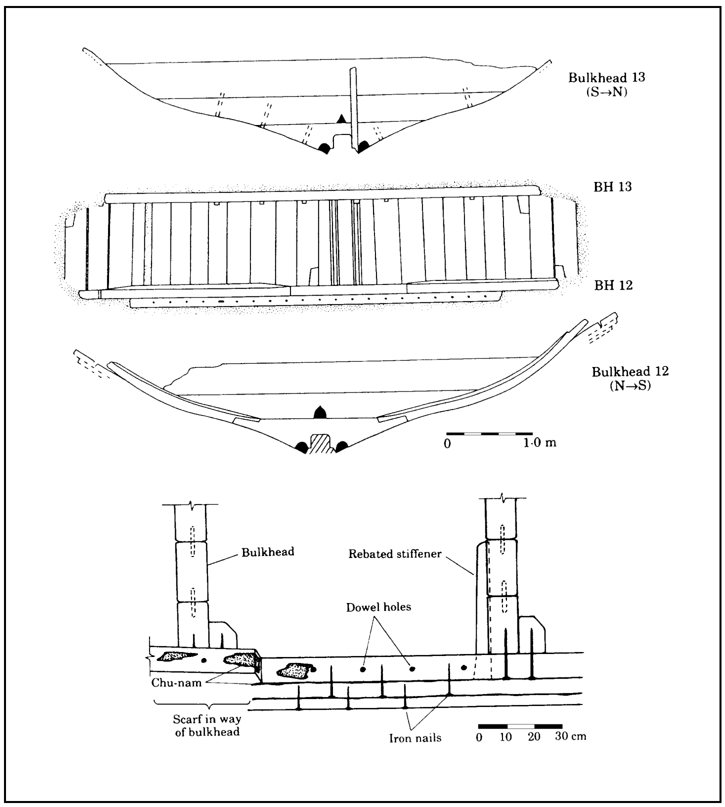
The other sample that was identified was of a light-colored soft wood, a fragment of a small rectangular beam with a beveled edge. The best match is that of *Alstonia scholaris* (common name: white cheesewood or milkwood), which is native to Africa and the Philippines, as well as the countries listed above. This timber is easy to work and comes from large trees. Being a soft wood , however, it is not durable. Unfortunately, as a result of the highly degraded nature of the sample, this identification should not be regarded as conclusive.

6.4 Identifying the Ship

Despite the fact that the main cargo of iron and ceramics is from China, it is unlikely that the ship is of the same origin.

6.4.1 Construction Materials

The few surviving fragments of wood provide an important clue as to vessel origin. The Java Sea Wreck seems to have been built largely of mandailas, a predominantly Southeast Asian timber, and milkwood, also tropical but may be found in the very south of China. It is interesting to note the woods identified on other non-European shipwrecks discovered in Asia.



Bulkhead and compartment plans of the Phu Quoc Wreck.

The Phu Quoc ship (Blake and Flecker, 1994) has bulkheads of padauk (*Pterocarpus* Sp.), a timber today restricted to Myanmar and the Andaman Islands, and hull planks of teak (*Tectona grandis*), which occurs mainly in Myanmar, Thailand, and Indonesia. The planks were edge-joined with dowels of sappan wood (*Caesalpinea sappan*), which is widely used by Southeast Asian boatbuilders, such as the Bugis, to this day (Horridge, 1985). This wreck was dated to the fourteenth or early fifteenth century and was almost certainly built in Thailand, although probably under Chinese supervision or influence.

The Pattaya ship (Green and Harper, 1982), had bulkheads constructed from beech. The particular species was not identified. Beech is found across central and northern Europe, the Baltic, and throughout Asia. Japanese Beech is restricted to Southern China, Japan, Thailand and Korea. This wreck is also thought to be of Thai origin.

The Quangzhou ship (Green, 1983) had a pine keel, a cedar hull, and a camphor transom beam. This wreck from circa 1277 is believed to have been built in Southern China. It is contemporary to the Java Sea Wreck. The construction appears to be similar, with 12 closely spaced bulkheads being the most striking parallel, and yet the materials used are very different. By way of interest, the aspect ratio of the Quangzhou ship was 1:3.1 compared to 1:3.4 for the Java Sea ship.

From the wood identification alone, it seems unlikely that the Java Sea ship was constructed in China. Teak was one of the main timbers used for the construction of vessels in Thailand, due to its availability, workability, excellent durability, and resistance to the toredo worm. The absence of teak on the Java Sea Wreck suggests that it may not have been constructed in Thailand either.

6.4.2 Stones Anchors

As previously mentioned, two stone anchors were found in Grid K3. They were lying side by side, parallel to the axis of the ship. The larger anchor measures 1180 mm long, 480 mm wide, and 280 mm thick. It has been shaped out of a hard sandstone. In profile and in section it looks like a ship's rudder. Barely visible lines chiseled into the stone strangely correspond to the pintel straps of a rudder. The other anchor is shaped out of a large block of limestone. It is 1120 mm long, 430 mm wide, 220 mm thick and has a similar shape to the sandstone anchor. It is interesting that a porous and relatively light limestone has been used for an anchor, where weight is a prime consideration.

Stone anchor shaped from sandstone, in situ.

Stone anchor shaped from limestone, in situ.

A stone anchor stock was found on the Breaker Shoal Wreck in the Philippines, which has a very similar cargo and date to the Java Sea Wreck. That stone is described as "a slab, measuring 3 m in length, in the shape of an angular column thickening at the middle and narrowing at both ends" (Dupoizat, 1995). It is similar to anchor stones found on the Quanzhou Wreck, dated circa 1277. The anchor stones from the Java Sea Wreck are nothing like them.

A bas relief on the Bayon of Angkor in Cambodia clearly depicts an anchor being lowered from a large seagoing vessel. The anchor appears to have a large stone slab fastened near the crown (more like a modern danforth anchor than an admiralty pattern anchor) that has the stock well down the shank. This flat stone slab depicted on the bas relief bears far more resemblance to the Java Sea Wreck anchors than to examples on the Quanzhou and Breaker Shoal Wrecks, which are both thought to be Chinese vessels.

Anchor depicted on the Bayon of Angkor, Cambodia.

6.4.3 Fastenings

Chinese ships were fastened exclusively with iron bolts and nails (Waters, 1946). Sometimes wrought iron straps were also used to fasten hull planks to bulkheads. Horridge (1985) states that the typical Southeast Asian cargo vessel, which he calls a *jonque*, is distinctively so due to the absence of iron fastenings. He suggests that Southeast Asian shipwrights did not use iron, as it rusts rapidly in warm tropical waters.

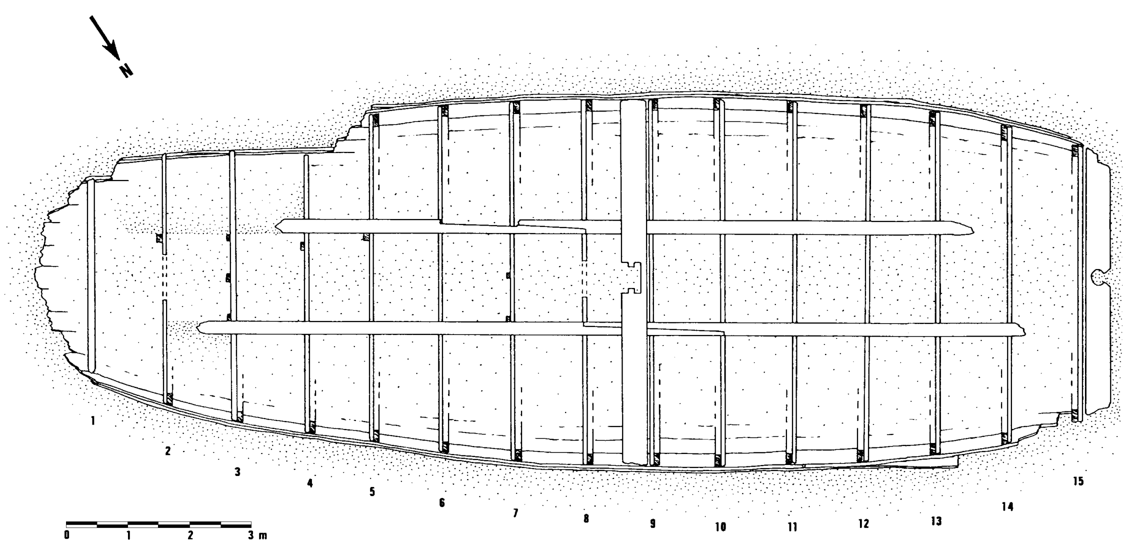
The temperature difference between temperate and tropical waters would actually have little effect on the oxidation of iron. Furthermore, the Chinese skillfully covered nail recesses and sealed edge joints with a lime-based caulking compound called *chu-nam* to inhibit oxidation of the iron fastenings (Li, 1989). Thai ships of the fourteen to sixteenth centuries have hull and bulkhead planks edge-joined with dowels, and yet the inner strakes are attached to the bulkheads with iron nails. This is the case with the Pattaya wreck (Green, 1983), the Phu Quoc wreck (Blake and Flecker, 1994), the Central Gulf of Thailand wreck (Flecker, unpublished), and the Royal Nan Hai wreck (Sjostrand, pers. comm.). Worcester (1947), in describing methods employed in building Chinese junks, comments, "The side planks are then placed longitudinally in position and hove down by a Chinese windlass, after which they are firmly nailed to the edges of the bulkheads." So it may be said that the presence of dowel edge-joining precludes Chinese construction, but the presence of iron fastenings does not preclude Southeast Asian construction.

This conclusion can perhaps be further refined. There is no evidence that ancient Indonesian ships used iron fastenings at all. Some craft are of lashed-lug construction, and some are fastened exclusively with dowels and treenails. Horridge's observations, therefore, probably refer to Indonesian rather than Southeast Asian vessels. The dowel holes in chunks of wood recovered from the Java Sea Wreck indicate that it is not a Chinese vessel, but other characteristics must be examined to determine in which part of Southeast Asia it was constructed.

6.4.4 Bulkheads

Compartmentalized design has long been attributed to the Chinese, primarily through the study of early Chinese manuscripts (Needham, 1971). The Thai wrecks mentioned above also had bulkheads. Green (1978) suggests that as a result of the drastic reduction in the export of Chinese porcelain caused by the so-called "Ming Ban" on private overseas trade, which came into effect in 1371, and the Interregnum (1435-65) calling for the closure of the imperial kilns at Jingdezhen, Chinese emigrants in Southeast Asia may have been building fleets of trading vessels to establish a new basis of trade in the region. Such ships would naturally incorporate aspects of both Chinese and local ship building traditions. Most of that new trade was in Thai ceramics (which are also heavily influenced by Chinese ware, particularly Sawankhalok ware which has strong parallels to Longquan ware from northern China), so it is reasonable to assume that the vessels required to implement the trade were also built in Thailand.

The Java Sea Wreck had at least twelve closely spaced bulkheads. If it was indeed built in Thailand, then bulkheads have been a feature of Thai ship construction from well before the boom in the Thai ceramics trade in the fourteen and fifteenth centuries. With the close proximity of China and continuous interaction over preceding centuries, it would not be surprising if Chinese techniques were adopted well before this time. It is also quite feasible that Thai features, such as butt-jointed multi-layered hull planking, were adopted by the Chinese.



Plan of the Central Gulf of Thailand Wreck*, a Thai vessel with bulkhead construction.*

The attributes of early Indonesian vessels are determined mostly from a very limited number of temple carvings, such as the ninth century relief at Candi Borobudur in Java, which is thought to be a coastal trading vessel rather than an ocean-going ship. Obviously, nothing can be ascertained about internal structure from such sources. According to Manguin (1980), sixteenth- and seventeenth-century Dutch and Portuguese travelers describe Indonesian vessels in considerable detail, but nowhere is there mention of bulkheads; whereas early foreign writers describing Chinese vessels are enthralled by them (Needham, 1971). Furthermore, no modern

Indonesian vessel still constructed by the dowel edge-joined method incorporates bulkheads in their design. So it seems unlikely that compartmentalized construction was an Indonesian shipbuilding feature.

There is one other Thai wreck with noteworthy similarities. The Ko Si Chang III wreck of the fifteenth or sixteenth century is estimated to have had sixteen bulkheads, creating compartments approximately 1.2 m wide. The aspect ratio of 1:3.3 is almost the same as the Java Sea Wreck, although it is considerably smaller at 20 m LOA.

6.4.5 Conclusion

It is impossible to conclusively determine the country of origin of the Java Sea Wreck. There was no surviving cohesive hull structure, and there are minimal contemporary Asian wrecks with which to compare.

The wood identification indicates that the vessel was not built in China. But the absence of teak may also place doubt on Thailand as the place of origin. The stone anchors seem to be non-Chinese from the very limited information available. The dowel holes in two surviving pieces of timber and the absence of iron fastenings, some of which should have survived in concretion form had they been present, adds to the likelihood that China is not the place. While common in Chinese and Thai ships, bulkheads are not known to have been utilized in Indonesian shipbuilding, although there is almost no evidence on the internal layout of such craft.

It is almost certain that the Java Sea Wreck was not built in China. Both Indonesia and Thailand are possible countries of origin. Hopefully, future discoveries will shed more light on early construction techniques practiced by these two countries.

6.5 Dating the Ship

Both Roxanna Brown and Dr. John Miksic date the ship to the mid-thirteenth century, based on a stylistic analysis of the ceramics cargo. In order to check this hypothesis, a resin sample was sent to Beta Analytic, Inc., a radiocarbon-dating laboratory in the USA, for C14 content measurement and C13/C12 ratio analysis (see Appendix H).

Wood or ivory could also have been used for analysis. However, the wood was perhaps too degraded to give meaningful results, and ivory has been known to exchange C14 with sea water over prolonged periods and hence provide misleading data. Wood can also predate a ship by 100 years or more, if old timber is used for its construction. Resin, on the other hand, is unlikely to have been kept in storage for any significant period before being shipped, and the sample has suffered minimal degradation.

The C13/C12 ratio is used to correct the measured C14 age and to calibrate the result to the conventional calendar. From the analysis there is a 95% probability date range of AD 1215 to 1405. The 68% probability date range is AD 1265 to 1310. So it can be said with some certainty that the ceramics cargo does not predate the thirteenth century. This is significant, as several of the finer wares did suggest an earlier date. While it is certainly feasible that such wares were manufactured over a longer period than previously thought, it is unlikely that production continued on into the fourteenth century. Thus, the thirteenth century remains the most likely date for the wreck and its cargo.

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7. ARTIFACTS *by Michael Flecker*

The positions of individual artifacts are depicted in the Artifact Distribution Plan (see Appendix C).

7.1 Iron

The most prominent feature of this wreck site is the iron cargo. Concreted blocks of iron up to 4 meters long, 1.5 meters wide, and projecting up to 1.5 m above the wreck mound mark the position of a ship that plunged to the seabed approximately 750 years ago. The iron cargo concreted together in the ship's compartments before the hull and bulkheads disintegrated and have maintained that shape ever since.

The concretions cover an area approximately 18 m long and 9 m wide. Most blocks are well consolidated. However, there is quite a wide scattering of constituent parts in Grids F4, F5 and G5. This area is thought to be the stern of the ship. The stern, being higher, may have collapsed before the iron had a chance to fully consolidate. Hence, the scatter of smaller pieces there.

Several different types of iron cargo have been identified. There are cauldrons of different sizes, which have been recorded on a number of shipwrecks lost in Asia. But the bulk of the iron cargo consists of bundles of bars, which were probably blanks intended for forging by Indonesian blacksmiths.

7.1.1 Cauldrons

Cauldrons are distinguished from woks in that they have a wide rim, whereas woks have no rim at all and tend to be shallower. Cauldrons of various sizes can be clearly seen in Concretions 4, 6, 9 and 19 in the Iron Concretion Plan. Several small stacks were also found loose, and two of those were recovered for measuring.

Concreted stacks of cauldrons, in situ.

A stack of cauldrons after the surface concretion layer has been removed.

After the thick concreting material made up of iron corrosion products, sand, and calcareous marine growth was carefully chipped off the outside of one stack, 7 individual cauldrons could be discerned. There was no base metal remaining. The cast iron had transformed to a black material that in some areas was brittle and in others could be washed out with a jet of water. This black material did, however, maintain the original shape of the cauldrons. They were 510 mm in diameter and 2.6 mm thick. The wide rims were decorated with two sets of three concentric rings, either cast or etched finely into the surface.

A smaller stack of 5 cauldrons was in a similar condition. Each one measured 320 mm in diameter and 2.0 mm thick. They were decorated in the same fashion as the larger cauldrons. It is interesting to note that small pieces of rattan were found embedded in the concretion near the top of the stack. The stacks of cauldrons may well have been bound with rattan, and may also have had rattan handles to facilitate carrying.

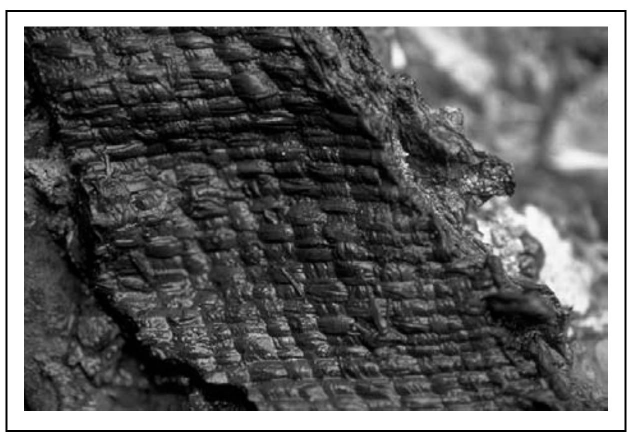
Larger cauldrons can be seen in Concretions 6 and 19. It is estimated that their diameter is close to 700 mm. Large cauldrons were used to prepare rice wine (Brown, pers. comm.).

7.1.2 Iron Bars

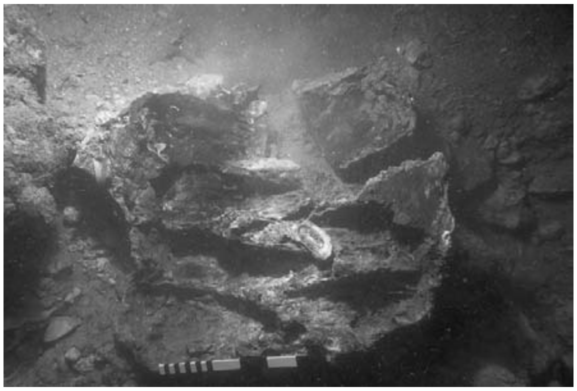
Most of the iron cargo consisted of bundles of bars. Two different types were identified, although there may be different sizes of each type.

An amorphous iron concretion, measuring approximately 200 x 120 mm, was carefully dissected to reveal four rectangular iron bars, each 160 x 28 x 28 mm. They were bound together with three strips of rattan and wrapped in a coarse woven material that looks very much like hessian. Another contained five bars, each 220 x 30 x 22 mm and rounded at the ends. This one was also tied with rattan, but wrapped in strips of cane. It is thought that these iron bars are blanks for making tools, weapons, and agricultural implements for use in Java and possibly for trade throughout Indonesia. Only the two stacks of rectangular bars were recovered, although it is likely that at least one concretion block consists entirely of them. Unfortunately, most of the concretion blocks have fused together so solidly that it is impossible to distinguish the constituent parts.

Rectangular iron bars bound with rattan.



Detail of the material covering the rectangular iron bars.

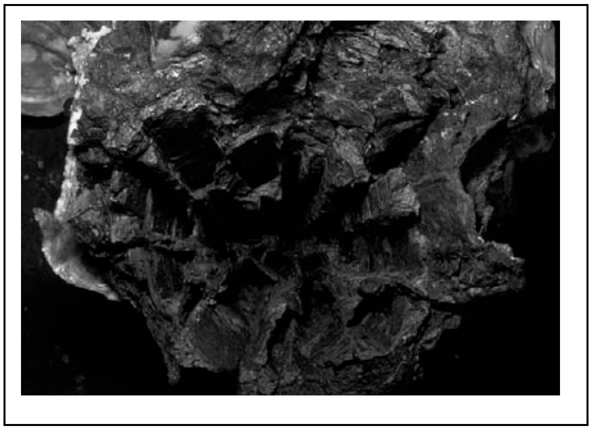


A broken concretion showing bundles of bars stacked end-to-end.

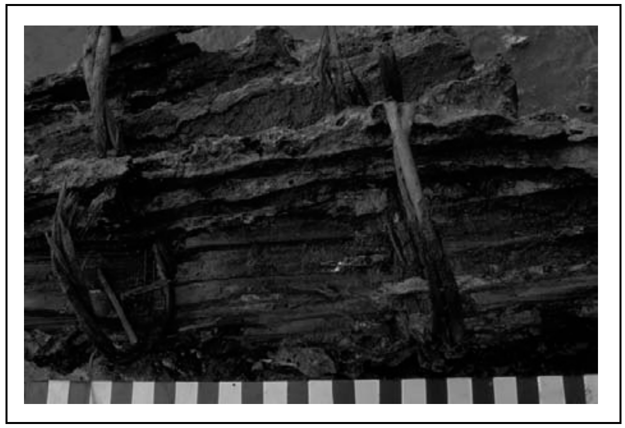
Individual concretions of trapezoidal bars.

Far more common are conical concretions, typically 400 mm long. Most of the scattering of concretions towards the stern consists of these, and they can be made out in many of the concretion blocks. A very interesting lump of concretion that has been broken open (possibly by fishermen's explosives) shows clearly how these cones were stacked end-to-end in the hold of the ship.

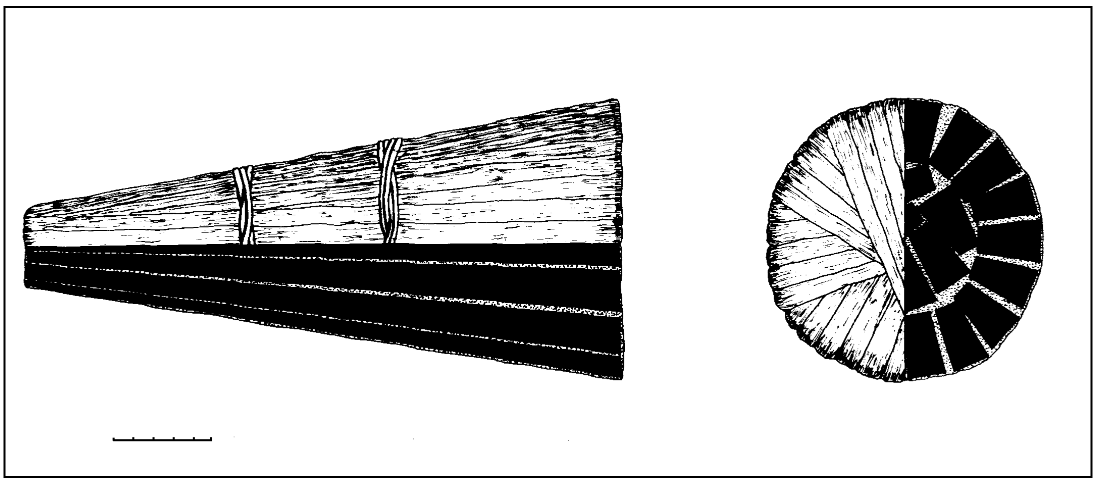
Several of these concretions were carefully dissected to reveal their contents. Each was found to contain a bundle of iron bars with a trapezoidal section and tapering along their length. The bars were bundled in the same orientation; hence, the conical shape. The bundles were held together with two loops of twisted rattan, and impressions in the concretion suggest that they were wrapped in leaves or strips of cane. The individual bars were separated by a white material that is thought to be a lime compound, such as was used for caulking and sealing iron fastenings in ships. This compound is known as *chu-nam* and consists of lime and tung oil. This would be an excellent method for preventing the iron from corroding in storage and during the long voyage from China to Java. Iron bars of this unusual shape could have been forged into large one-sided blades, like a modern parang.



Cross section of a bundle of trapezoidal iron bars.



Long section of a bundle of bars clearly showing the rattan binding.



Artist's impression of a wrapped and bound bundle of trapezoidal bars (scale in cm.).

7.1.3 Ax

One concretion was formed by a small ax head. It measures 145 mm long, 42 mm wide at the handle, and in profile varies from 55 mm at the handle to 61 mm at the cutting edge. As there was only one found, it is likely that this was an item of ship's equipment.

7.2 Ivory

In the southwest quadrant of the site, 16 pieces of ivory were recovered. From the reasonably concentrated nature of the finds (Artifact Distribution Plan, Appendix C), it seems that the ivory was stowed in the stern of the ship on the starboard side.

Elephant tusks, approximately 400 mm long.

The ivory is in the form of unworked elephant tusks. The largest piece measured 590 mm long and 130 mm in diameter. Unfortunately, ivory deteriorates badly underwater, tending to exfoliate. As a result, many of the pieces found are hollow or just the outer layers of a tusk. In several cases the solid tip of a tusk has survived.

Two pieces have been cut by hand. One is a 245 mm long tip of a tusk that has had the very end neatly cut off. There are also cut marks on the surface of the piece, and it is hollow. The other is the outer layer of one half of a tusk, which had had a portion roughly shaved off. The tool marks are still quite clear.

7.3 Resin

Eight pieces of resin were recovered. Like the ivory, they tended to be in the southeast quadrant of the site. However, they were more spread out, probably due to their low specific gravity. In fact, one small piece was found at the opposite end of the site in Grid N2. As with the ivory, it is likely that the resin was stowed in the stern of the vessel, probably on the starboard side.

Hundreds of years of immersion have not had that much effect on the resin. There has been a bit of erosion, and the outer millimeter or so has become a soft powdery pale brown. But within, the solidified tree sap remains glassy, and the fragrance remains distinctive. The largest piece is 410 mm long by 180 mm across. Most of the other pieces are half to quarter that size. Two of them have very well defined cut surfaces on one end.

A block of resin, 410 mm long.

7.4 Balance Weights and Bars

In all, 14 balance weights were found from at least 4 different sets. This is not sufficient to conclude that they were an item for trade. It is more likely that they were the personal property of various merchants on board. Of the 14, 12 are made of a copper alloy. They have been very finely cast and finished. To obtain an exact weight, holes have been drilled out of the center of both sides and then plugged with a copper alloy of slightly different composition. There are two types: one plain and the other with a scalloped edge. Not surprisingly, all of the heavy copper alloy weights were found in close proximity to the iron concretions that mark the original position of the ship. Most of them were found to the north of the concretions. However, a scatter of over 25 meters confirms that they were not stowed in one place as a trade consignment.

One unusual balance weight found in Grid H5 has been carved out of milky quartz. As with the copper alloy weights, holes have been bored out of the center of each side to obtain the correct weight. Another very finely crafted weight is of composite construction and is only 26 mm in diameter. It appears to be made of marble with copper alloy inserts plugging the usual central holes. Judging from the perfect fit, the alloy may have been cast in the holes.

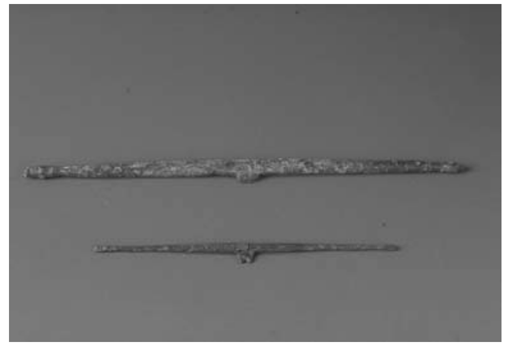
Different types of balance weights — plain Cu alloy (top left), scalloped Cu alloy (bottom left and right), composite (bottom center), and quartz (top right).

By weighing all of the balance weights it becomes apparent that there are six distinct weight categories. These are tabulated below (weights in grams).

	Plain Cu alloy	Scalloped Cu alloy	Composite	Quartz
1.	-	-	27	-
2.	37	-	-	-
3.	70	71	-	-
4.	171, 190	189	-	-
5.	340, 363, 364	384	-	-
6.	760, 762	-	-	727

Discrepancies in the weights may be accounted for by the differing degrees of corrosion of the copper alloy. The large quartz weight has been eroded and in places penetrated by marine borers.

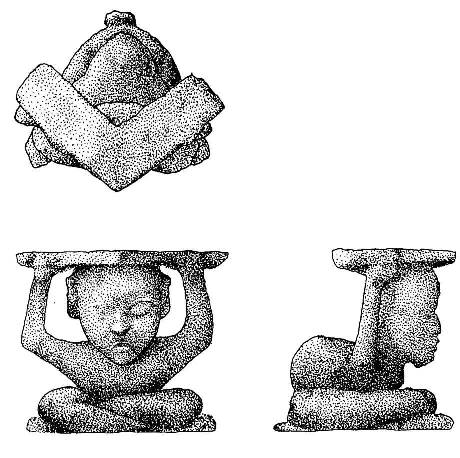
Two balance bars were also found. While being very different in size, they are exactly the same shape, a round bar tapering from the center to approximately half the diameter at both ends. The ends are "turned" and there is a flat pivot point in the center that is broken on both pieces. The small balance bar was found in Grid K3 and is 150 mm long, and the large one was found in Grid E2 and is 221 mm long. Presumably the different sized bars were used for different weight categories and both types may have been in a set, although contextual evidence suggests this was not the case.



Balance bars.

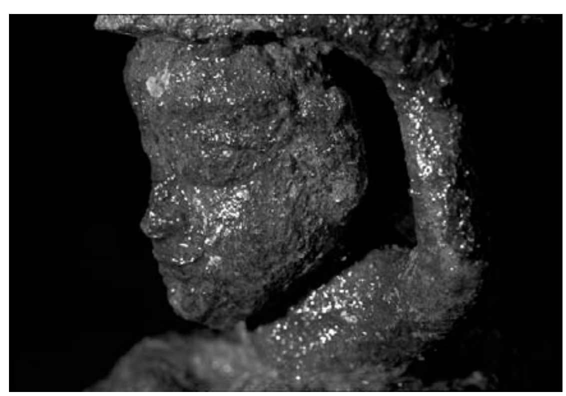
7.5 Figurines and Finials

Two very interesting copper alloy figurines were found on the site. The first was from Grid J5. It is a man, 65 mm high, sitting cross-legged and holding with upstretched arms a corner support for a small platform, perhaps an altar. He is one of an original set of four, which would have been legs for the platform. He is very much stooped under the load, his back being bent double. His large head is quite un-Chinese, displaying big eyes, a small flared nose, a down-turned thick-lipped mouth, a pointed chin, and long ears. No parallel has been found.



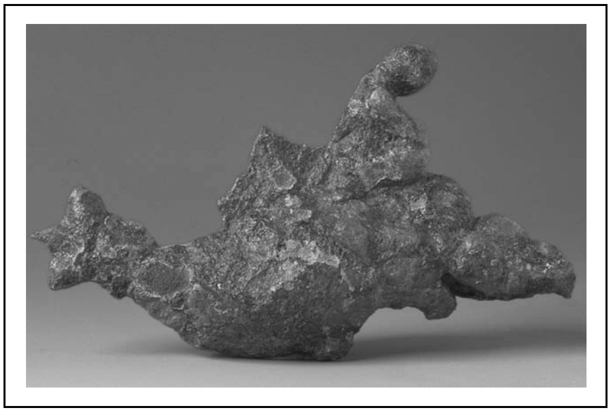
Various views of platform leg figurine (scale in cm).

Platform leg figurine.

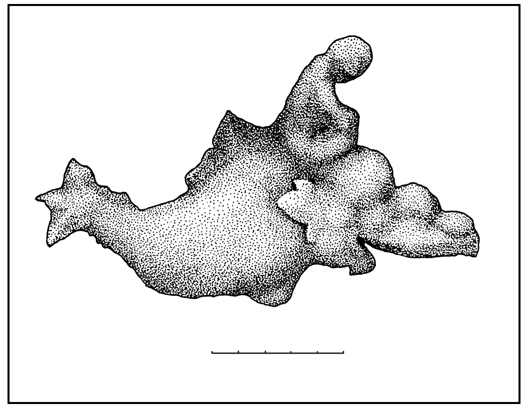


Close up of face.

The other figurine was discovered in Grid H2. Measuring 172 mm long, it is a figurine of a woman riding a sea creature. The creature bears an uncanny resemblance to those spouting monsters depicted on European sea charts of the sixteenth and seventeenth centuries, having a large mouth, bulbous nose, and three pronged dorsal, pectoral, and tail fins. The rider sits with one leg crossed over the other. Her right hand rests on her knee. Her left arm is missing. She has long hair flowing half way down her back and looks out to the left, her head slightly bowed.



Bronze figurine.

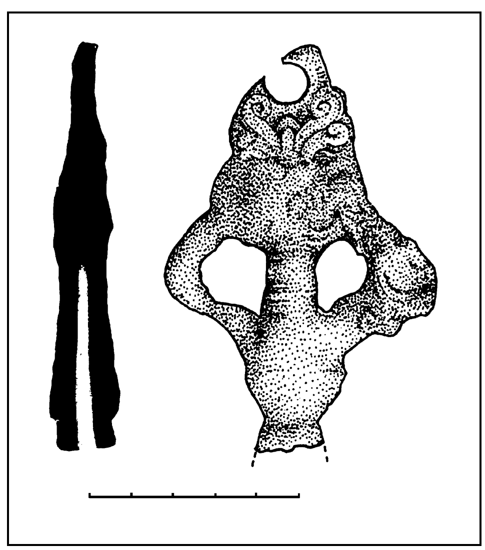


Bronze figurine (scale in cm).

Pre-Majapahit folklore explains the role of this fine lady and her unusual steed. An ancient Javanese text, the *Sri Tanjung*, describes the afterlife journey of a princess who was killed before she had made preparations to liberate her soul and therefore could not attain salvation. Her soul was rescued by a monstrous fish and carried to the next world. This scene is depicted on a diverse range of Majapahit relics, such as a bronze hanging lamp, a carved stone window grill, and a gold modesty cover (Miksic & Soekatno, 1995).

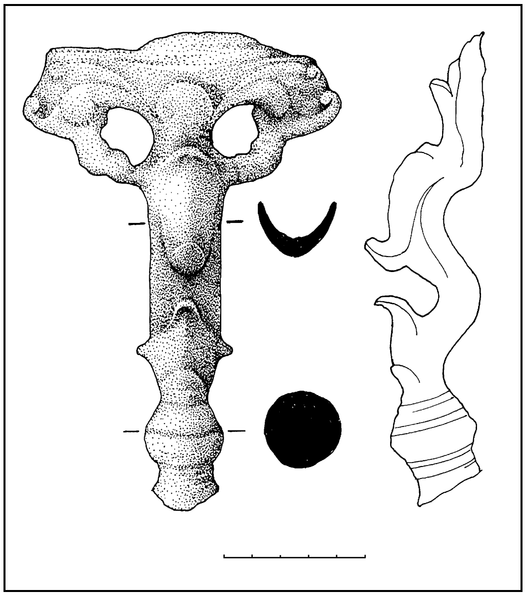
The Majapahit and pre-Majapahit religious ceremonies may explain the presence of two unusual finials. A small one, 90 mm long, was discovered in Grid H2. It is a badly corroded geometric shape, although some elaborate cast decoration can still be seen on one side.

Bronze finial.



Bronze finial (scale in cm).

The other was found in Grid E2. This one has the appearance of a masquerade party mask with holes for the eyes and distinct upturned eyebrows. It has a wavy cross section, incorporating a stylized mouth and nose.



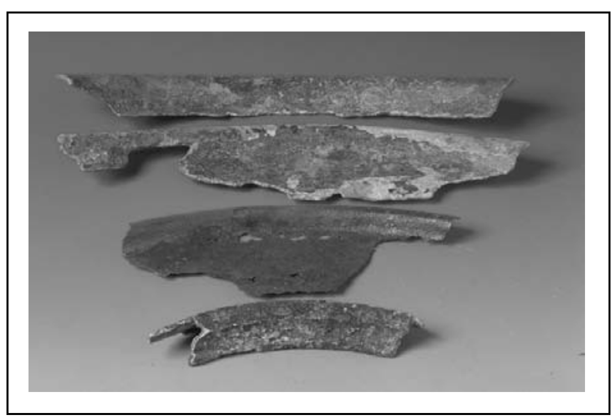
Mask-type finial (scale in cm).

Mask type finial.

These finials were originally mounted on wooden staffs and were carried by priests during religious ceremonies. Finials from the Majapahit era have been unearthed in eastern Java and in Bali. They often depict *nagas,* a mythical cobra-like creature. Bronze finials with loose rings that rattled (*khakkhara*) adorned the top of walking staffs carried by mendicant priests (Miksic & Soekatno, 1995).

7.6 Trays

Unfortunately, no complete trays were found. The long exposed site afforded no protection for these thin copper alloy artifacts. Only the thicker rims, and in a few cases the central portion, of a variety of trays remained. A tray is defined loosely here as being a shallow dish with a distinct raised rim. A few rims have sufficient body still attached to confirm this identification, and all the thin sheet fragments are relatively flat. Other rim types without identifiable fragments may be from deeper vessels, such as copper bowls or cauldrons.



Tray fragments.

There are four distinct types of rim. The first is a half-round section and is definitely from a tray. The rim thickness is approximately 1.5 mm, while the tray body is less than 1 mm thick. The rim is decorated with a faintly impressed double line on the inner surface. These trays would have had a diameter of approximately 420 mm.

Another definite tray is heavier and unadorned. It has an everted rim, approximately 12 mm wide and 3 mm thick. The body of the tray is 1.5 mm thick. The diameter would have been approximately 520 mm.

The third type is very solidly made; but as only rim fragments survived, it cannot definitively be termed a tray. The rim is squared and beveled in tiers and is typically 4 mm thick. The original vessel would have had a diameter of only 250 mm, suggesting that perhaps it was a solid bowl rather than a tray.

The fourth type is represented by only two small rim fragments. They are roughly half round, only 8 mm wide and 4 mm thick, suggesting that they may be cast. The diameter would have been 160 mm.

Thin copper alloy sheets, heavily corroded around the edges, are thought to be the central parts of trays. One large piece, measuring 290 x 220 mm and approximately 1 mm thick, may be the center portion of the first type of tray described above. Three groupings of concentric circles decorate this fragment: a central group of 30 mm diameter, a middle pair of 160 mm diameter, and a very faint outer pair of 340 mm diameter. One slightly bowed piece with a thickness of 2 mm may be from the second type of tray described. Like the rim, it is undecorated.

During the Majapahit era, bronze trays with incised circular decorations were used as offering trays in religious ceremonies (Miksic & Soekatno, 1995). Some were more elaborate with incised lotus blossoms and scrolls.

7.7 Gongs

Only two gongs were recovered: one more than half intact and the other just a highly corroded central portion. They were found relatively close together in the stern area of the ship in Grids B3 and D3. The better preserved piece has an overall diameter of 270 mm, and the central raised dome is 60 mm in diameter. The fragment has a slightly larger raised dome with a diameter of 65 mm. There is no sign of decoration on either piece.

A bronze gong.

Bronze gongs have been found on only two other wrecks to the author's knowledge. One was a Thai vessel lost in the central Gulf of Thailand, which yielded one nearly complete unadorned gong of 380 mm diameter and one gong fragment (Flecker, 1991, unpublished). This ship was probably bound from Ayudhya to the Philippines. Others with a six-pointed star decoration were found on a sixteenth century trading vessel, probably Chinese, that was lost on Royal Captain Shoal in the Philippines (Goddio, 1988). It is postulated that this ship was bound from China to Borneo with a primary cargo of porcelain.

Gongs were manufactured in China from the sixth century and grew to be extremely popular throughout China and Southeast Asia. Made from a copper-rich alloy, they were initially cast, then repeatedly heated, hammered, and filed until the desired sound quality was achieved. They were used extensively in civil and religious ceremonies, Buddhist rituals in particular. A poem from the Majapahit era, the *Nagarakrtagama*, describes a posthumous ceremony in honor of the poet's grandmother. The rite of *parisharma* was performed to recall the soul of the departed. *Parisharma* is a rhythmic, possibly vigorous, ring dance performed by dancers in a trance-like state, accompanied by the chanting of sutras and the rhythmic beating of drums and gongs (Miksic & Soekatno, 1995).

7.8 Copper Ingots

Strangely, only three copper ingots were found. Two of them are small conical ingots, found widely separated in Grids F6 and I3. They flare out slightly at the base and are decorated with molded concentric circles midway between the base and the peak. They weigh 174 grams and 231 grams. Similarly shaped but undecorated lead ingots have been found on many Thai wrecks of the fifteenth and sixteenth centuries and on a few European vessels of the early seventeenth century. There is some speculation that they were used for currency.

Conical copper ingots.

Copper bar ingot.

A single large copper ingot was also found in Grid I3. It is the typical tapering rectangular shape of a modern gold or silver ingot. The surface is pitted by corrosion, and there are no markings. The ingot measures 195 x 88 mm at the base and is 52 mm high.

It is thought unlikely that other ingots were removed during earlier excavations as they lay down at the clay layer and hence could not be reached without excavation equipment. It remains a mystery why there were so few on board the ship, unless they were the lost remnants of some previous cargo.

7.9 Miscellaneous Copper Alloy Artifacts

There are six artifacts that defy ready classification. One is a 230 mm long hook-shaped piece found in Grid K3. What appears to be a round pan holder is partly missing from the end of the hook. There is a possible pivot point at the top, so this could be a tray holder for a large set of weighing scales. There is a decorative knob at the base of the hook.

Possibly part of a weighing scale set.

Another hook-shaped artifact is possibly a handle of some kind. It has a rivet driven through one flattened end with evidence of some form of textile under the rivet head. The wood-like grain structure of the piece indicates that it has been wrought. It was found in Grid I2.

Possibly a handle.

A complete rim of 110 mm diameter is probably that of a small copper alloy bowl. None of the interior has survived.

A small tubular piece of copper alloy, slightly pinched at the waist, may be a bushing for a small wooden pulley. It is from grid G3.

An unusual piece resembles the base of a large candlestick and is badly corroded and highly porous. The base is slightly domed, and is decorated with concentric circles and striations. The neck of the piece is flanged. The copper alloy casting has been filled with another metal, possibly an alloy of lead, which is now exposed where the copper has corroded away. It was found in Grid D0. Its function is a complete mystery.

Unidentified copper alloy artifact.

A conical hollow piece, open at each end, cannot even be guessed at. The bottom seems to be the original surface, but the top has been broken off or eroded away.

7.10 Glassware

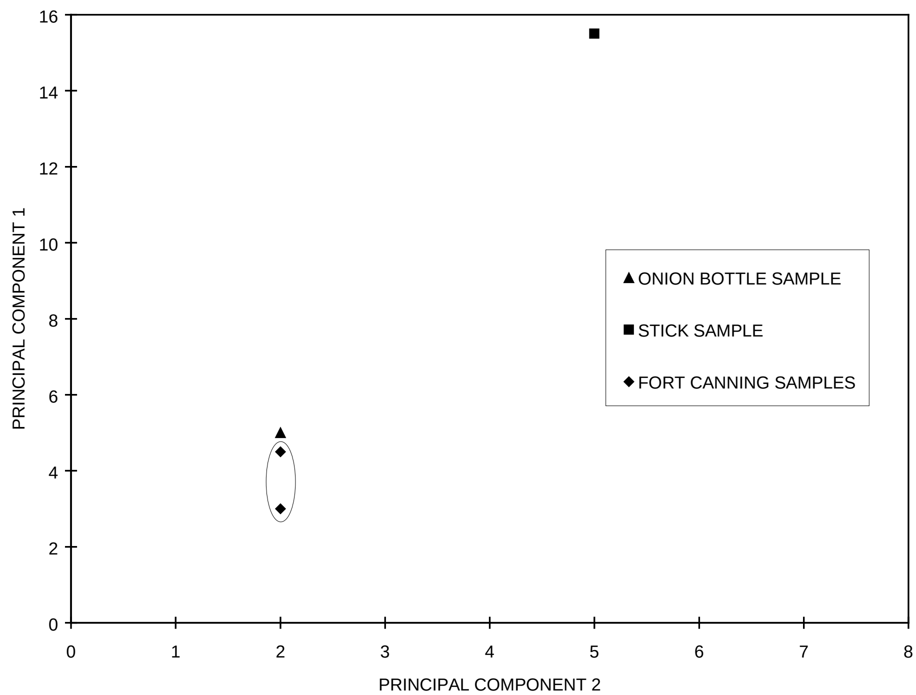
A total of five glass artifacts were recovered, only two of them of the same type. Those two are deep olive green shards with a sharp conical peak, very similar to the base of a European onion bottle. The glass is less than 1 mm thick and has minimal bubble inclusions. These shards were spread way apart in Grids B6 and I9. Another base type shard was found in E9. It is a fairly clear dark green glass with many bubble inclusions. The thickness varies from 1 to 2 mm, and the central peak is a relatively flat dome.

The only intact glass artifact appears to be some kind of lid. It has a domed top and angled sides with a sharp lip between the two. The lid has a diameter of 52 mm and a thickness varying between 3 and 5 mm. The glass is a very pale green, full of bubbles. It was found in Grid H7.

A range of glass artifacts — lid (bottom left), 'onion bottle' (top left, bottom center), thicker 'onion bottle' (top right), and stick (bottom right).

The last glass artifact is a small stick, 12 mm in diameter and 44 mm long, found in Grid J4. It has been formed by rolling very thin sheets of yellow and green glass together, giving a spiral cross section. The outer surface is deeply pitted.

Glass from the so-called onion bottle and the stick has been analyzed by X-ray florescence at the Chemistry Department of the National University of Singapore and compared to glass samples excavated from the fourteenth century stratum at the Fort Canning site in Singapore; they appear to be of Chinese origin (Miksic, 1996). X-ray florescence is a nondestructive qualitative technique where the first two principal components are plotted using the relative concentrations of 17 elements in order to compare directly to samples of known origin. The results are plotted below.



X-ray florescence analysis of glass.

The onion bottle sample is very similar in composition to the Chinese Fort Canning samples, to the extent that it can be confidently concluded that it was made in China.

Evidence of glass making in Southern China goes back to the third century, when it was described by the contemporary authors Wan Zhen *(Strange Things of the South*) and Ko Hung. The *Tai Ping Yu Lan* reports that Emperor Wu-Ti (140-87 BC) sent emissaries to “barbarians” in southwestern China to learn glass making techniques (Francis, 1986). Zhao Rukuo, harbormaster of Canton in 1225, noted that the Chinese merchants exported glass beads and bottles to Borneo and the Philippines (Hirth and Rockhill, 1911) (from Miksic, 1996).

The stick sample is very different from the Fort Canning samples. Glass was also manufactured in India and in the Middle East at the time, but there is no firm evidence of glass manufacture from primary materials anywhere in Southeast Asia during the premodern period. It is strongly suspected, though, that the Javanese in the late first millennium A.D. engaged in this activity (Miksic 1996).

7.11 Rocks

Every rock found on the site was brought to the surface. They vary in size from river rounded stones weighing 5 kg to fingertip-sized pebbles. Some of the rocks have obviously been hand shaped, and these have been treated separately in Section 7.12. The total number recovered was 64. Only half of those could be classed a ballast stone size, and, with rare exceptions, those are well rounded and waterworn. With the massive iron cargo it is plain that there was no need for stone ballast on the last voyage. The larger stones may be remnants from a previous voyage where ballast was necessary, and many of the small rocks may be chips and pebbles mixed with the ballast. The identification of many of these rocks by Gina Rockett, the curator of the E. de Clarke Geology Museum at the University of Western Australia, and her associate, John Ridley, provides other possibilities as follows:

a) Eight small and odd-shaped rocks are fossils or fossil-bearing mudstone. One is very evidently the fossil of a tiny crab. The fossilized inclusions have a dark brown to reddish color and when tapped give a distinct "ping," being light and hard. The associated mudstone is brown to light brown and is soft enough to have been attacked by marine borers. These rocks are almost certainly native to the site.

b) Four small, highly porous, gray rocks are readily identifiable as pumice. With Krakatoa Volcano 120 km from the site, this is not an improbable find.

c) Three small and one large (160 mm x 130 mm) irregular but smooth rocks may also be of volcanic origin. Dark brown, and in some cases slightly lustrous on the surface, a chipped piece revealed a rust-colored outer edge with some iridescent dark blue and green inclusions. They may be iron manganese chert nodules. There is a slight possibility that these rocks are native to the site.

d) Seven water-worn rocks (the largest being 130 mm x 60 mm) are of sedimentary origin. They are a form of siltstone known as greywacky and have sulphide crystal inclusions. These rocks are definitely not native to the site and therefore may be the smaller fraction of a previous ballast cargo.

e) Three small, angular, thumb-sized rocks have been identified as the mineral corundum (Al_2O_3). It is almost certain that they were onboard the ship. Corundum, when occurring with magnetite, is known as emery and is harder than any other common mineral. It is used as an abrasive. Rubies and sapphires are gem-quality corundum.

f) Six small, heavy rocks with a reddish-purple surface and crystalline interior have been tentatively identified as rhodonite, a calcium manganese silicate. They were all found within meters of each other. When polished, rhodonite is regarded as a gemstone; therefore, this rock may have been part of the cargo, possible a private trade item judging from the limited quantity recovered. An attempt to polish one of these rocks was unsuccessful, as it broke into pieces due to internal weathering.

g) Three rocks, or rather lumps, measuring roughly 120 mm x 100 mm present a bit of a dilemma. The outer surface is light brown. One example is layered in solidified waves, as if a viscous flowing material has hardened before another layer flowed over that and hardened in five distinct episodes. There is much finer layering within the lump. Another has a globular-domed surface and concentric fine layering. The material is white and chalky, and under a magnifying glass there appear to be minute quartz crystal inclusions. These rocks were found close together, in Grids B1, B2, and C1. Their individual characteristics are sufficiently different to make it unlikely that they derived from one larger piece. On contextual grounds, they were initially thought to be some form of processed mineral that was part of the ship's cargo, possibly lime or some kind of flux for smelting. It has since been suggested that they are rhyolite bombs, lava fragments thrown into the air by volcanic explosions. Pumice, which is a rhyolite lava blown into a sponge-like consistency by the release of gases, has been positively identified on the site, thereby supporting this theory.

h) An orange-to-brown "rock" presents another identification problem. Dozens of pieces were recovered from all over the site, generally down at the clay layer and sometime penetrating it. These have not been included in the total number of rocks recovered. The outer surface is very irregular. The largest piece measures 220 mm x 130 mm and is shaped like a bent shoe. It is completely hollow with a wall thickness of 10 to 20 mm. Other pieces are similarly convoluted. They appear to have been cast in the odd-shaped wormholes that riddle the clay seabed. But for the shape of some of the pieces, they could have been classified as weathered laterite. Angular inclusions in some pieces may indicate a poorly consolidated calcareous breccia. Contextual evidence, however, indicates that these rocks are native to the site. Another interesting thought is that they are pieces of kiln slag from the Chinese iron foundry that produced the cauldrons and bars that make up a large portion of the cargo.

i) Three pieces of water-worn milky quartz were found widely spread out in Grids B1, G3, and H2. The larger piece, measuring 100 mm x 90 mm, was broken, revealing an angular interior.

j) One raw quartz crystal was recovered from Grid H8. The main hexagonal crystal is 60 mm long, and there is one small offshoot crystal. The surface is slightly stained with a brown iron corrosion product. Although there are some internal fractures, there are few impurities within the crystal. This was probably a curio belonging to one of the ship's company.

Quartz crystal.

k) Only one rock that is slightly weathered but not water-worn is readily identifiable as granite. It is reasonably fine grained, and the weathered surface has an orange hue.

l) Most of the ballast-sized rocks are sedimentary, ranging from a course-grained sandstone to the very fine-grained greywacky mentioned above. Two exceptions appear to be gabbro and diorite with some quartz content, both igneous rocks. There is only one example of each.

7.12 Sharpening Stones

Nine stone artifacts have been positively identified as sharpening stones. Five of them are small and easily held in one hand, while the other four would have rested on the ground.

Small sharpening stones.

The hand-held sharpening stones are shaped out of a hard siltstone. Four are more or less finger shaped, but one of a lighter colored stone has the shape of a flattened "L". All have one surface worn smooth, so they have all seen active duty. They were well scattered, lying in grids C1, E9, G0, I8, and J8.

The larger stones tended to be water-worn, elongated pieces of rock. One 350 mm long piece is completely smooth along its full length on one side, and has two well-worn hollows on the other.

A wider rock is roughly chipped flat on the base and well worn on the working surface. A smaller stone is worn in two places on both sides. One of the sharpening stones is broken in two, and had been for a long time, judging from the encrustation of coral and oyster shells on the broken faces. Three of the larger stones were found fairly close together, 2 in Grid I3 and 1 in G3, but the other was well away in Grid F-1.

Three sharpening stones and a stone roller (left).

One other similar stone has been hand shaped, although it is not actually a sharpening stone. It is like a roller, with both ends tapered slightly as if to fit end bearings. The surface of this so called roller has been worn smooth. It has a length of 280 mm and a diameter of 80 mm.

The fact that all of the sharpening stones were well used implies that they were part of the ship's equipment or perhaps belonged to soldiers assigned to protect the vessel, rather than items for trade.

7.13 Organic Finds

Apart from the small chunks of wood that were the only remnants of the ship's hull, and some branches which may have been dunnage or perhaps an aromatic wood, there were very few organic finds. Given the exposed nature of the site, it is surprising that there were any at all. In fact, it must be suspected that some of the items that were found are intrusive.

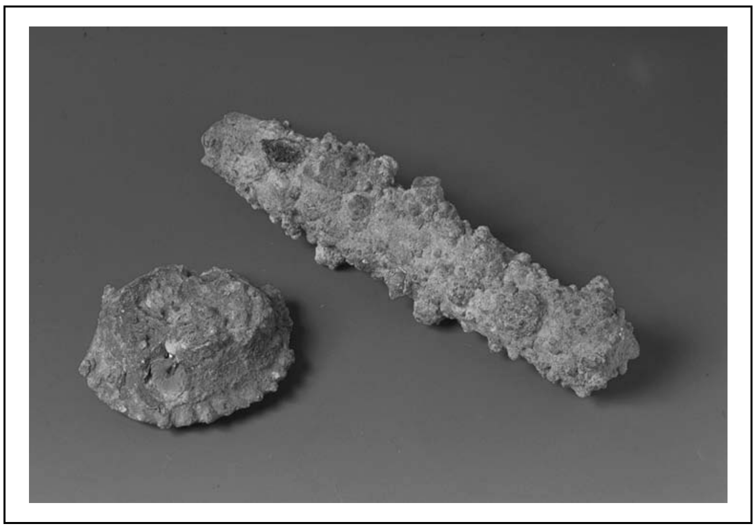
Two organic finds were tentatively identified by Prof. Wee Yeo Chin and Dr. Ian Turner of the National University of Singapore Botany Department. One nut found in Grid A6 is thought to be canarium, or canary nut, which is typically used for food flavoring. Another very degraded specimen was identified as the fruit from a nipa palm, which contains what are commonly known as atap seeds. These seeds are sweet and chewy, and highly edible. The nipa palm is found throughout Southeast Asia and grows prolifically in swampy river deltas.

An unidentified seed casing was found in Grid J8. It is woody, roughly spherical, and appears to be internally divided into three cavities. Another unidentified nut is badly deteriorated, but slightly resembles an almond.

The other organic finds include rattan that was used to bind the bundles of iron bars, and a small piece of hessian-like material that was used to wrap up a bundle of four rectangular iron bars. These were preserved by the encasing iron concretion.

7.14 Tin Ingots

Two unusual tin ingots were discovered. Why there were only two remains a mystery.



Badly corroded tin ingots.

One, recovered from Grid J5, is a truncated cone 110 mm in diameter and 30 mm in height. The base has a scalloped edge, although this decorative feature is highly degraded on one side. The ingot is badly blistered with yellow, white and crystalline corrosion products. Both the base metal and the corrosion products have been analyzed by Miss Anna Fletcher, Senior Material Scientist with the Materials Institute of Western Australia, for Dr. Ian MacLeod of the Western Australian Maritime Museum. The metal was found to be almost pure with 99.6% tin, and only a trace of lead (0.019%).

The second ingot was recovered three grid squares away in Grid G5. This one is a cylindrical rod, 265 mm in length and 45 mm in diameter. It is heavily corroded, with many blisters showing a radial crystalline structure. The rod ingot was found to contain 98.4% tin, 0.175% lead, and 0.006% zinc.

The detailed results of the metal and corrosion products analysis for both ingots can be found in Appendix I.

8.0 THE IRON INDUSTRY AND TRADE ***by Dr. Bennet Bronson***

8.1 The History of Iron Production in Asia

Iron is known to have first been made in India by 1000 B.C. (Chakrabarti, 1992), in central and southern China by 600 B.C. (Wagner, 1996), and in Thailand and Vietnam by 500 B.C. (Bronson, 1985). Its first appearance in peninsular and island Southeast Asia is later, but there is no reason to doubt that many parts of the region were making and using iron by 100 B.C.

The raw materials for iron making are distributed quite unevenly within Southeast Asia. This is especially true of large deposits of high-grade iron ores. Several areas have none, including Java, Sulawesi and Mindanao (all of which have substantial lower-grade deposits) as well as southern Vietnam and the Visayas (where even low-grade ores are quite scarce). Other areas, however, are rich in excellent iron ores, notably Luzon, the Malay Peninsula, and a belt that runs from northern Thailand through Laos to northern Vietnam and China. Although available information on smaller high-grade deposits in the 10,000-500,000 ton range is very incomplete, it seems reasonable on geological grounds to conclude that most of these occur in the same areas as the multimillion-ton deposits. Useful quantities of rich ores also exist in Central Thailand, Borneo and the islands between Borneo and Sumatra (Survey, 1970; Bemmelen, 1949; MRDS-39, 1972; DMR, 1975).

Existing historical records indicate that commercial iron making during preindustrial times was concentrated in areas with high-grade ores, like those of Phnom Dek in northern Cambodia (Moura, 1883:43-6), or with unusual ores like the iron-nickel deposits of central Sulawesi (Abendanon, 1917-8). Whereas almost all parts of Southeast Asia contain enough mediocre sedimentary ores (many of them lateritic) for a competent early smelter to make sufficient iron for local use, production on a slightly larger scale seems to have required rich contact-metamorphic ores. This was not because iron made from lean ores was worse in quality but because it was more expensive, requiring more fuel and labor to produce a unit of finished metal. Hence, ore-deficient areas such as southern Cambodia and southern Vietnam may never have been producers of iron.

It does not follow, however, that all areas with iron ores necessarily used them. Luzon and West Malaysia, both of which possess excellent deposits of accessible iron ores, never seem to have been iron producers on more than a strictly local scale. The case of Java is even more striking. The magnetite sands along its southern coast are not only abundant enough to have been considered for use by modern steel making firms but are of a type that was often preferred by early smelters. Similar iron sands accounted for a large proportion of the iron produced in traditional furnaces in southern India and Japan. Yet the Javanese have never been known to smelt this or any other iron ore, from the time the Portuguese arrived in the early sixteenth century through to the mid-twentieth century. Raffles (1830,1:240) is quite clear that in the early nineteenth century Java produced no iron at all. As far as is known, every kilogram of iron used for hundreds of years in one of the most densely populated parts of Southeast Asia has come from other islands, the Asian mainland, or Europe.

This imbalance either of resources or interest in using them resulted in an active iron trade in and around the Java Sea. In recent centuries, a number of regional centers are known to have provided raw or worked iron to be fed into the traditional maritime trade network of western Indonesia. Examples include the Ngaju Dayak of South Kalimantan, whose iron and steel were fabricated at Negara near Banjermasin and exported by sea to other islands (Hendriks, 1842); the West Toraja and ToBada of central Sulawesi, whose tools supplied the Moluccas (Kruyt, 1901:148-9) and whose nickel-containing unworked iron, the famed *pamor luwu*, was carried as far as northern Sumatra (Groneman, 1910:138); the inhabitants of Belitung and Karimata, whose bar iron and much-esteemed parangs and axes were used throughout Indonesia (e.g., Daghregister, v.1679: 121, 137, 178, 222, 229, 342; Reid, 1988: 110-1); and the Minangkabau of Sumatra, noted kris exporters (Valentyn, 1726,5:2) and suppliers of iron to several other parts of that island (Marschall, 1968: 130-2).

The same historical sources, the most important of which were produced in Batavia (modern Jakarta) by the Dutch East India Company (or "V.O.C."), make it clear that western Indonesian sources could not keep up with demand for ferrous metals. The Journals or "Daghregisters" of the V.O.C., of which a number of sixteenth-century volumes have been published, contain numerous references to imports of iron to Java. In the decade 1673-1682, 9 Chinese ships from Xiamen, and "Chincheo" (either Quanzhou or Zhangzhou) in southern Fujian province brought 55,214 iron pans, 22 hampers of pans, 92 iron shovels and 6 iron cannon to Batavia as well as quantities of ceramics and other goods. During the same period, 47 Chinese and European ships coming from Canton and Macao in Guangzhou province brought a further 4,125 pans, 6,542 nests of pans, 332 kettles, 50 knives and a case of needles. Still more iron pans came in Chinese ships sailing from Japan. India supplied quantities of bar iron as well as nails and "hammer steel" (Bronson 1986: 22). Ships coming directly from Europe brought iron cannon, cannon balls, miscellaneous hardware and, again, nails. The V.O.C.'s records are incomplete. But they show unmistakably that in the seventeenth century, when Indonesian economies still were very similar to those of the pre-European period before 1500, the region was by no means self-sufficient in iron. A very substantial percentage of the iron consumed in Indonesia was imported from East Asia, South Asia, and even Europe.

That the island region of Southeast Asia simply did not produce enough iron for its needs seems an inescapable conclusion. Why this should have been so is not obvious. After all, as pointed out above, the region is not especially poor in ore, and the conversion of ore into iron is not such a difficult process: indeed, judging from the fact that almost every part of Eurasia and Africa knew the smelting of iron in antiquity, it is a process that almost every society can (and did) master. Further, Indonesians of the historical period were not at all primitive in terms of fabricating objects from already-smelted iron. As Tome Pires noted in 1515, the swords and daggers of Java were prized enough to be exported to Malacca in Malaysia and even to India (Cortesao, 1944: 93, 179). But why, then, did ancient Indonesia not smelt enough iron to become self-sufficient, as was most of Africa, India and Mainland Southeast Asia by the early first millennium A.D.?

Part of the answer lies in technology. Due to Indonesia's excellent maritime communications and extensive trade links with East and South Asia, would-be iron makers there must have been exposed to severe competition from low-cost producers in India and China who were probably the most efficient in the world during preindustrial times. Further, both East and South Asian iron makers were technically advanced in terms of the kinds of iron they made. India led the ancient world in the production of steel, employing a variety of crucible processes to make a uniform, medium-carbon metal that was unmatched elsewhere in the world before the nineteenth century (Bronson, 1986). And China, beginning about 500 B.C., had evolved a unique complex of iron-making technologies that would not be discovered in the West until modern times (Wagner, 1996).

8.2 Iron-Making Technology

The differences between the techniques used for making iron in China on the one hand and in Southeast and South Asia on the other are crucial to understanding the importance of the iron cargo on the Java Sea Wreck. For that reason, it is worth devoting a few paragraphs to technical issues.

The first such issue relates to the fact that until the mid-nineteenth century most of the iron used in the world was of the low-carbon variety known as wrought iron. This is characterized by a high melting temperature, which makes it impossible to shape by casting; by relative softness and ductility at red or white heat, making it easy to shape by forging; and by relative toughness and low strength. A pure wrought iron contains almost no carbon and is in fact less strong and hard than many bronzes. However, it has two advantages over any bronze or other copper alloy: (1) because iron ores are very abundant, it is much cheaper, and (2) through adding some but not too much carbon by one of several methods it can be converted to steel, which in terms of combined toughness, strength and hardness is superior not only to bronze but to most other ancient or modern materials.

Low-carbon wrought iron and its derivative, steel, were the only types of iron used in most places for most of history. East Asia, however, began at an early date to employ a third type: the very hard, brittle and moldable high-carbon metal known as "cast" iron which, though a good material for making objects like kettles and stoves, is unsuitable for functions requiring shock resistance, as in axes or swords, and which cannot be shaped by forging. The methods of handling cast iron seem to have been unknown to the other technologically advanced nations of antiquity, giving China a world monopoly on cast iron production for perhaps a thousand years. The technology of cast iron was picked up by the Koreans and Japanese sometime in the early first millennium A.D. and by Central Asians several centuries after that; it was not learned by Europeans until about A.D. 1300. And yet even in China the market for a brittle, castable iron was limited. As in other countries a great deal of the iron used by the Chinese was of the forgeable wrought variety.

The second issue concerns the way in which forgeable iron is made, for it can be obtained through either of two processes (Rostoker and Bronson, 1990). One is the so-called "direct" process that was preferred by early Europeans, Africans, and most Asians, including Indonesians. A mixture of iron ore and fuel (generally wood charcoal) was heated at a relatively low temperature (between 1200 and 1250 degrees Celsius) in a low furnace, perhaps about a meter or so high or perhaps a carefully shaped hole in the ground. Most such furnaces were equipped with two or more medium-sized bellows. The bellows were worked while impurities ran off in the form of liquid slag, with more fuel being added as needed, until a solid lump or "bloom" of iron formed at the bottom of the furnace. At that point, the bellows were stopped and the furnace allowed to cool until the bloom could be extracted. Historians of technology call such furnaces bloomeries because of the nature of their product. After extraction, the bloom was hammered while still hot until most of the slag was squeezed out. The result was a piece of low-carbon (<0.1%) metal, generally of high chemical purity due to the low smelting temperatures involved, ready for immediate use by a blacksmith.

The other method for making a low-carbon wrought iron, the "indirect" process, appears to have been used in early times only in China, then later in Korea and Japan, and not until recent centuries in the West. As its name implies, the process involved more than one stage. The ore and fuel (either charcoal, mineral coal or coke) were first heated, almost always in a true blast furnace, a larger and taller structure than the bloomeries used in the direct process, to a temperature high enough actually to liquefy the iron (about 1350 degrees Celsius). Much larger bellows had to be used, which meant either water power or a large number of bellows operators. Due to the high temperatures reached, not only the slag but also the iron could be tapped from the furnace in liquid form through a small opening in the lower part of the furnace. This made it possible to operate such furnaces continuously, often for periods of weeks or months, which saved fuel and increased per-day production.

The liquid metal that is tapped from any blast furnace cools quickly, solidifying as a piece of brittle cast iron with a very high carbon content in the 3-5% range as well as significant amounts of phosphorus, sulfur and silicon. It is of course possible to remelt this type of iron and to pour it into molds then and there — the techniques and temperatures needed for molding cast iron do not differ greatly from those needed in casting bronze. Cast iron as a metal is good for making bells, is extremely hard but easily broken, an only fair conductor of heat (which makes it heat evenly when used for cooking or industrial purposes), resistant to chemical damage, and capable of being formed into very complex shapes with only minimal expenditure of labor.

However, if early Chinese iron workers wanted a softer and more malleable metal which could be shaped in a blacksmith's forge, it was necessary to put this high-carbon cast iron through a second processing step in a second furnace, a finery. This "fining" step involved reheating the iron until it again became a liquid and then exposing it to oxygen for long enough to burn most of the carbon out, yielding a solid mass of low-carbon wrought iron. Fining took almost as much fuel per unit output as bloomery smelting, and the process was quite labor-intensive.

Why the complex and seemingly wasteful two-stage method should have been preferred in ancient East Asia cannot be discussed here. It is enough to say that the indirect process was more efficient in some ways, that the large blast furnaces involved were capable of turning out much more metal in a given period of time than the smaller bloomery furnaces used in the direct process, and that at the present day almost all iron makers use two-stage processes not greatly different in principle from the one invented by the early Chinese.

Whether made in a bloomery or finery, early low-carbon irons tend to be very similar. Indeed, most specialists feel that they cannot be distinguished by any currently available method of analysis except that finery iron, due to the very high temperatures at which it was originally smelted, tends to contain rather more phosphorus, sulfur and other undesirable impurities. The form in which the two kinds of iron were traded might sometimes offer a clue. In some parts of India, slaggy blooms seem to have been the standard form in which iron was traded (see for instance, Buchanan, 1807, 2: 437). But elsewhere in India and in much of the rest of early Eurasia, low-carbon iron in historic times was generally traded in the form of rods or bars: in fact, Europeans have traditionally used the term "bar iron" as a synonym for wrought iron.

The Chinese too are known to have traded low-carbon iron in the form of bars (Tegengren, 1923-4:336). Generally speaking, this bar iron did not have a particularly high reputation among foreigners in the eighteenth and nineteenth centuries, when compared with either European metal or the bloomery-made iron of the rest of Asia. The Chinese metal often had a rather high phosphorus content, which made the metal "cold-short": liable to break under stress at low temperatures.

This is why, in the eyes of economic historians and archaeometallurgists, the Java Sea Wreck finds may seem surprising. Judging from later historical records like those cited above, one would expect China to have exported quantities of cast iron during the Song and Yuan periods. Chinese merchants should have found cast iron implements and cooking wares to be ideal commodities for long-distance trade: relatively inexpensive to produce, impossible for Southeast Asian consumers to copy due to the complex technology involved, and with special properties (evenness of heat distribution, strength, chemical resistance and sheer size) that made them irreplaceable by indigenous metal wares. But bar iron, one would think, was quite a different matter. The Chinese product would have faced real competition from locally made Southeast Asian bloom iron as well as from Indian iron and steel.

8.3 Historical and Archaeological Parallels

We do not know much about those local producers at the time that the Java Sea ship went down, but it seems certain that they existed. One of the few contemporary iron-working areas in Southeast Asia that have been studied in any detail is the Sarawak River delta around Santubong in northwestern Borneo (Harrisson and O'Connor, 1969). Most datable artifacts associated with the iron slag and other debris at Santubong were Chinese stoneware and porcelain of the early Song to early Yuan dynasties. A few coins were also found from the Tang (earliest: A.D. 618) and Song periods. Thus, the probable peak of activity at the sites occurred in the twelfth to thirteenth centuries. The original excavator, Tom Harrisson of the Sarawak Museum, believed that the iron ore worked at the site was brought by boat from upstream; the site at the river mouth would have been chosen because it provided mangrove wood, which yields excellent fuel for the furnaces, and was accessible to the sea so that the products could be readily exported. The site also provided access to fresh water. Other isolated sites with slag and "crucibles" were found between 6 hours and one day's sail in either direction along the coast. How much iron was produced at these sites is still unclear due to difficulties in distinguishing smelting slag from natural concretions, but there might have been enough iron to support an export trade (Harrisson and O'Connor, 1969: 203-204).

Historical sources too indicate that Indonesians were actively engaged in producing and shipping iron. Early Arab writers mention that a group, identified by some scholars as Indonesians, traded for iron from places as distant as east Africa (Ferrand, G. 1922: 66). Zhao Rugua, writing in the thirteenth century, mentions non-Chinese iron in several places (Hirth and Rockhill,1911: 46, 61,69, 78). Iron swords, he says, were being made on islands somewhere near Java, and other swords were imported from India to Java and Sanfoqi (or Srivijaya), probably in Sumatra. He even says that another Southeast Asian locality, in northern Vietnam, was exporting iron. He may be implying that this was wrought iron in unfinished form, although Wheatley thinks that this metal “must have been a re-export" (1959: 117).

Zhao also mentions that Chinese tripod cauldrons were imported by two places, one of which is thought to be in the Philippines and the other in Java. As such items would have had to be made of cast iron, this is what one would expect in the light of other evidence. But Zhao was not greatly interested in iron and mentions it infrequently. The best early Chinese source for international trade in iron is Wang Dayuan, who in the mid-fourteenth century compiled an important (and partly firsthand) account of the countries of Southeast Asia and the regions farther west (Zhu Fan Zhi, 1993).

The list below summarizes the places which, according to Wang, imported Chinese iron. Although many cannot be confidently located on a modern map, there is no doubt that a high proportion were in Southeast Asia.

Pieces of (scrap?) iron, presumably wrought rather than cast: Rili [Pattani in S. Thailand? Somewhere in W. Malaysia or S. Vietnam?]; Sandao [somewhere in the Philippines]; Mayi [Mait/ Mindoro, C. Philippines?]

Iron, variety not specified: Sian [Siam]; Jiaozhi [N Vietnam]; Suluoli [?]; Duduya or Duduan [?]; Wenlaogu [Maluku Is.?]

Iron ware or objects, variety not specified: Ashili [?]; Bajielajian [Pajekan, near Surabaya, E. Java?]; Bandali [?]; Boni [Brunei]; Boshili [?]; Dawudie [Orissa, E. India?]; Dongtanmiao ["East Demak", Java?]; Dongxizhu [island near Longyamen or perhaps Pulo Aur]; Lanwuli [Lambri, Aceh, N. Sumatra]; Panhang [Pahang, Malaysia]; Tanyang [Tamiang, NE Sumatra]; Xiaojunan [Quilon, SW India?]; Zhaowa [Java]

Iron wire: Xialaiwu [unidentified; somewhere near Malay Peninsula]; Pubin [?]

Iron tripod cauldrons: Baduma [Martaban, S Burma?]; Banzhu [Pancur, Singapore River Estuary]; Dajila [?]; Jianshan [?]; Jinta [in Thailand or Burma?]; Longyabodi [Langkawi Is., W. Malaysia?]; Longyamen [Keppel Harbor, Singapore]; Malilu [somewhere in northeast Malay Peninsula?]; Mayi [Mait/ Mindoro, C Philippines?]; Wuzhipa [?]; Zhenlu [?]

Iron woks: Sanfoqi [Jambi, in Sumatra]; Xiaopan [?]

Iron bars: Banzhu [?]; Dabadan [?]; Ganmaili [Cape Comorin, S. India?]; Huamian [Batak area, N. Sumatra?]; Jialila [?]; Luowei [Ligor/ Nakhon Si Thammarat, S. Thailand?]; Lingshan [Cape Varella, S. Vietnam]; Qianlima [?]; Sulu [Sulu Islands, S. Philippines]; Wuniangang [Pontianak, Borneo];

Wang notes that many of these and other places also imported Chinese copper objects, and that one or two (for instance, Boshili) were supplied with Japanese as well as Chinese iron. His impressive list cannot be used to draw maps of the routes followed by metal traders without much more work by historical geographers in identifying ancient place names. But the list does show two things of importance to archaeologists working on cargoes of early Chinese ships sunk in Southeast Asian waters: first, metals played an important role in the international trade of fourteenth century China, and second, that—contrary to expectations—China did export quantities of low-carbon bar iron as well as utensils made of high-carbon cast iron.

Archaeological data on Chinese-Southeast Asian trade routes and goods has until recently been even scarcer than historical data, but now relevant information from terrestrial and, more importantly, maritime excavations is beginning to appear. With regard to trade in metals, the archaeological and historical data seem to support each other.

Recent excavations on the island of Bangka, just off the Musi River, found five piles of twelfth-century *qingbai* bowls on top of five piles of iron woks facing upward, which in turn rested on three piles of woks facing downward, nearly 2 m deep in a Vishnu temple of the sixth to seventh century (ACRO Update: 1995). This enigmatic site raises many questions which only further excavations can resolve. Some fragments of iron excavated at the Parliament House Complex site in Singapore, of the fourteenth century, on analysis, proved to be cast iron and therefore Chinese imports.

The Dinghai wreck of the Song period contained two concretions of iron, each 1.5 m square and 1 m high (Kenderdine, 1995). The Pulau Buaya wrecksite, which contained 30,000 ceramics of the late Song, found near Bintan Island, Riau, yielded large quantities of iron woks concreted in stacks, as well as bundles of iron parangs still tied in bunches with some type of rattan-like fiber. The Vung Tau wreck, a Chinese lorcha of c. 1690 (Flecker, 1992), had the midships cargo hold full of large stacked cauldrons and woks with handles. This vessel was on its way from China to Batavia with a primary cargo of blue-and-white porcelain. Thus the Southeast Asian demand for cast iron vessels from China continued for many centuries.

By way of interest, several Thai shipwrecks of the fifteenth and sixteenth centuries had one or more cargo holds filled with iron. The Pattaya wreck (Green, 1983), the Royal Nanhai wreck (Sjostrand, pers. comm.), and the Phu Quoc wreck (Blake and Flecker, 1994) all had iron cargoes that interestingly had formed amorphous concretions entrapping several large storage jars. Some of these jars were completely encased in iron concretion, suggesting that the iron was stowed around the jars. Worked iron shapes could not be discerned within the concretions, so it seems unlikely that the iron is a transshipped cargo originating from China. It has been suggested that the original cargo was in the form of pellets or high grade ore. While long-distance shipping of raw or beneficiated (pelletized) iron ore is not known to have existed anywhere in the world before the late nineteenth century, the possibility must be borne in mind as other shipwrecks are excavated in the future.

In metallurgical terms, the chief importance of the Java Sea Wreck is the presence of the hundreds of tons of iron bars. This has not only confirmed the accuracy of Wang Dayuan's account but has posed an important new problem to economic and social historians of Southeast Asia. It has long been known that cast-iron vessels were in demand throughout the region. But in spite of what Wang recorded, few specialists had suspected that China was a major supplier of as basic a raw material as wrought iron to Indonesia. Why was it so? How did Chinese merchants, with a commodity that cannot have been better than locally produced low-carbon iron, manage to compete with Southeast Asian iron makers? Could they have made a profit from it, or did the trade in such high-technology goods as cast iron and inexpensive porcelain produce high enough profits to subsidize the wrought iron trade?

One would also like to know whether there was a link between the ceramic and iron trades. Tegengren (1923-4: 337-8) notes that in the early twentieth century, the Dehua-Yongchun-Anxi area not only was still producing small quantities of iron by traditional methods but that it also has significant reserves of anthracite as fuel; from personal observation, the present writer can confirm that small-scale smelting in Anxi County (using local hematite ores but an electric arc for heating) has continued to the present day. Significantly, kilns in Dehua, Anxi and Yongchun (Ho, 1988) produced a large proportion of the celadon and *qingbai* wares recovered from the Java Sea Wreck. It is also significant that later Chinese ships arriving at Batavia from southern Fujian in the seventeenth century often carried cargoes that included both ceramics and cast iron vessels.

8.4 Analysis of Iron from the Wreck

One iron bar and a fragment of cauldron were analyzed by Dr. Jonathon Leader, of the University of South Carolina (see Appendix J), using electron microscopy.

The cauldron showed high concentrations of magnesium, aluminum, silicon, chlorine, calcium, and sulfur. The high sulfur content is a clear indication of casting. The silicon may have been a derivative of the casting process, but it could also have been from sand contamination from the wreck site. Aluminum and magnesium most likely came from clay contamination. The chlorine is from dissolved salts in sea water.

The results for the iron bar are very interesting. There are high concentrations of silicon, chlorine and sulfur. The presence of silicon and chlorine have been explained, but the presence of sulfur in a wrought iron is almost definite proof that the bars were produced in China by the "fining" of cast iron (see Section 8.2). Once sulfur is introduced into cast iron by the coal fuel it is very difficult to remove. Contemporary Southeast Asian, Indian, and European wrought iron manufacturers used the "bloom" method which did not introduce sulfur into the end product.

Sulfur is not desirable in wrought iron. It makes the metal brittle and likely to shatter on the blacksmith's forge. The Chinese product was therefore inferior to more locally produced wrought iron. Either there was insufficient local product, or the Chinese iron was substantially cheaper. It would not have been the first choice of the Javanese blacksmiths.

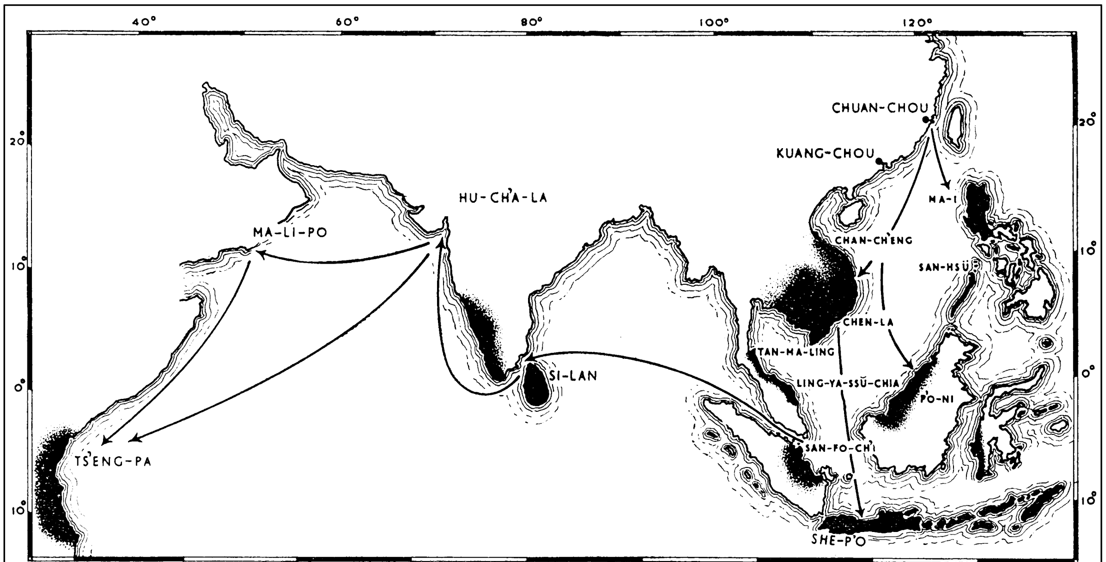
9.0 HIGH-FIRED CERAMICS OF SONG DYNASTY CHINA: THE JAVA SEA CARGO IN CONTEXT

by Roxanna Brown

9.1 Introduction

China held a world trade monopoly on high-fired ceramics for almost two thousand years. Wherever Chinese traders went, and often far beyond, there are now traces of their ceramics. China's pottery was so superior, for so long, that its very name came to stand for dishes made of clay. Until Europeans began making successful imitations of "chinaware" in the eighteenth century, the market seemed insatiable. Ceramics, along with silk, made China rich.

In order to stop the outflow of currency and precious metals to countries overseas, the emperors decreed toward the end of the Song dynasty that ceramics be traded instead. Markets already favored more highly fired wares, or this policy might not have been practical. For example, the brightly colored earthenware temporarily popular during the Tang dynasty was extremely decorative, but stoneware, with its greater hardness, could be transported over greater distances without breakage. Thus high-fired clay, valued for its durability in daily use, acquired still more value.



Export routes and regions where Chinese ceramics were imported during the Song dynasty.

9.2 China's Supremacy

Whenever early peoples established settled communities, they somehow discovered that clay subjected to fire will harden into permanent shapes; that vessels made this way can be used for cooking and storage, and toys and figures can be modeled from it for play and decoration. Of all the natural resources available to primitive cultures, clay is probably the most versatile (only plastic, these days, might be considered comparable). Yet it was only in China that the possibilities of the material were so fully explored in ancient times. Elsewhere, until modern times, ceramic technology did not advance beyond the production of decorated earthenware.

The supremacy of Chinese ceramics began with China's vast geography of mountains and rivers; clay could be found almost everywhere. There was also practically unlimited energy available from coal (Marco Polo's story of black stones that burned, it might be recalled, met with disbelief at home in Europe). Despite the abundance of coal, ceramic technology made its greatest progress after the Song court's relocation to Hangzhou, in southern China, in 1127, when abundant supplies of wood largely replaced coal.

In other cultures different materials were developed to answer practical needs filled by stoneware in China. In Burma, for instance, lacquer-making evolved to answer both utilitarian and aesthetic needs. In desert environments, animal skins were employed to carry food and liquids. In the Islamic world metallurgy provided most daily utensils; many of these metal shapes, incidentally, were copied into clay by Chinese potters. In fact, the history of a great many shapes known in ceramics lies in the natural development of other materials. Chinese potters, at one time or another, copied the shapes of their own archaic bronzes, of Middle Eastern pouring vessels, of the animal-skin bags of the Mongols, and of artifacts of many cultures.

Of course, all these materials were used at one time or another in China as well. But, given the initial success of a kiln design that could assure sustained high temperatures, plus clays that could withstand those temperatures, it was the field of ceramics that was continually explored. Examples of high-fired glazed ware appear as early as the Shang dynasty, in the period of about 1300-1028 B.C. That amazing beginning can perhaps be attributed to luck; nothing similar seems to have happened anywhere else in the world. Still, for realizing the potentials of this technology, one must thank generations of Chinese potters and entrepreneurs, who had, of course, a steady clientele of massive numbers of domestic consumers from all the social classes, and at times a vast overseas trade. At any rate, the particular combination of circumstances prevailing in China did spur ceramic technology to heights of art and material science that could only be approximately imitated anywhere else until comparatively recent times.

9.3 Sources and Properties of Clay

The words pottery and ceramics refer to any product made from clay. Clays vary widely. Some are too sticky to model easily, some consist of large grains, some have fine and dense grains; the colors are practically infinite. Whole ceramic industries today are based on one type of clay or another. Studio potters spend as much time finding and mixing their own personal formulas as they do actually constructing shapes. The specific qualities of any clay mixture impose limitations even as they provide opportunity.

Clays can be divided into two general types: primary and secondary. Primary clays are found in the close vicinity of their parent rock. Without going into their exact chemical structure, they could be described as rock dissolved in water. They may lie beneath rocky surfaces or are associated with the running water of streams. Primary clays are white or pale grey, and they have a large grain size that makes them relatively non-plastic.

River valleys, which were usually the first places to support large populations, yield secondary clays. Secondary clays have been washed away from the parent rock and have usually gained a number of mineral impurities along the way. The most common of these is iron, which, in concentration, can color the clay reddish. The smaller grain size of secondary clays makes them easier to model than primary clays.

Being able to recognize various fired clay bodies is one of the most important clues in identifying old trade wares. Ceramics specialists always check the base of any object they handle: besides looking for a possible mark, or noting the way the foot is cut, they are seaching for an unglazed part of the pot that shows the clay body.

9.4 Firing Temperatures

Clay subjected to heat will become hard. The greater the heat, the harder the pottery. Earthenware fired at 900° C is harder than earthenware fired at 500°. With too much heat, however, the clay will slump into a viscous mass and eventually liquefy.

Because of the great variety of clays, it is difficult to be precise about the exact temperature at which changes occur, but they are approximately at 500° and again at about 1200° C. Impurities that act as fluxes can lower the temperature required. The second change, vitrification, transforms the clay into a glass-like structure. The chemical changes are translated into three recognizable categories of fired pottery: earthenware, stoneware and porcelain. However, Chinese terminology recognizes only two categories: *dao*, low-fired; and *ci*, high-fired. The borderline temperature between them falls approximately at 1150°-1250° C. Porcelain, a term devised in the West, referred initially to shell-like characteristics of the end product rather than the chemistry of its making. Porcelain is translucent and resonant. A strong light can be seen through its walls and, if tapped, a porcelain vessel "rings."

Concerning the differences in the categories of ceramics, one could say that earthenware consists of an impure clay fired at low temperature; stoneware consists of purer clay (fewer impurities) fired at a higher temperature; and porcelain is a pure clay fired at very high temperature. Earthenware and stoneware are each made with a single clay, even though it may be a mixture of clays from different sources. Porcelain is made from two distinct materials: kaolin, a practically pure primary clay, and then petuntse, a prepared form of decayed granite. It is the structure of the petuntse that holds a pot together at high temperature when the remainder of the mass is viscous. Stoneware clay fired at high temperatures may be enough like porcelain to be called porcellaneous.

9.5 Glazes

Another way to categorize ceramics is according to their glazes. Essentially a type of glass coating, glazes add physical strength to the form, decorate it, and make it impermeable. With glaze, a pot does not break quite so easily, and glazed jars provide sanitary containers for liquids and food products. This quality, indeed, is a source for the Middle Eastern myth that a person would be warned about poisoned food if it were served in Chinese celadon-glazed dishes: the dish, they believed, would change color. Only the specific link between eating and poison was misidentified. The poisoning came, certainly, from the locally produced lead-glazed dishes that were the alternative to Chinese wares; those who ate from them often enough would have suffered from lead poisoning. At any rate, the solution worked: dining from high-fired Chinese ware solved the problem.

Tang dynasty China is well known for its lead-glazed earthenware; the famous three-color horses, camels, and human figures prized by collectors today, for instance.

The Song dynasty, is famed for monochrome stoneware — the blue-glazed Ju wares of northern China, the white-glazed wares of Fujian, and, of course, celadon.

Blue-and-white is associated with the Ming dynasty. Then there are the colorful, intricately painted, enamel-decorated porcelains that typify the Qing dynasty. A simplistic but helpful generalization of Chinese ceramic history is thus contained in the phrase "Song celadon, Ming blue-and-white, Qing polychrome."

Blue-and-white wares, in fact, seemed to have appeared during the Yuan dynasty, several decades before the beginning of the Ming. With evidence currently available, the closest one can date its appearance is within the quarter century between 1325 and 1350. This important innovation was in part the result of intense competition for the wealthy Muslim Middle Eastern market, a trade actively encouraged by the Mongol rulers who had conquered southern China by 1280.

9.6 High-Temperature Glazes

Together with high-fired clay bodies, Chinese potters searched for high-temperature glazes to cover them. The lead glazes for earthenware were unsuitable because lead volatizes at about 1150°. (This limitation could be overcome, as it was later, by first firing the stoneware or porcelain, then adding the colors in a second low-temperature firing.)

High-fired Chinese glazes can be called alkaline (meaning in effect, lead-free), or felspathic (composed largely of feldspars, a natural component of clay), and ash glazes. Essentially, the technique employed a mixture of clay, ashes, and water. A basic celadon glaze, for example, might be composed of wood ash kept from a previous firing of the kiln mixed with the same clay as used for the body, and water. A small amount of iron present in the clay, not more than 1 to 4%, is responsible for the green color. Sometimes one sees brown celadon, showing a slightly greater percentage of iron. The type of wood from which the ash is taken may cause the shade of green to be bluish or green. Potters in northern Thailand, for instance, can produce five distinct shades of celadon by varying only the type of wood ash. White glazes are made from an iron-free mixture.

Besides the presence of minerals and the effect of ash, another influence on the color of glazes is the kiln atmosphere. Two kiln atmospheres are possible, though in practice both will occur at different points within a single firing. In the thirteenth century, such a firing required about three days. An oxidizing atmosphere consists of a free flow of air; the heated glaze then acquires oxygen from the air. Ferrous oxide, for instance, will become ferric oxide. With reduction, the kiln is suddenly closed, so that the fire burns away free oxygen, then pulls oxygen molecules from the molten glaze. Induced at varying points in the firing cycle, at certain temperatures and for short or prolonged periods, reduction can cause a variety of effects. Proper control of the cycle, attained only with repeated experimentation, could consistently produce blue celadon, the legendary Ju ware of northern China, for instance. For the famous celadon wares of the Song dynasty, the basic principles for control of reduction began with the Yueh wares of northern Chekiang province. The best, most famous of these date to the ninth and tenth centuries. Along with white-glazed Hsing wares, examples of these have been discovered as far afield as Egypt.

9.7 Glaze Color

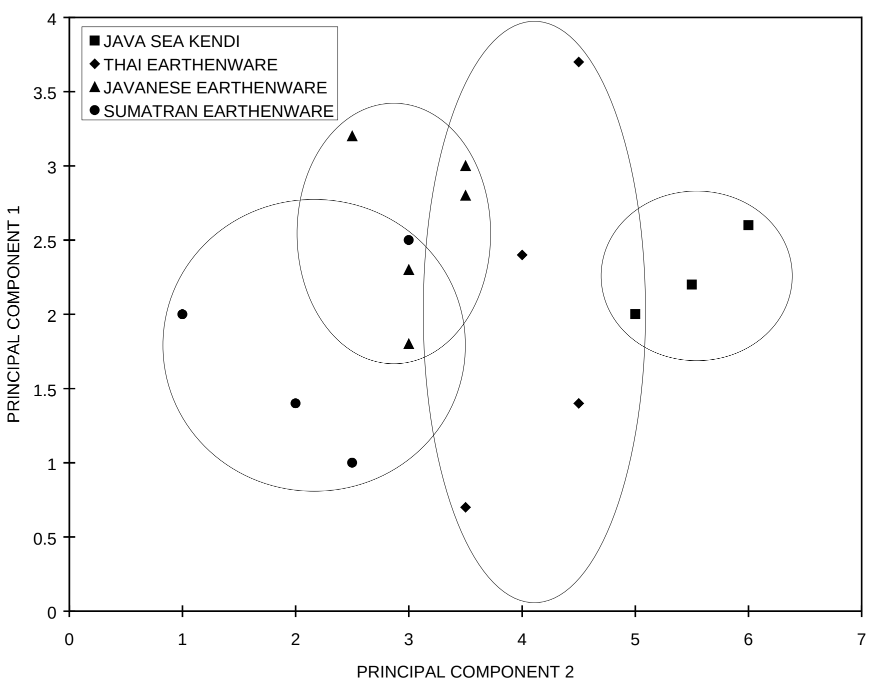
Only three minerals can influence color in high-fired ceramics: iron, copper and cobalt. Iron is the most common. In the oxidized atmosphere of a kiln with free air flow, iron will fire, depending on its concentration, to a variety of brownish shades to black. If fired in a reduction atmosphere, a small amount of iron, 3% - 4% of the glaze mixture, will produce shades of green, i.e., celadon. Without reduction the possible glaze colors on high-fired wares would be hopelessly limited.

Copper, in an oxidized atmosphere, will also produce green; and in reduction, red. But the firing conditions in either case must be finely honed — copper red is notoriously difficult to achieve. This is one of reasons why red-glazed wares are so very highly prized. In the fourteenth century, for instance, both underglaze blue and underglaze red were attempted, but underglaze-red decorated wares were quickly discontinued because of the difficulties of production. More often than not, the glaze fired to a brown or gray color. Cobalt, oxidized or reduced, will produce blue. It is no accident that a blue-and-white color scheme is associated with porcelain. Of the three mineral colorants known, cobalt is the least difficult to fire, and the most colorful.

9.8 The Java Sea Ceramics Cargo

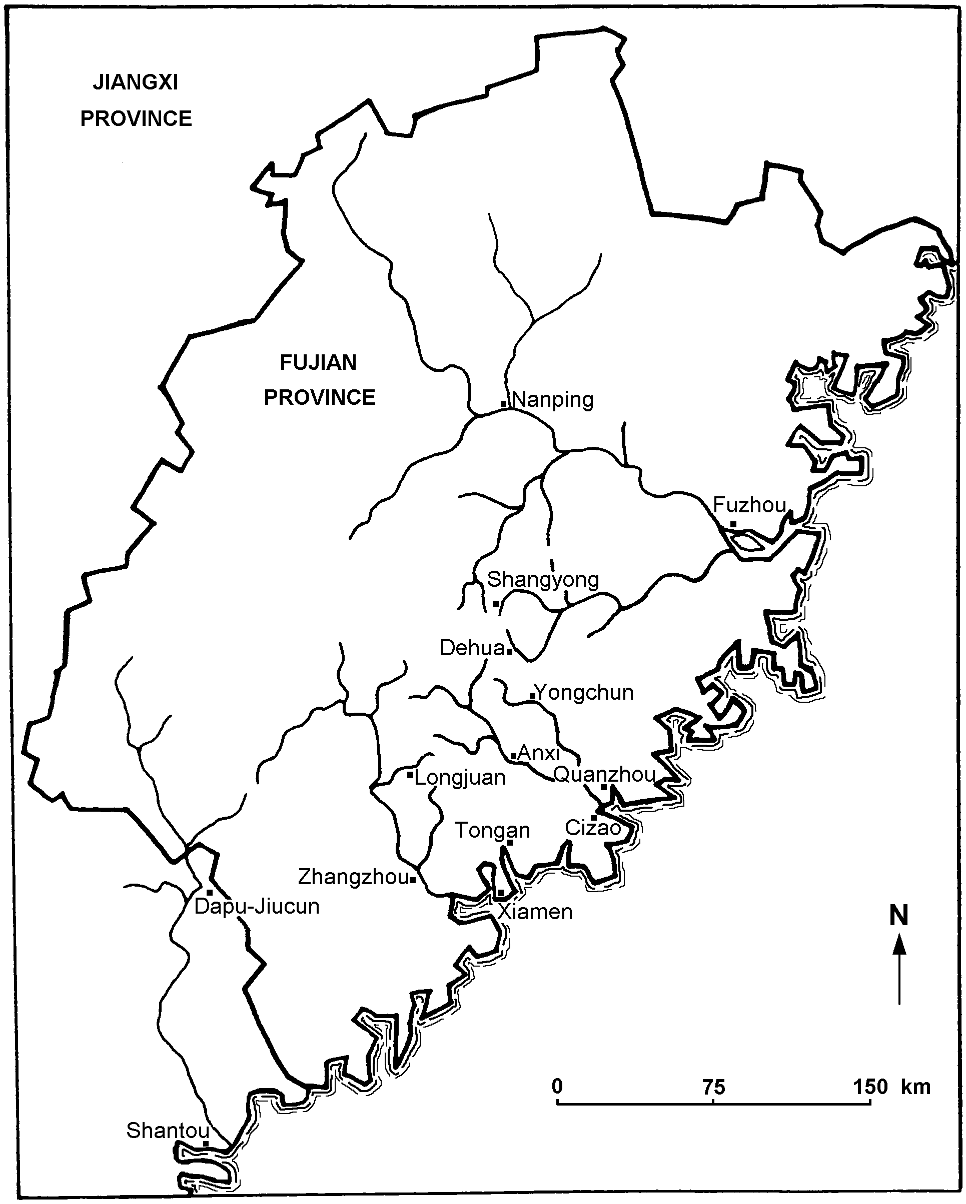
The ceramics recovered from the Java Sea Wreck were manufactured in China, except for a range of unglazed earthenware in unusual ritual shapes. Rare Cizhou type ware was found in small quantities. The remainder of the ceramics are monochrome wares with green, brown, black, white or *qingbai* (bluish white) glaze. The very finest pieces, which are few in number, are *qingbai* wares from the Jingdezhen kilns of inland Jiangxi province. All other wares appear to have been made in Fujian province.

The finely potted earthenware bears a general resemblance to wares associated with the southern Thai region of Patani. X-ray florescence component analysis shows distinct similarities to pottery from Kok Moh, in Patani. The discovery of hundreds of these vessels on the wreck clearly demonstrates the importance of earthenware as in intra-Southeast Asia trade commodity, a fact absent from any documentary records. Several shapes are completely unprecedented, in particular toroid kendis, which were previously only known from Ming dynasty China.



X-ray florescence analysis of earthenware kendis.

Upright shapes decorated with painted designs in underglaze black, and originally covered in a green lead glaze, constitute an unusual find. In general their clay and decorative motifs are similar to those associated to the Cizhou kiln complex. They are usually decorated with floral designs in slight relief, with the background painted solid underglaze black. Designs painted in black on a flat surface are less common.



There is an interesting group of white to *qingbai* glazed covered boxes. Many have the cover sealed to the base by drips of glaze, proving that covered boxes were fired, packed and shipped with the covers in place. These boxes were sometimes used to hold mirrors in China, and in Southeast Asia they are known to have been employed as containers for cosmetics and jewelry. In small and miniature sizes they have served as amulets. The boxes, and similarly glazed small vases, were manufactured in molds.

Kiln sites and major markets in Fujian Province.

A small group of black glazed tea bowls appear to be "southern Temmoku," rather than the famous Ch'ien tea bowls.

The majority of the wares are green-glazed bowls of varying size and quality. The glaze is sometimes opaque and sometimes translucent, and the shades of green differ even on pieces that would otherwise be identical. Such wide variation in color and texture can be caused by firing conditions that vary within the kiln. Consistent, standardized glaze effects were practically impossible to attain in ancient wood-fired kilns. The better quality wares are higher fired and are decorated with cursive cloud and floral designs incised into the clay prior to glazing.

Brown-glazed jars in the cargo are distinct in their structure and purpose. Rather than being items of trade, they were used to store food and water for the ship's crew, and for packing organic products for trade. To preserve the contents, the mouths of the jars were often sealed with a disk of wax or wood, secured with tie strings looped through small handles on the jar shoulder. Stamped Chinese characters adorn the shoulders of the majority of the larger jars.

The late Song dynasty was a prosperous time for the ceramics industry. A great many kilns were in operation in Fujian province. They served the great port of Quangzhou, the most probable port of departure of the Java Sea ship.

10.0 THIRTEENTH CENTURY POTTING TECHNIQUES: AS EVIDENCED BY THE JAVA SEA CARGO *by Roxanna Brown*

By the late Song dynasty, a ceramics factory was highly organized and capable of mass production. There could be a dozen or more divisions of labor, depending on the complexity of the end product.

10.1 Collecting and Preparing the Materials

First came the collection and preparation of materials. As a rule, haulage was minimal because a factory would be located near a good source of clay. For ready access to unlimited quantities of water, factories were also normally located near a river or large stream.

Once the clay was collected, workers had to clean and refine it. This process would consume vast amounts of water. Thoroughly submerged, in a large pot or specially constructed pit, the clay was then stirred so that larger impurities could be skimmed off the surface. It was filtered in a variety of ways. Sometimes heaps of clay were left outside for many months to be naturally weathered before any other preparation processes were begun. Coarser clay was used for storage vessels, but finer-grained clay was necessary for any wheel potting.

After separating the different grades of clay, workers formed the clay into balls of workable size for the potters. The balls of clay had to be thoroughly kneaded to extract any bubbles of air, which could cause a vessel to break during firing.

10.2 Preparing the Glazes

Meanwhile, glaze mixtures were being prepared. Every kiln master undoubtedly had his own trade secrets, but glazes in the late Song period were generally made from a mixture of finely ground clay mixed with ash. The particular type of wood from which the ash was obtained could affect the shade of the fired glaze. Sometimes a type of limestone was burned together with the wood.

The most important coloring agent for pottery throughout the Song dynasty was iron, a natural impurity in most clays. A large iron content in a glaze would produce brown and black; a minute quantity in a reduction firing could produce various shades of green.

If a lead glaze were used, as seems to be the case in the painted wares of the Java Sea cargo, then a lead-bearing clay was required. For painting an underglaze decoration in black, a clay with very high iron content was applied with a brush after being mixed with water to a brushable consistency.

Once formed, dried, and decorated, all the Chinese pottery of the Java Sea cargo was glazed. The glazing appears to have been accomplished by dipping the pieces into the glaze, although there are signs that it may have been applied by brush as well. A heavier glaze could be achieved by dipping a vessel into the mixture more than once. The celadon-like olive-green glazed pieces were probably dipped at least twice.

10.3 Furnishing the Kiln

A third group of workers manufactured such kiln furniture as spacer disks, stands, and saggars, the tall round boxes, sometimes with covers, into which finer pieces are set for firing.

Fine wares had to be kept spotlessly clean prior to firing. A single speck of dirt or a bit of grit, perhaps falling from the kiln walls, could mar them. They could be damaged by direct flame or blasts of hot air. Saggars, designed to protect them, were made from a rough, durable clay and themselves fired before use.

The saggars were formed on a potter's wheel, left to dry for a time, then shaped with a knife. The saggar makers sometimes used the same rough clay to make common earthenware vessels for their personal daily use at home.

Cruder wares could be fired without being packed within saggars, and bits of grit caught on the surface of the glaze during firing is evident on them. For the coarser varieties of bowl, an unglazed ring round their interior bottom allowed them to be stacked directly one upon the other, the footring of the bowl above set into the unglazed ring of the bowl below.

Sometimes kiln stacking supports for separating wares in the kiln are also required. Apparently these were not consistently used for the wares of this shipwreck; only a few pieces show traces of circular scars on their bases from the tubular supports, or pontils, onto which the pots were set.

10.4 Making the Molds

Another group of more skilled workers prepared molds for such shapes as the covered boxes, ewers and vases. The molds were made from a white plaster into which liquid clay could be poured or damp clay could be pressed. On the box covers from the Java Sea Wreck, one can sometimes see finger impressions on the inside where the clay has been pressed into the mold. The boxes were formed in two pieces, the upper and lower halves. Upright shapes were more complicated. Ewers, for example, with their handles, spouts and covers, required the greatest skill; the many different parts had to be formed in separate pieces, then luted together. In luting, the dry clay edges are slightly roughened or scored with a pointed tool, soaked with water, then joined. Join marks are usually visible on the interiors of such pieces. Among wares from the Java Sea Wreck, joins can be seen on the exterior surfaces as well. This is probably a consequence of the pressures of mass production.

Molds had to be made continuously, as they would become worn with constant use. The mold makers also had to be very familiar with the shrinkage properties of the clays, for the finished pieces would always be smaller than the mold after firing. This was particularly important for ensuring that box covers fitted on bases. At any one factory only three or four workmen might have the skill to produce similar molds consistently. Another set of workers would join the finished sections of pottery.

10.5 The Potter's Wheel

Certain shapes, such as those that are ribbed, lobed or angular, are more easily and economically produced with molds. The round bowl shapes, on the other hand, were more easily and quickly made on a fast-turning potter's wheel. For this function yet another set of skilled workers were employed. Some were trained in turning smaller pieces, while others made larger shapes. The wheel, essentially a round wooden table set on a perpendicular axle, is made to turn continuously. The potter raises the shape from a prepared ball of clay, using his fingers and hands. A skilled potter can make the basic form of a dish shape in a few minutes.

Vases, bottles, and ewers of some shapes could also begin on the potter's wheel. After drying, the vessel would be returned to the wheel for final touches.

10.6 Finishing the Form

The finishing work, the final cleaning and shaping of the dried clay, was carried out by another set of workers with their own special tools. Knives, for instance, were used to pare away superfluous clay. This paring of dried pieces accounts for the chatter marks seen around the lower walls of some of the Java Sea cargo's undecorated green-glazed bowl shapes. Craftsmen also used knives to cut out a footring from the solid foot of clay left by the wheel potter. The footring could not be cut until the dish or vessel was dry enough to be set upside down. With this final cutting and polishing the potters' work was done.

10.7 Decoration

In the Song dynasty factories, another group of specially skilled workers would apply incised or carved decoration to the surfaces of round shapes begun by wheel. Various hand tools, such as knives and bamboo combs, were used for this work. A floral decoration, for example, will first have a heavy outline carved, and then the petals and leaves will be enhanced with strokes of a comb.

Compared to later designs in underglaze blue, the underglaze-black designs of the Song dynasty, as evidenced by the Java Sea cargo, were not very complicated. It is possible that, although a few decorators may have been specially trained in brushwork, those who became skilled in incised and carved design may have also handled the painted motifs.

10.8 Firing

Stacking the kiln could take a day or more, depending on its size. The finer wares would first be set in saggers, then carried in stacks to the kiln. Inside the firing chamber, the pots were arranged to take advantage of every square inch of space without inhibiting the flow of heat from the firebox to the chimney. Old Chinese kilns were long and narrow, and built up an incline toward the chimney. The heat would be most intense at the upper end, so wares requiring more or less heat were positioned accordingly.

A sufficient fuel supply had to be maintained for the kiln firings, which usually required three days of continuously sustained heat. In northern China, coal was normally used, but in the lands south of the Yangtse River, wood-burning kilns were more common.

The most exciting moment in the long involved pottery process was the opening of the kiln. This had to be timed perfectly. If it was opened too soon after firing ended, the sudden coolness would cause uneven contraction between the clay body of a pot and the glaze. The glaze would consequently craze or crackle, an effect that was sometimes intentional. Many other kiln accidents were possible, ruining weeks of work. When beautiful pots emerged, all those that contributed to their creation must have felt intense pleasure and relief.

Any celebrations at the completion of a successful firing, however, provided only a short break. After the ceramics were taken out of the kiln, they had to be packed for transport. In the mean time, all the departments of the factory would have been simultaneously preparing for the next firing, and the one after that.

10.9 Illustrating the Potting Process

1. CLAY

As the primary material involved in pottery-making, clay undergoes a series of purification and preparation processes before being introduced to the potter. Although their opinions on the suitability of any one clay mixture are taken into account, the wheel potters first see the material in prepared lumps of appropriate size for immediately throwing onto the wheel. Here, one of the lumps is being kneaded a final time to make certain that its texture is uniform and that it contains no tiny air pockets. Any bits of grit in the clay would scar the surface of a pot as it is being thrown, and air pockets might explode during firing.

2. WHEEL-THROWING

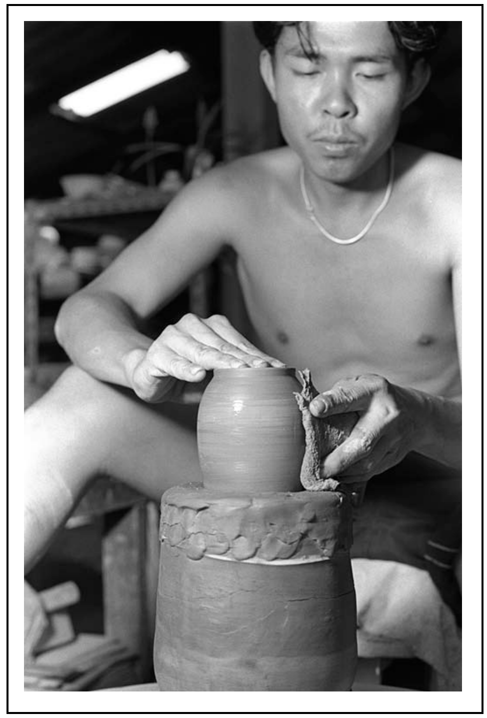
Potters able to throw shapes on a potter's wheel are considered skilled labor. They are creators whose training may take years. Here a potter draws a lump of clay upward into a jar shape. The potter often holds a wet rag in one hand to keep the clay pliable. By applying pressure with his fingers and hands, the potter controls the contours of the vessel.

3. MOLDING

Elsewhere in the factory liquefied clay is poured into molds made from white plaster. Depending on the skill of the mold designers, the variety of shapes made by this method is practically unlimited. Separate molds may provide multiple parts for a single final form. Besides providing a way to utilize clays that lack enough plasticity to be easily formed on a potter's wheel, the method is economical. With molds, an order for a hundred jars all in the same shape and size could be quickly and efficiently filled with a mostly unskilled labor force.

4. FINISHING

Once the basic shape is formed, whether by wheel or by mold, it is allowed to dry and thus slightly harden for a day or more. Mouthrims are shaved smooth, extraneous bits of clay are removed, and flat bases are cut or footrings carved. For objects made from piece molds, the join lines are smoothed away.



5. INCISED DECORATION

One of the oldest forms of pottery decoration is to cut designs onto the surface of the clay. The designs, incised with a variety of tools, are mostly floral or vegetal in nature.

6. UNDERGLAZE DECORATION

Once the clay is completely dry and hard, underglaze decoration can be added with a brush. Iron black and cobalt blue are the most common colors. Straight lines around the body of a pot can be applied easily if the pot itself moves on a turning table.

7. GLAZING

After the vessel has been decorated, it is dipped into a vat of glaze, a viscous liquid. The most common mixture is made with clay and wood ash. After dipping, the glaze is allowed to dry.

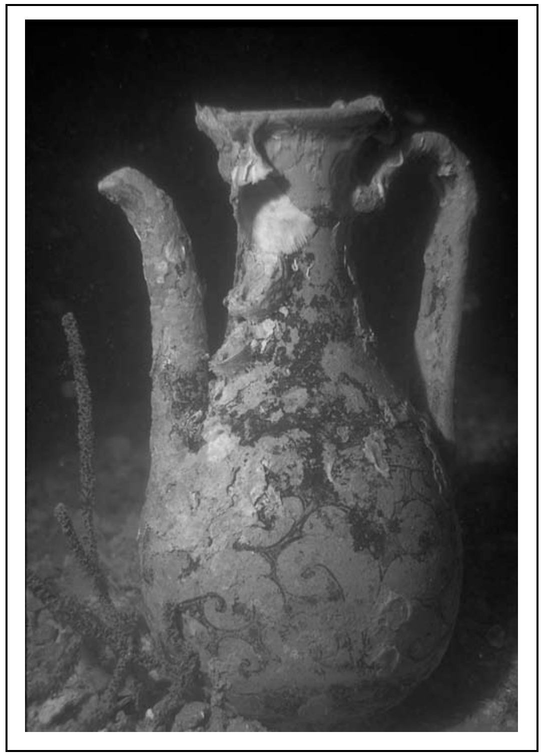
8. FIRING

Finally the clay pots are baked in kilns. Kilns have been made in all shapes and sizes and the technology of applying the appropriate amount of heat, the period of firing and controlling the kiln atmosphere is complicated. The exact combination of firing conditions is also usually considered part of the special trade secrets associated with fine ceramics. In the past, the fuel for kilns was wood or coal. Today it is gas or electricity.

11.0 CERAMICS INVENTORY *by Roxanna Brown*

11.1 Painted Ware

No kiln site has been documented as a source for the once colorful ceramics described in this section. They might come from the Cizhou kilns, or from the Quanzhou (or Cizao) kilns, where lead-glazed kendi were produced — some of them with the same green glaze that originally covered the painted wares (see Hughes-Stanton and Kerr, 1980, 32; and Adhyatman, 1987, Nos. 58-61). The variety of these pieces in Southeast Asia may indicate that they were made only for a short period. From collections of trade ceramics, only one example in similar style has been published (Southeast Asian Ceramic Society, 1983, no. 180), and it was tentatively identified as being from Northern China. Some equivalent examples were recovered from the Breaker Shoal shipwreck discovered in the Philippines (Dupoizat, 1995, Figs. 40-41). The shapes from the Java Sea Wreck range from bowls and cups to ewers and covered boxes. The decoration is sometimes in simple underglaze black, but more often the design is either incised, or molded in relief, with the ground painted black. The whole piece was then covered in a bright shade of green lead glaze, a low-temperature glaze that would have been applied after the first stoneware firing of the pottery. A second low-temperature firing would mature the glaze.



Painted ewer on the seabed.

The painted ware designs are basically floral, usually featuring a peony spray, sometimes along with leaf scrolls. There are also examples of the phoenix frozen in flight on the covers of boxes, but standing when they appear on upright shapes. There are two box covers with a sinuous dragon drawn in underglaze black.

The clay body of the ware is hard and grayish-white, although it can be buff-gray on exposed surfaces where the original glaze has eroded. The potting of the upright shapes is sometimes so thin as to seem fragile; many of them were constructed from parts formed in molds. The dish shapes and covered boxes have a more substantial feel about them.

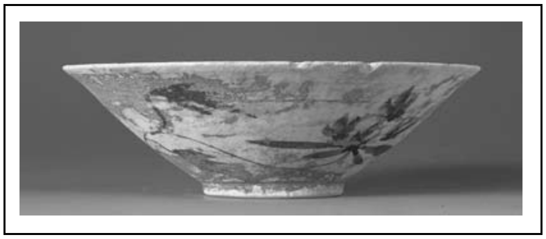
BOWL SHAPES

The dish shapes range from a small conical bowl to a large flared dish. The designs vary in detail but include foliage and peony scrolls incised in outline and reserved against an underglaze black background. Usually the exterior is plain but it may also be painted with a design in underglaze black of scrolling foliage. The entire dish, including the base (presumably with the exception of the footring on which it would have set for firing), was then covered in green glaze. The present exposed surface of the clay, where the glaze has eroded away, is buff-gray.

Small Bowl

Conical, with a short carved footring. The interior has a scrolling floral spray incised below an undecorated band at the mouthrim. The exterior has a painted design of scrolling foliage.

Example: 1
Diameter: 14 cm



Large Bowls

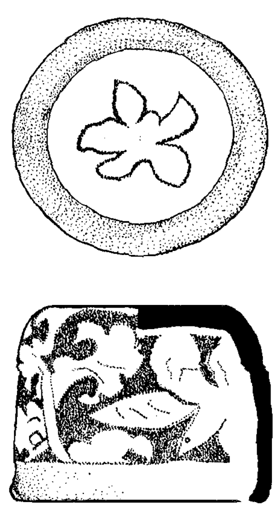
Several somewhat similar fragments are from larger size bowls with a straight mouthrim but curved walls. The largest of these shows traces of a circular stacking scar on the interior bottom, perhaps from the footring of a dish set upon it for firing.

Examples: 4 damaged
Estimated diameter of largest bowl: 25 cm

Large Dishes

Dishes with a narrow everted mouthrim, decorated on the interior with scrolling foliage, the exterior plain.

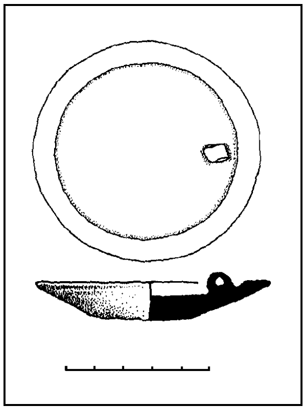
Examples: 3 damaged
Largest diameter: 30 cm



COVERS

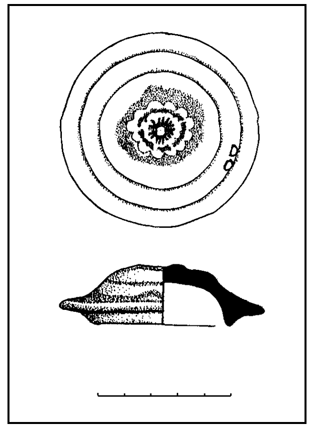
Cup-shaped, heavily-potted, and decorated with incised scrolling foliage around the exterior reserved on an underglaze black ground then originally covered in green glaze.

Examples: 3
Diameter: 6.8 - 7.5 cm



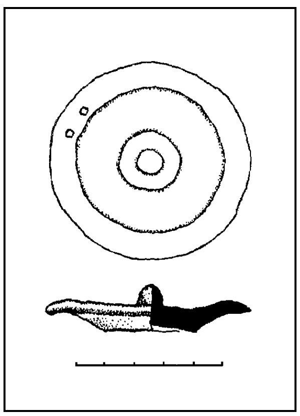
Concave center area set with a tiny ring handle at one side and wide, flat mouth flange, covered on the upper side with bright green glaze.

Examples: 11
Diameter: 8 cm



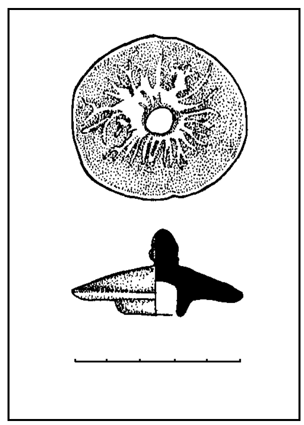
Dome-shaped with a wide mouth flange and two tiny perforations at one side. They are molded with the design of a plum blossom reserved on an underglaze black medallion at the center. There are traces of bright green glaze on the flange.

Examples: 14
Diameter: 7.2 - 7.5 cm



Concave depression around a short knob handle, and wide flat mouth flange with two small perforations at one side.

Smaller Examples: 17
Diameter: 7 cm
Larger Examples: 2 with a retaining ring to one side in place of the perforations
Diameter: 8 cm



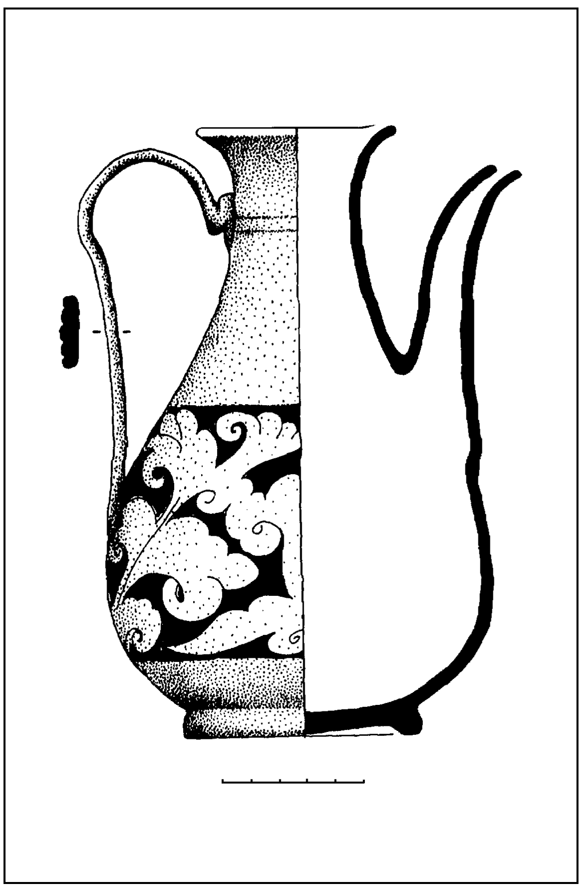
Cover with a ring of overlapping lotus petals in slight relief around a knob handle, the underside with a short vertical flange; with traces of green glaze on both the upper and lower surfaces.

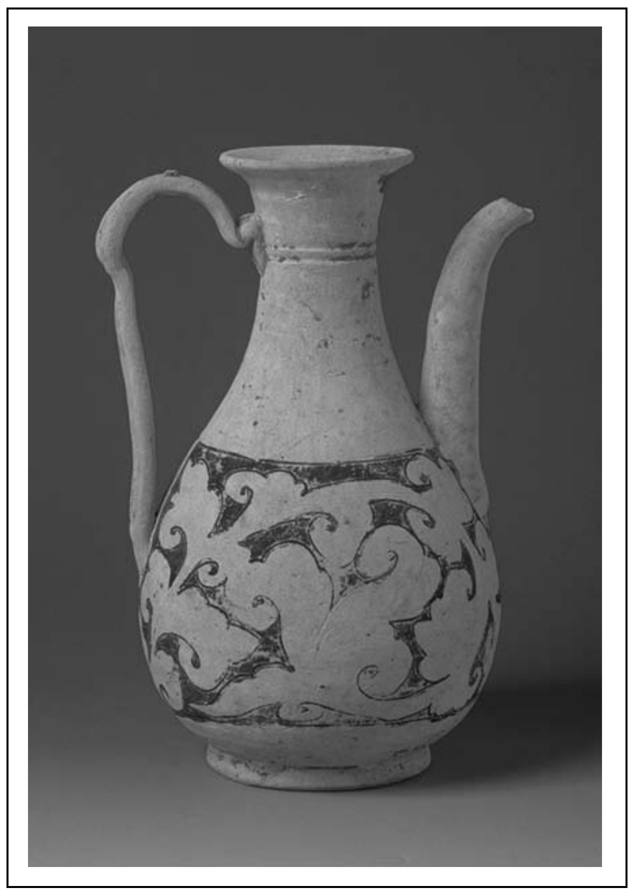
Examples: 3
Diameter: 5.2 cm

EWERS

The ewers are mostly pear-shaped with a bulbous lower body curving upward into a graceful neck flared at the mouth. They are unusual in being mold-made, in parts, rather than wheel-thrown. A strap handle is applied to one side and a tall curved spout opposite. They are decorated either with painted floral designs in underglaze black, scrolling foliage incised in outline against an underglaze black design, or with the white designs in relief (the clay having been pressed against a mold to obtain the motifs) that include the phoenix amidst scrolling foliage, all on an underglaze black ground, then covered in bright green glaze. The various styles show slightly differing proportions. The foot of these vessels is particularly unusual. Rather than being carved out with a knife after preliminary shaping, it was made by the clay being pressed into a mold that also formed the lower walls. Thus it imitates wares with a carved foot, but the footring is uncharacteristically rounded and the base concave rather than being flat. This potting technique is seen clearly on several ewer fragments intricately modeled with eight vertical panels of floral and phoenix motifs. One ewer also has Chinese characters in relief on the base.

Examples: 27 in damaged condition plus fragments of more
Height: 23.5- 24.5 cm





WINE POTS

These have lobed walls, an inset base, a strap handle applied to one shoulder and a short curved spout at the other. A circular depression around the mouth suggests the shape was meant to be combined with a cover.

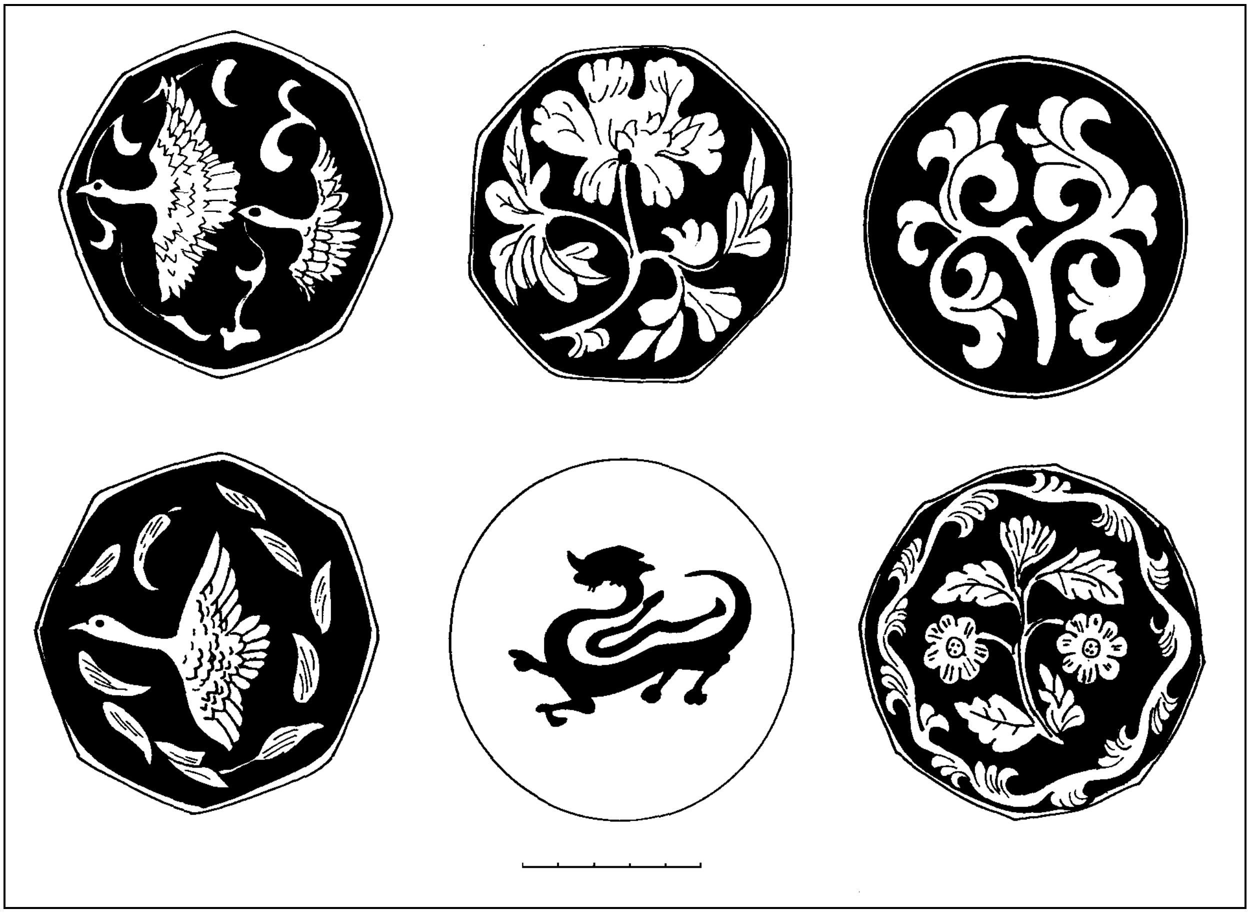
Small example: 1
Height: 10 cm

Larger examples: 2 damaged
Height: 15 cm

COVERED BOXES

Examples are in various sizes, with rounded walls or with flattened panels on the sides. The domed covers are sometimes slightly flattened. Most covers are decorated with incised or molded decoration (usually floral) on an underglaze black ground, then originally covered in bright green glaze. Very occasionally the cover features an underglaze painted design. Two show a sinuous dragon, another (a complete, sealed box 7.5 cms in diameter) features a peony spray; the lower portions of the boxes are undecorated except for the green glaze.

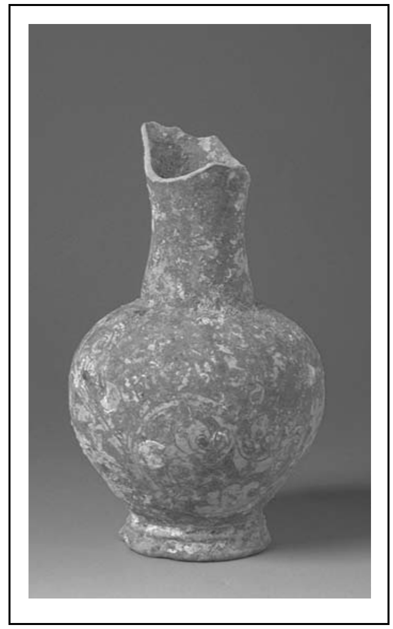
Diameter: 9 - 13.5 cm



BOTTLES

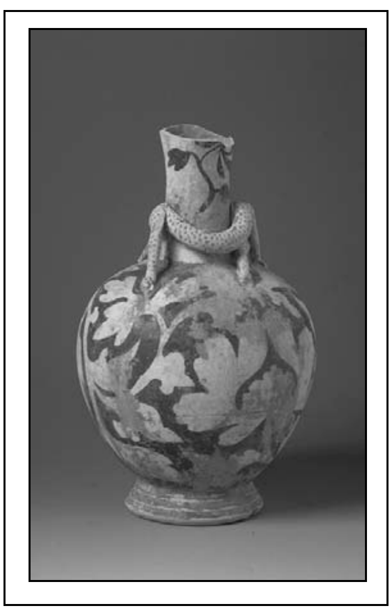
The main body is roughly spherical, with a tall flared neck and carved footring with tiers on its exterior side; decorated with scrolling foliage on an underglaze black ground. The clay is unusually thin, and the glaze is eroded.

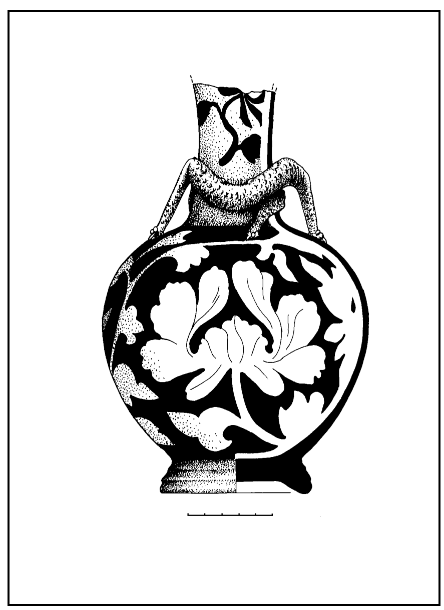
Example: 1
Height to break at neck: 19 cm



The main body is roughly spherical, with a tall neck flared toward the mouth, and a carved splayed footring with tiers on its exterior side. It is decorated with peony scrolls reserved on an underglaze black ground, and with a sculptural representation of a long sinuous dragon wrapped round the lower neck. The modeled dragon attached to the lower neck of this vessel is the same as that seen on similar bottles with *qingbai* glaze described later.

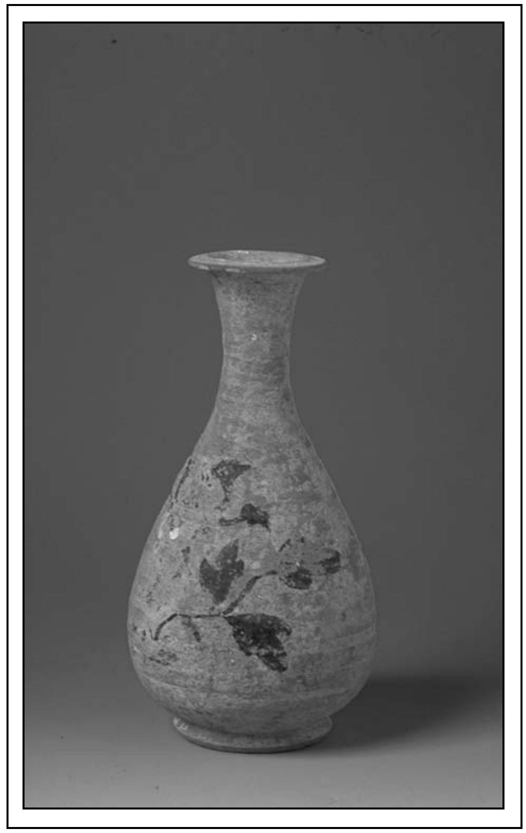
Example: 1
Height to break at upper neck: 24 cm

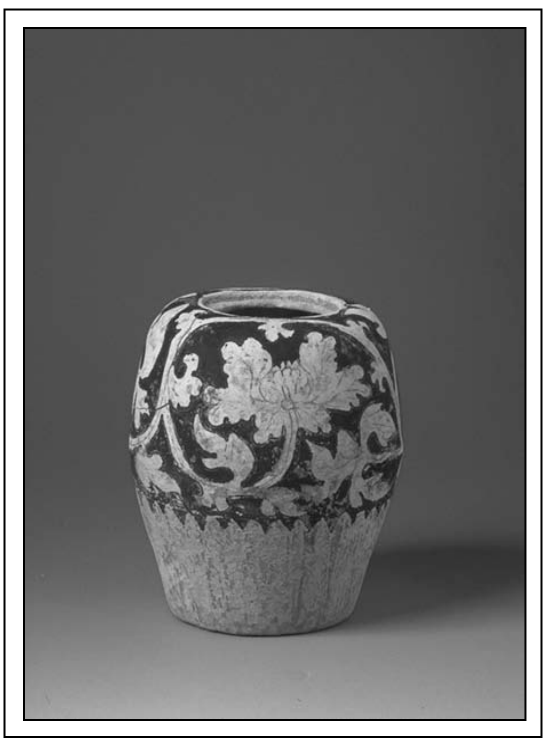




Pear-shaped bottle, with a carved splayed footring and sharply everted mouth flattened on its upper side, decorated in underglaze black with sprays of foliage. Its original low-temperature, bright-green lead based glaze is completely gone.

Example: 1
Height: 21.5 cm





JAR

Barrel-shaped jar, with in inset base and depression round the wide mouth meant to be fit with a cover; decorated in relief with incised peony scrolls on a ground of underglaze black round the upper body and with a band of tall lotus petals round the lower walls; with some traces of the original bright green glaze.

Example: 1
Height: 12.5 cm

VASES

Vase in *meiping* shape, sturdily potted, with an everted flattened mouthrim; the carved foot with an inset base; decorated round the upper body with incised peony sprays, then covered in bright green glaze; the clay body dark gray. (Whether underglaze black was originally applied is unclear in the vessel's present condition; only traces of the green glaze remain.)

Examples: 1 complete and a shoulder fragment of a second.
Height: 28.4 cm

Vase, with a more whitish, more compact clay body than apparent on other painted ware shapes; the main body almost spherical, the foot flared, and with a tall graceful neck that opens outward into a lotus leaf shaped mouthrim; decorated round the body with an incised peony scroll set on an underglaze black ground.

Example: 1
Height: 17 cm

Vase, upper portion only, with rounded shoulders and fairly straight sides, the neck straight, slanted inward and unglazed, as though it were meant to have a cover – probably one of the cup-shaped covers also recovered; decorated on the body with incised peony sprays reserved on an underglaze black ground; the clay body dark gray.

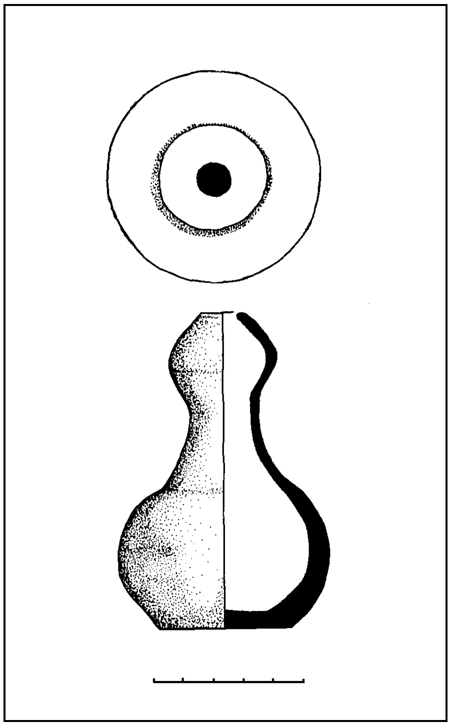
Examples: 1
Present height: 14 cm

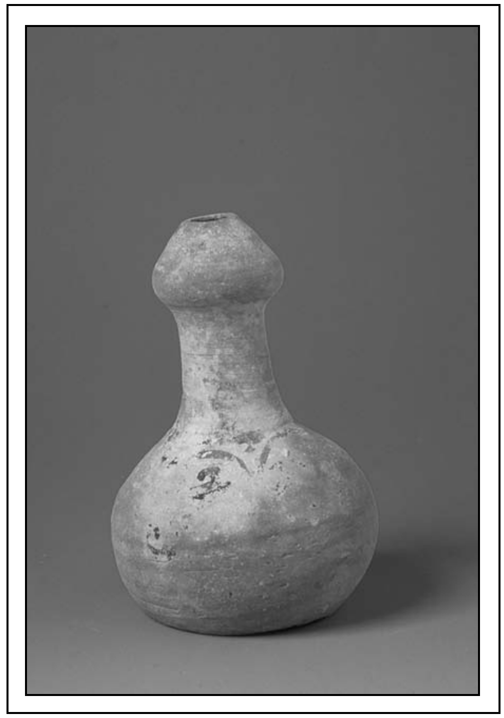
AMBROSIA BOTTLES

Potted solidly, with a bulbous lower body, a tall neck and bulbous mouth. The shape formed to be hand-held at the neck. With traces of cursively painted underglaze black decoration, but with no traces of glaze presently apparent; the flat base sometimes with three spur marks or, on one, traces of a circular kiln support scar; the present surface of the clay orange-gray in color.

This shape is rare among existing pottery in Southeast Asia, but it is well-known from Indian-style sculpture where such bottles are often held in the hand of gods and said to hold the elixir of immortality. It was perhaps a container for especially treasured medicines. A few similar examples are recorded from the Breaker Shoal shipwreck in the Philippines (Dupoizat, 1995, Fig. 38), and a single white-glazed one was found in a Yuan-dynasty (1280-1369) context in Sarawak (Chin, 1988, Plate 37).

Examples: 2 intact, 3 damaged
Height: 10 cm



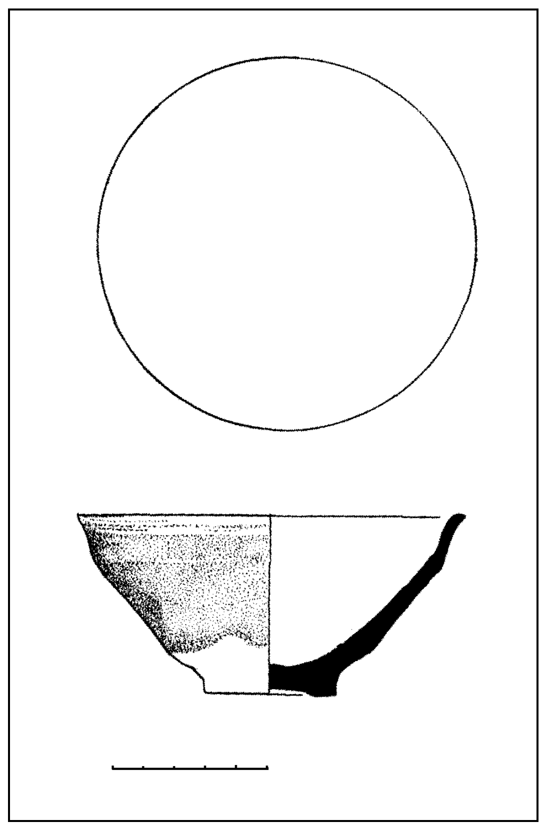


11.2 Black-Glazed Ware

There are only bowls in this category, and they are a standard size and shape valued as a tea-drinking bowl. The glaze is “temmoku” black with brownish patches, thin at the mouthrim but flowing thickly onto the lower exterior walls. The mouth is potted with a slight curve to form a lip from which a liquid could be sipped. The footring is roughly carved leaving a shallow but thick base. Some bowls were made with a rough grainy gray clay; others display a similarly grainy brown clay body .

A similar bowl in gray clay, illustrated in an exhibition by the Southeast Asian Ceramic Society [1983, No. 159] is identified as made at Jizhou, Jiangxi. It is said to have originally had clear glaze applied to the mouth.

Examples: 10 mostly intact,
36 damaged
Diameter : 12 - 12.5 cm
Height: 5.5 - 6 cm



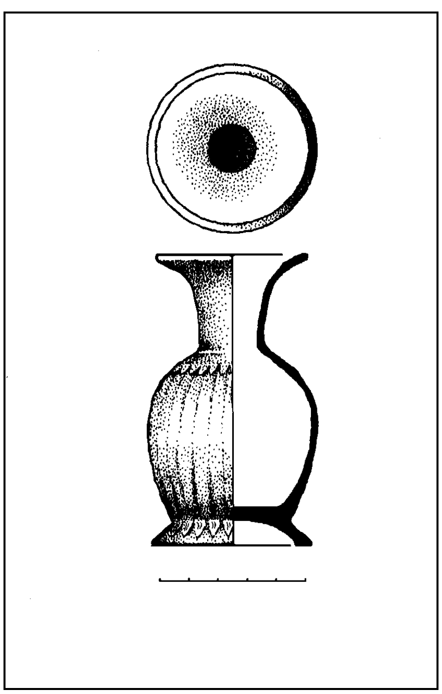
11.3 Molded White/*Qingbai* Ware

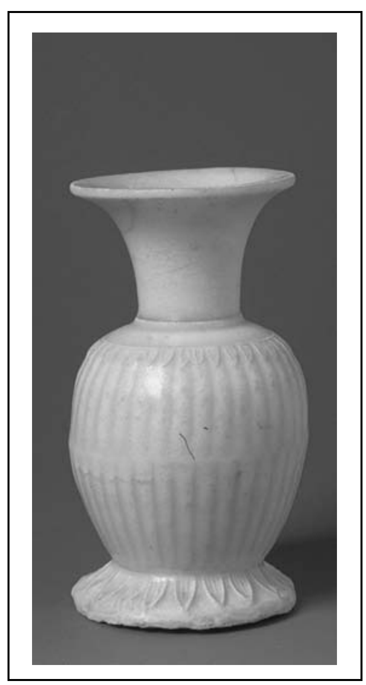
This group of ware made excellent use of a native white Fujian clay that was apparently relatively non-plastic; the problem of its not being easily shaped on a potter's wheel was solved by thinning the clay to a viscous consistency and pouring or pressing it into molds that formed both the shapes and decoration in relief. Small vases and covered boxes, particularly, could be made easily in quantity. The vases were probably used at altars to contain flowers or perhaps sticks of incense, and the boxes could be used for storing cosmetics, perfumes and medicines — or for the many miscellaneous uses for which boxes might be used even today. In Indonesian burials, boxes sometimes contain jewelry. In later years sculptural figures would be added to the Fujian white ware repertoire. The glaze color varies from white to gray to bluish-green. Probably the varying shades were chance results from individual placement in kilns and naturally varying firing conditions. Among this ware, the specific color was mostly fortuitous. At other kilns these effects could be planned and attained with proper glaze proportions and strict control of firing conditions. All the white-glazed ware of the cargo represent ceramics made in Fujian province, at both the Dehua and Anxi kilns (Hughes-Stanton and Kerr, 1980).

VASE

Made with four mold-produced sections that were subsequently luted together: the neck with flaring mouthrim, upper and lower halves of the main body, and a flared foot domed inward on its underside. The clay is whitish and somewhat grainy, with a sugary feel to its unglazed surface. Decoration is in relief, with ribbing on the main body and lotus petals round the footring. The interior is unglazed except at the flaring mouth.

Examples: 5 intact, 65 damaged
Height: average 11 cm; additional broken miniature, 6 cm in height





BOTTLE

Upper body fragment, with a spherical main body and curved neck, decorated on the shoulder in relief with two rings from which a border of petal design hangs.

Example: 1
Present height: 3.5 cm

COVERED BOXES

Mold-made in upper and lower halves, some undecorated except for relief striations down the walls, from a ring round the outer cover, that divide the sides into curved panels. Others are decorated with a floral spray on the upper cover and/or with ribbed walls. The flat base most often is concave; and the interiors are splashed with glaze that also covers the exterior to the lower walls. All the boxes are circular (rather than square), though some have flattened panels around the outer walls.

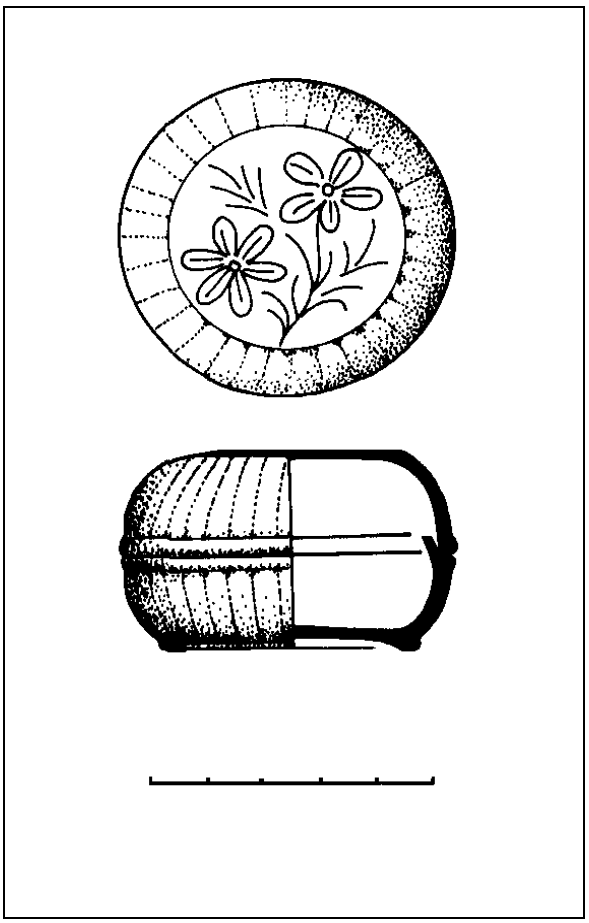
Two hundred and sixty-eight boxes were recovered sealed. Many, maybe even most, of them were shipped in this state. They are sealed by glaze having run from the cover onto the lower portion. Why they were shipped in this way is a mystery. Perhaps it was a sort of guarantee seal, one that could be broken by a judicious hammer blow, and maybe local brokers provided this service, in the way that certain persons become skilled at cracking open coconuts. Mud and water did gradually seep through open cracks between the two halves during their time underwater, so that these sealed examples are presently heavy; otherwise they were shipped empty.

Examples: 268 boxes were recovered sealed; 6 very small, 80 small, 60 medium, and 120 large, with approximately 600 separate covers and 900 bases in various sizes

Very Small Covered Boxes

These are decorated with fine, lush sprays of a variety of flowers at the flattened center of the cover and with bands of ribbing at the shoulder and round the lower section. The unglazed base is flat rather than concave as on larger examples.

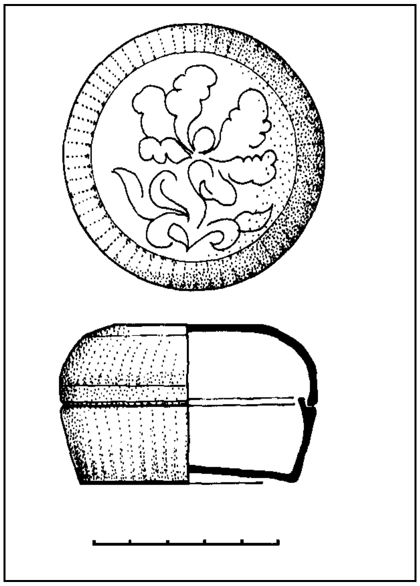
Diameter: 5 cm



Small Covered Boxes

With a peony or lotus spray in relief on the cover center and separate bands of vertical ribs round the cover shoulder and round the lower box section. The base is slightly convex.

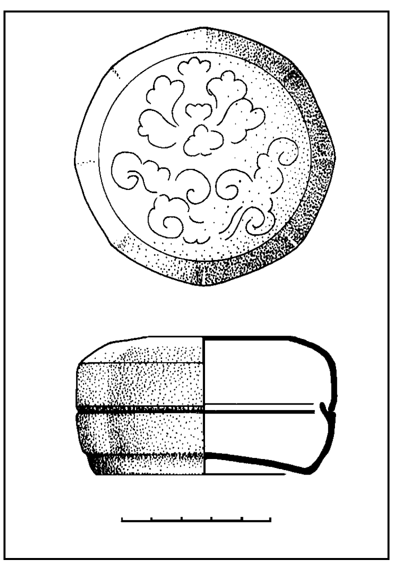
Diameter: average 6 cm



Medium Covered Boxes

With walls divided into eight sides, and decorated with a peony spray in relief on the center of the slightly domed cover encircled with a band of striations, sometimes together with a ring of dots.

Diameter: average 8.5 cm



Fruit-Shaped Covered Boxes

In medium size, with eight lobes and the design of a fruit stem at the depressed center of the cover; the base slightly inset.

Diameter: average 8 cm

Melon-Shaped Covered Boxes

In medium size, with ribbed walls extending to a floral design at the depressed center cover; the base flat.

Diameter: average 8.5 cm

Large Covered Boxes

The outer walls either 8-sided or with bands of ribbing over the shoulder of the cover and round the lower section, most with a floral spray (often a peony) in relief on the slightly domed center cover.

Height (with ribbing): 6.5 cm
Height (octagonal) : 4.5 cm
Diameter: average 11 cm

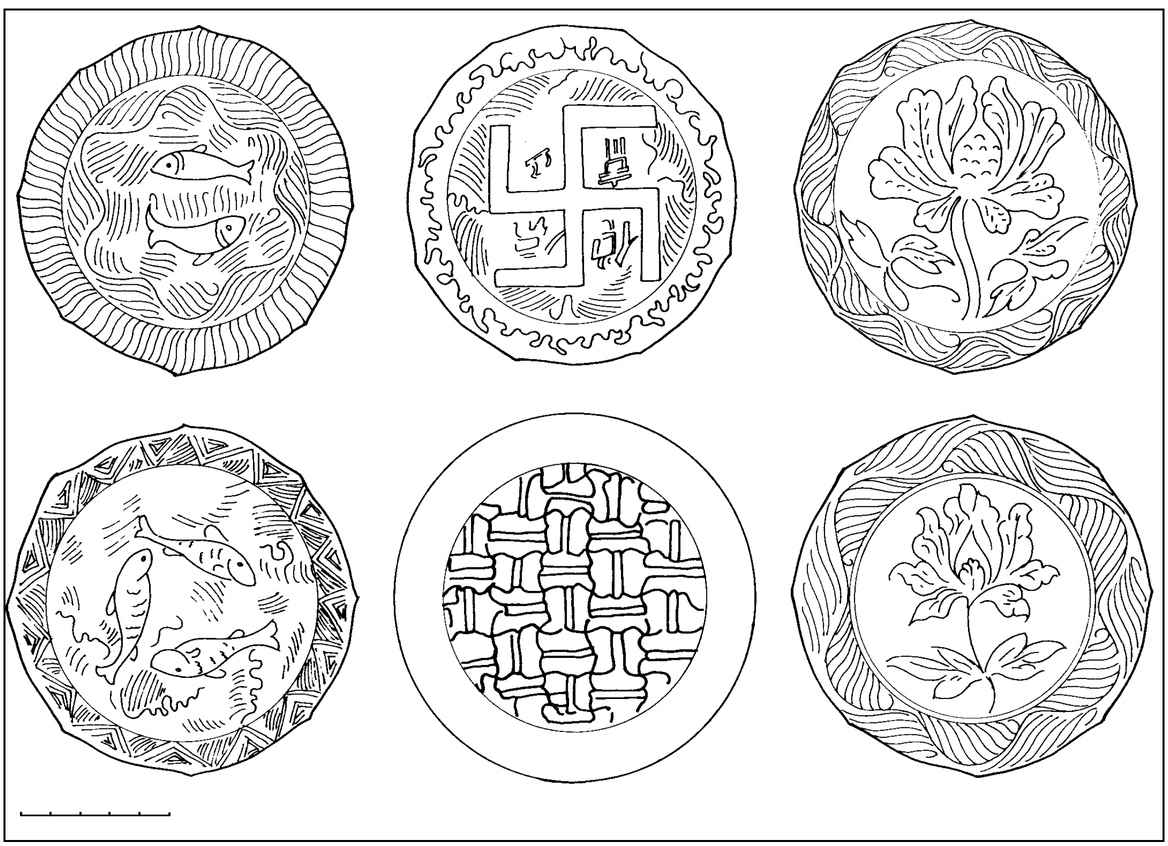
Unusual Examples of Covered Boxes

One small undecorated, perhaps wheel-thrown box, with a hand-modeled and detailed sculptural representation of an entwined, copulating couple attached to the inside bottom.

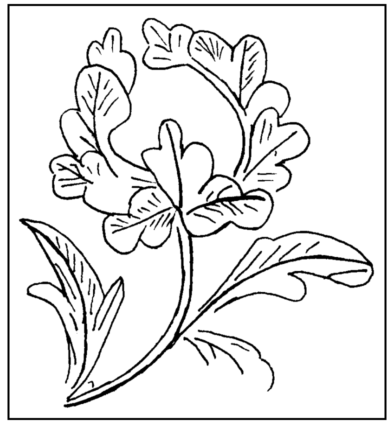
Diameter: 5.6 cm

Various covers with unique designs, including one with a Buddhist swastika, another with fish, and one with a geometric pattern, all from large boxes.

Diameter: 11.5 cm



Chinese Characters and Marks



A number of examples from the more standardized box shapes are made unique by having designs in relief on their base. These are sometimes simple floral motifs, and sometimes Chinese characters that seem to refer to family names, or which may be kiln factory names, something like a trademark (see following pages). In China boxes have been documented with marks such as “mirror box” or sometimes they have names of medicines written on them in black ink.

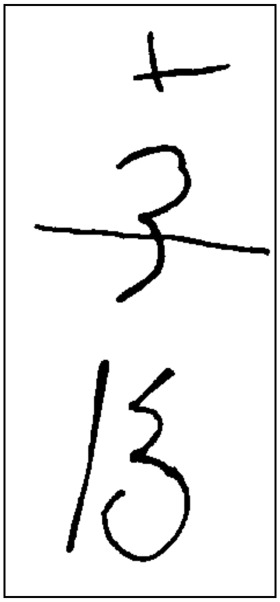
11.4 *Qingbai* Ware

A rather small but definite group of ware could be called *qingbai*. Their bluish-green glaze was an intentional effect, deliberately and consistently achieved. A small number, recognizable by the sureness of their potting, their whitish compact clay and a thick evenly applied glaze must come from the rightfully famous Jingdezhen kilns of inland Jianxi province. Others, with a brownish-gray grainy clay probably come from the same areas of Fujian as the green-glazed ware. A range of ewers displays the same grayish-white clay as some of the finer green-glazed ware. Structurally complicated shapes, they have a short foot with a smooth concave base that appears to have been hand-formed rather than carved with a tool. The main body was wheel-thrown, then neck-and-mouth, handle, and spout sections were attached separately. All the ewers were originally meant to have covers that would have had a matching retaining ring handle such as seen on the strap handles. A string would have been tied through them so as to secure the cover to the vessel.

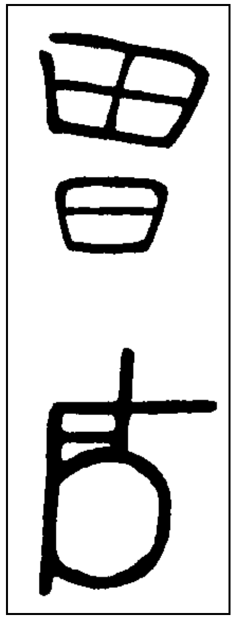
DISHES

Dish, with a foliated rim, very short foot and flat unglazed base. Decorated with an incised floral design on the interior and covered in mostly uncrazed bluish-green *qingpai* glaze. From the Jingdezhen kilns.

Examples: 1 damaged
Diameter: 15 cm

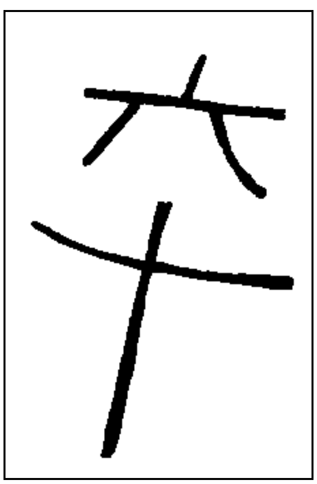


Zi □ Indecipherable □ molded on the base of a *qingbai* box

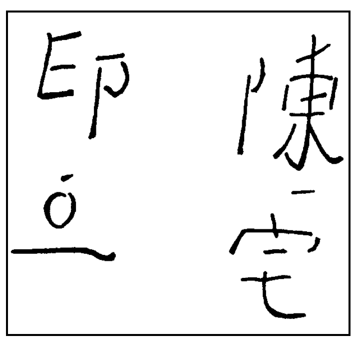


Indecipherable □ molded on the base of a Cizhou-type ewer

Li □ a surname □ molded on the base of a *qingbai* box

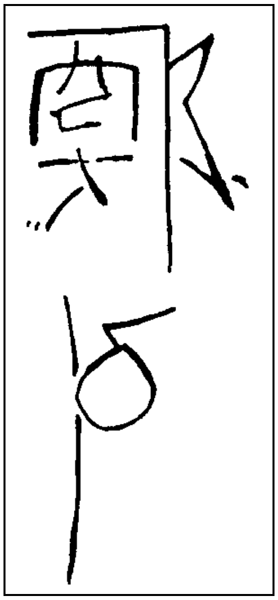


Liu Shi □ '60' □ molded on the base of a Cizhou-type decagonal box

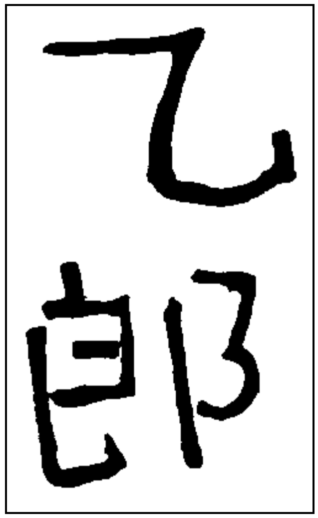


Chen Zhe Ying □seal of the Chen family □ molded on the base of a *qingbai* box

Zheng □ a surname □ molded on the base of a round Cizhou-type box

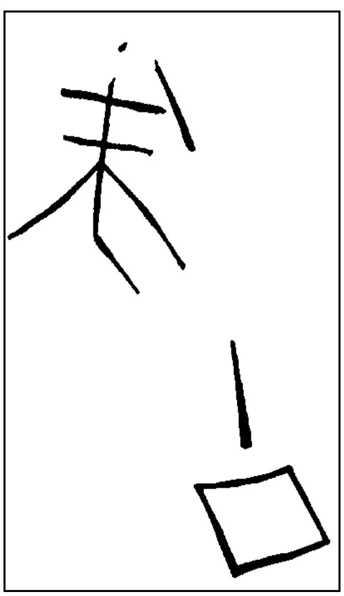


“Zheng” — a surname — molded on the base of a *qingbai* box

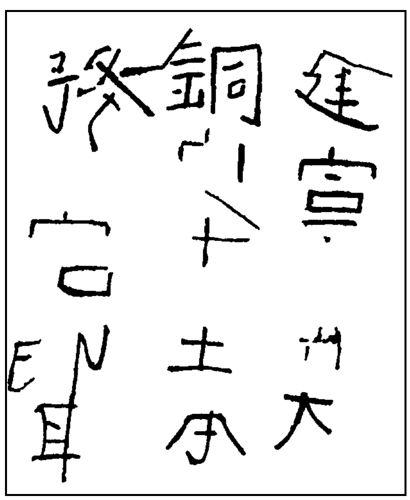


Yi Lang □- a surname □ molded on the base of a *qingbai* box

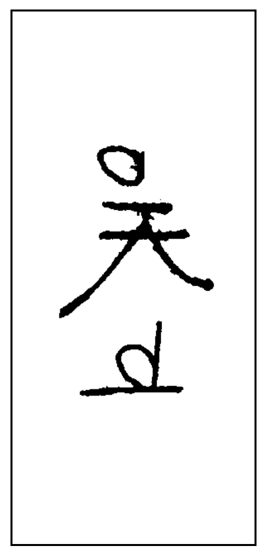
Chen □ a surname □ molded on the base of a *qingbai* box



Indecipherable □ molded on the base of a *qingbai* box



Da □ ‘big’, *Tong* □ ‘brass/copper’, only two characters decipherable □ molded on the base of a *qingbai* box



Wu □ a surname □ molded on the base of a *qingbai* box

Dish, or perhaps a cover, Jingdezhen *qingbai* ware, with conical walls and glazed all over except at the straight mouthrim. It is plain with no incised or molded decoration.

Example: 1
Diameter: 9 cm

COVERED BOX

Oval-shaped and undecorated, with a neatly carved shallow inset base. Covered to the lower walls in an opaque very pale bluish glaze. Probably Jingdezhen ware.

Examples: 2, one of them sealed
Diameter: 5.4 cm

COVERED BOX COVER

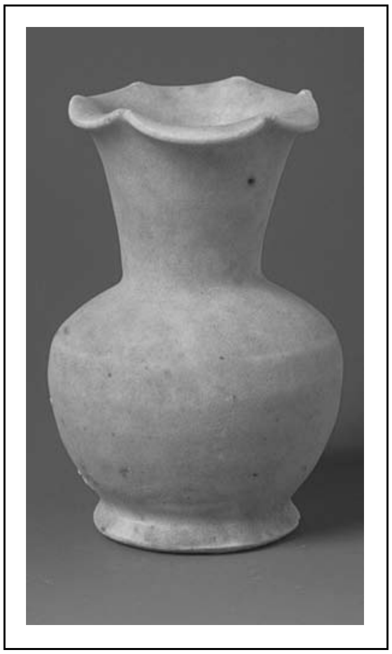
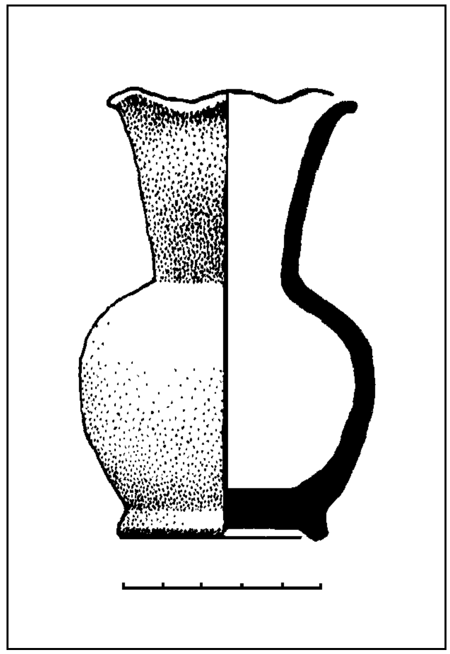
Finely potted with compact white clay, decorated with a spray of two peonies in high relief within a ring encircled by a band of classic scroll on its upper surface. Probably from Jingdezhen.

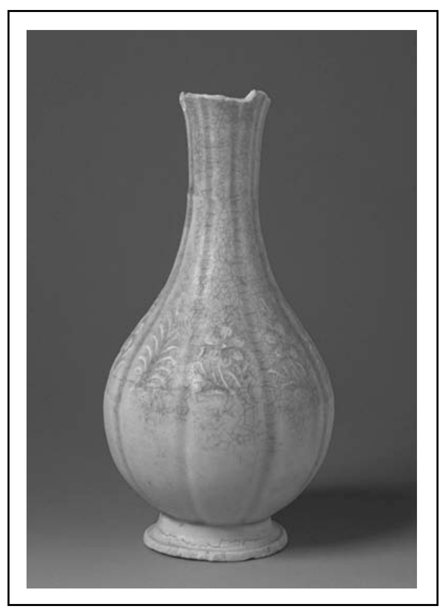
Example: 1
Diameter: 11 cm

VASES

Small and compact, with a bulbous body, flared neck and an everted foliated mouthrim and slightly splayed carved footring. Covered to the interior of the neck with thick opaque glaze presently eroded to a rough finish but probably originally extremely fine. The clay body is fine, smooth and gray on the interior but displays a rough texture on the unglazed base. Possibly from Jingdezhen.

Example: 1
Height: 9.5 cm



With a bulbous lower body, flared foot and tall curved neck. Made in four horizontal sections subsequently luted together □ the foot plus three body sections. The whole is divided into eight lobes, each containing a floral spray in relief. Covered in an unusually bluish opaque glaze. The clay body pale gray.

Example: 1
Height: 20.5 cm
(broken at upper neck)

A mouth section from a vase or perhaps bottle, made with eight lobes on the exterior which at the flared mouth are drawn outward to make a foliated rim; the bluish-green glaze crackled; the clay body gray.

Example: 1
Height: 5.5 cm
Mouth diameter: 7.4 cm

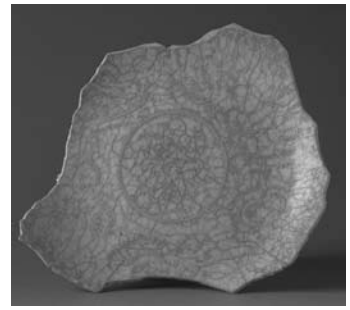
The following pieces are made from brownish-gray or buff clay.

DISHES

Small and thin, with a flat unglazed base and a wide ring round the interior bottom, otherwise plain.

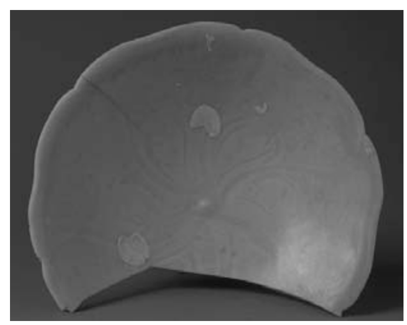
Examples: Two base fragments only
Diameter at widest point: 7.5 cm

With an incised ring at the interior bottom set directly above the circumference of a very short carved footring. The base is slightly concave and unglazed. Faintly impressed decoration at the center is no longer clear. The bluish glaze is heavily crazed. The clay body is gray and grainy.



Example: 1 damaged
Diameter: 18 cm

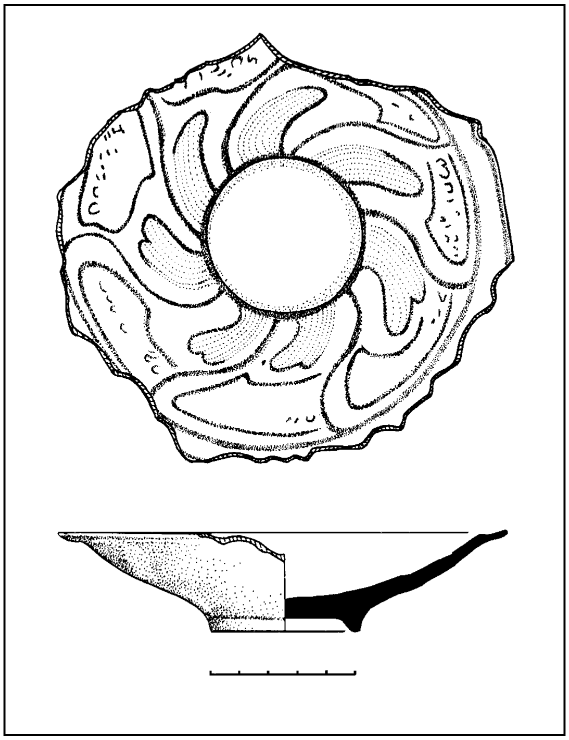
A damaged dish made with fine grayish clay, with a slightly everted foliated mouthrim and a finely carved footring. Decorated on the interior with a stylized swirling floral motif with an incised ring at the bottom and incised curls near the mouthrim. A small knob of clay is visible at the interior center. The glaze is thick, opaque and, in some places, more pale greenish than blue in color.

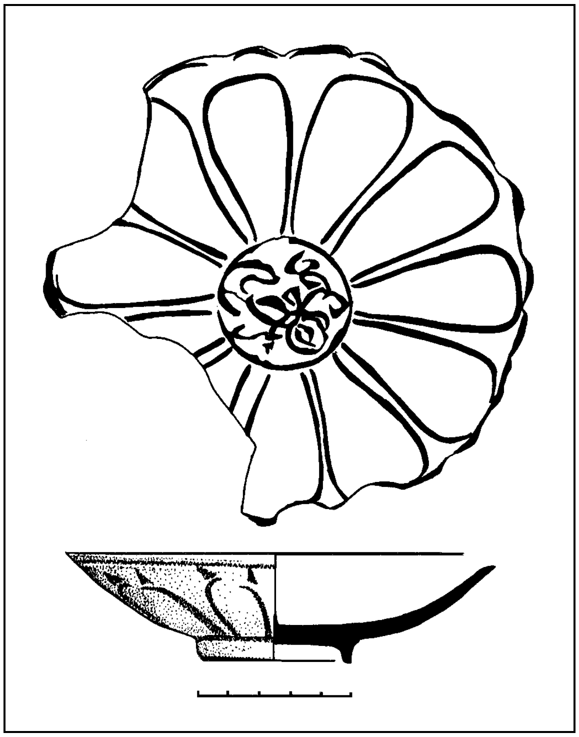


Example: 1 damaged
Diameter: 20 cm

Fragments only, of a saucer-like dish with a short carved footring and everted mouth with foliated rim. Elaborately decorated with a swirling floral motif on the interior in such high relief that the dish must have been formed by pressing the clay into a mold. A smaller incised or molded flower spray decorates a ring at the interior center. Covered in thick bluish-green glaze. The exterior walls are plain. Fragments similar to this and the following dish have been discovered at the Jingdezhen kilns, (Oriental Ceramic Society of Hong Kong, 1984, No. 11.)

Examples: 7 base fragments
Diameter: 16.5 cm





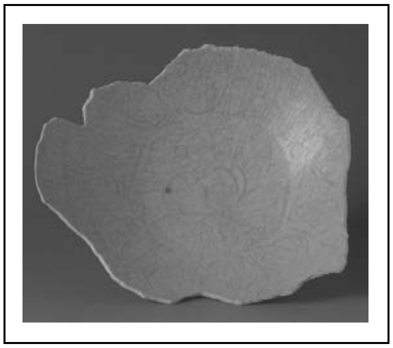
Further fragments, in the same shape as the previous group, display carved petals on the interior radiating outward from an encircled incised floral design at the center. Similar petals are also carved on the exterior walls.

Examples: 2
Diameter: 16.5 cm

BOWLS

Sturdily potted, with the footring carved so that the base is only slightly inset and so unusually thick. The interior is incised and combed with dense floral scrolling. The glaze is bluish-green and the clay body pale gray. All examples have traces of a circular kiln stacking scar on the base.

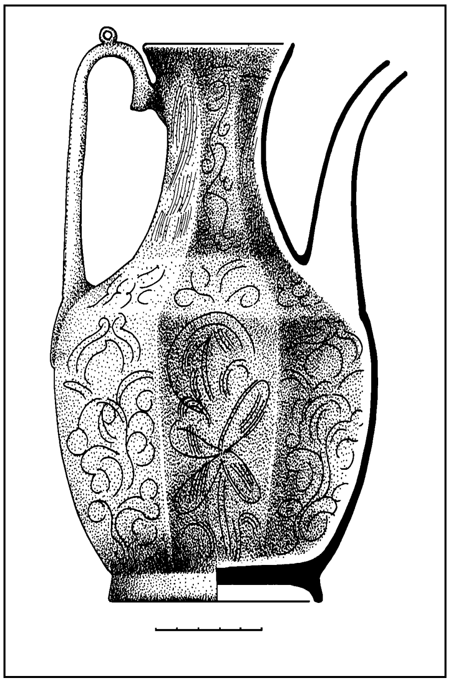
Examples: 3 fragments
Diameter: 22 cm at widest point

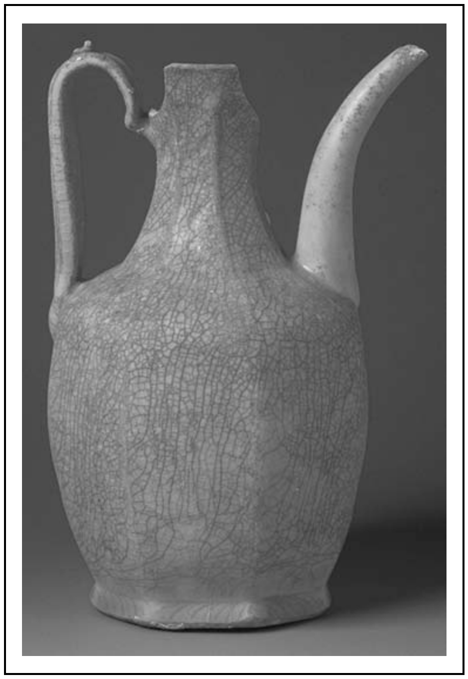


EWERS

Very thinly potted, with eight flattened panels around the walls, each of the panels incised with a floral design accented with combing. At the uppermost point of the long strap handle sits a small retaining ring. A similar ring on the original cover would have allowed the two to be tied together.

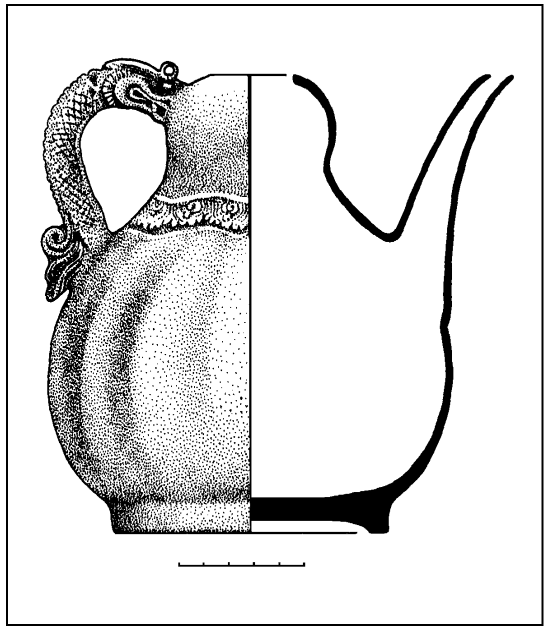
Examples: 3 damaged
Height: 25 cm

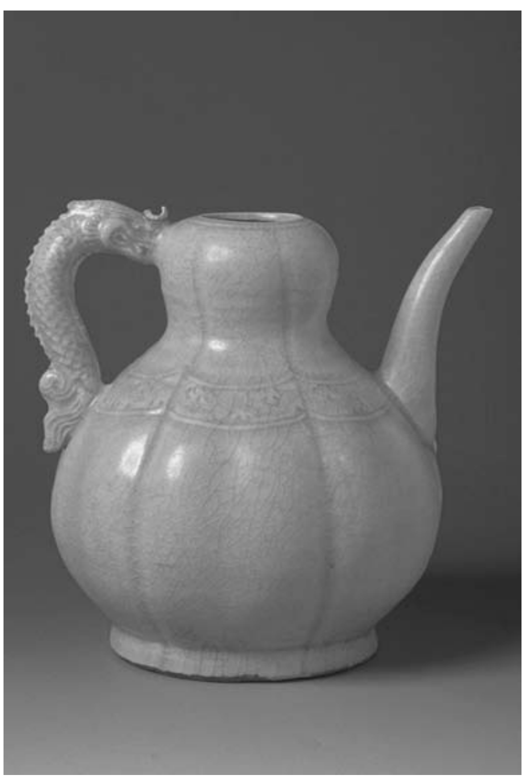




Gourd-shaped and lobed, these vessels were constructed from the parts formed in piece molds. Three types: (1) plain, (2) with a single band of decoration round the lower shoulder, and (3) with vertical floral sprays in relief. Its curved handle is intricately modeled into the shape of a leaping sea creature, with a retaining ring at its upper side (for fastening a string tie from cover to handle) and sometimes a perforation just below.

Examples: 10 damaged
Height: 20 cm





BOTTLES

With a bulbous body, a carved splayed footring, and long sinuous dragon in sculptural relief set around the tall neck. The dragon, unfortunately broken at the head and tail, is almost identical to those on the painted bottles of this same shape described earlier in this inventory. The body of the vessel is decorated with scrolling stylized foliage in incised and short combed lines.

Examples: 2
Height: 23 cm (broken at neck)

Gourd-shaped and mold-made, this miniature bottle is decorated with vertical rows of knobs on the lower portion above a band of tiny lotus petals at the base and with upright petals on the upper portion. The flat base shows traces of a circular stacking support scar. The glaze is fairly thick and bluish, and the clay body is brownish-gray.

Example: 1
Height: 6.5 cm

JAR

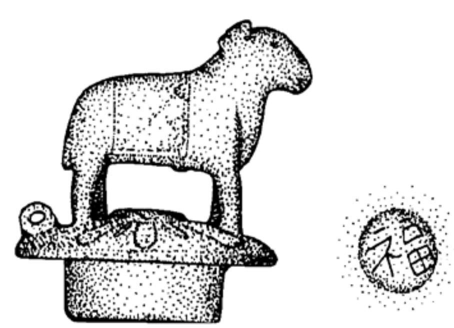
Small, with a bulbous upper portion, narrow mouth with everted rim and a base that is slightly inset. It is decorated with horizontal potting grooves. The runny bluish glaze ends in a thickened tier at the lower body.

Example: 1
Height: 10 cm

COVERS

This group is similar in size and construction but varied in design. The upper exterior portion, which is slightly domed, sets over a vertical flange that would have fit into the mouth of the parent vessel. Each has an attached retaining ring to one side. Some have floral designs in relief, with a small twirled clay handle. Another type features a sculpted model of a four-legged animal, possibly a ram.

Examples: 4
Diameter: 5.5 cm



11.5 Celadon and Olive-Glazed Ware

While most of the bowl shapes excavated from the shipwreck could be described as basically green-glazed, this group makes an obvious attempt to imitate wares traditionally known as Northern Celadon. Many art historians would prefer to discard the term celadon altogether. However, in order to distinguish this ware from the many other green-glazed wares in the cargo, the traditional term has been maintained. Some pieces in this category are better described as olive-glazed. All are relatively heavily potted and most are decorated with cursive carved and incised designs. The glaze varies in shades of green but tends to dark rather than light.

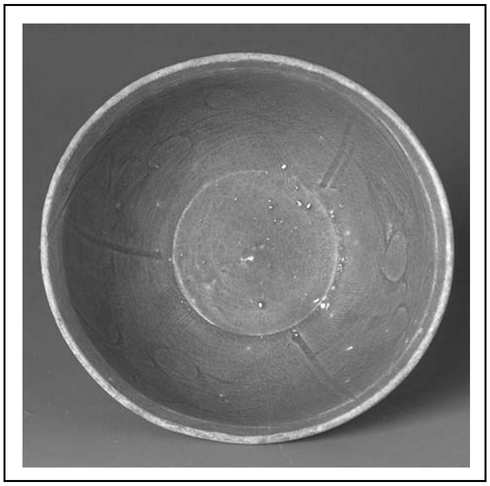
BOWLS

Plain, with a straight mouthrim, a sturdily carved footring, a single ring incised around the upper interior walls, and a carved ring round the bottom interior. The green glaze is heavily crazed and ends unevenly at the lower exterior walls.

Examples: 3 damaged
Diameter: 17 cm

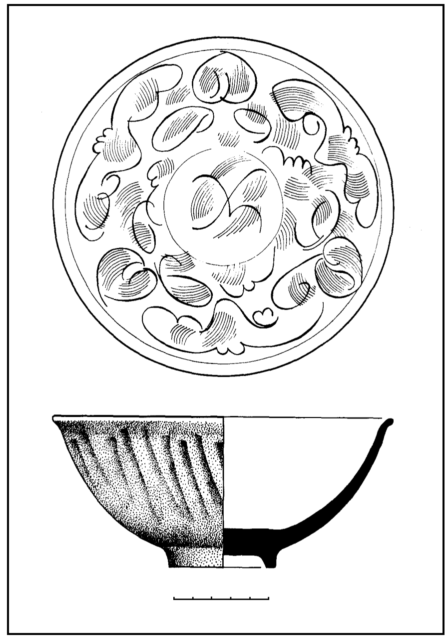
Deep with a slightly everted mouthrim and a carved footring beveled on its inner side to a relatively shallow base. Inside, an undecorated center is delineated by a carved ring. Decorated in carved and combed lines with cursive cloud forms on the interior walls, and with carved, stylized lotus petals around the exterior. Dark green opaque glaze runs unevenly to the lower walls. Tiny bits of grit sometimes mar the interior.

Examples: 2 intact, 3 damaged
Diameter: average 12.3 cm

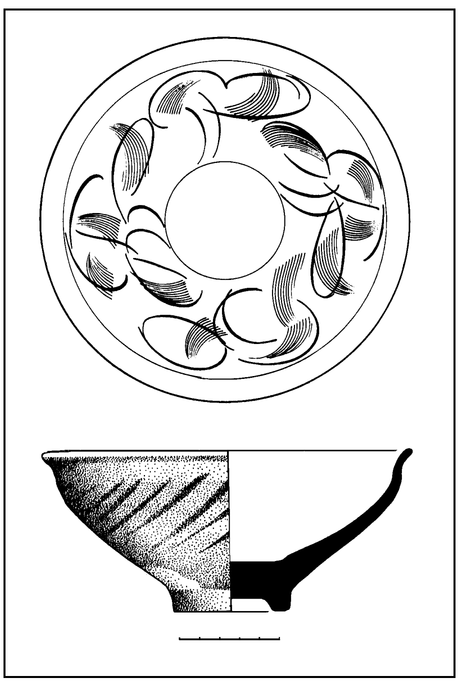


Heavily potted, with a slightly everted mouthrim and a carved footring bevelled on its inner side to a shallowly-cut base. Incised on the interior with a cursive, stylized floral design including three blossoms accented with wisps of combing, and on the exterior with striations down the walls. The glaze is thin at the mouthrim and ends unevenly just above the foot. The buff-gray clay is grainy.

Examples: 5 intact, 20 damaged
Diameter: 18 cm



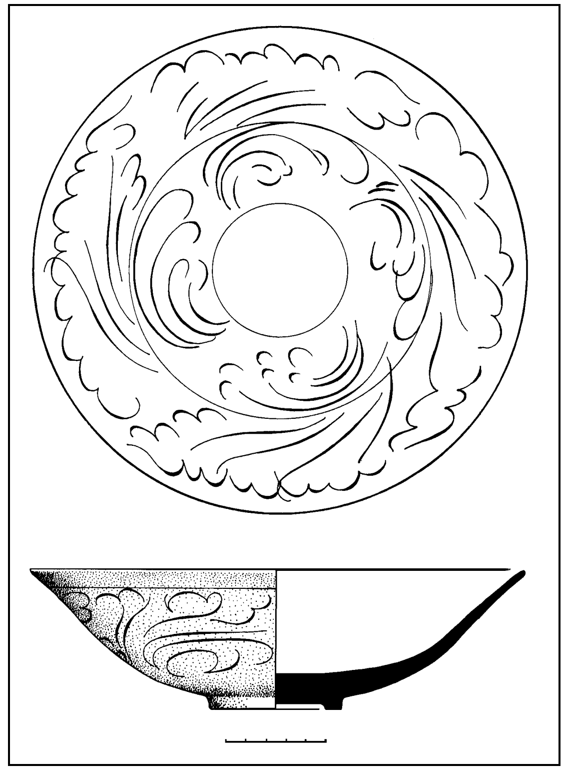
Heavily potted, with an unusual mouth that curves inward then out, and a heavily-carved footring showing silver-gray grainy clay on the unglazed base. Decorated on the interior with a carved ring around the bottom and with cursive cloud-like designs of incised and combed lines, and on the exterior with curved striations. The clay body is silver-gray and grainy.



Examples: 7 intact, 20 damaged
Diameter: 17.5 - 18.5 cm

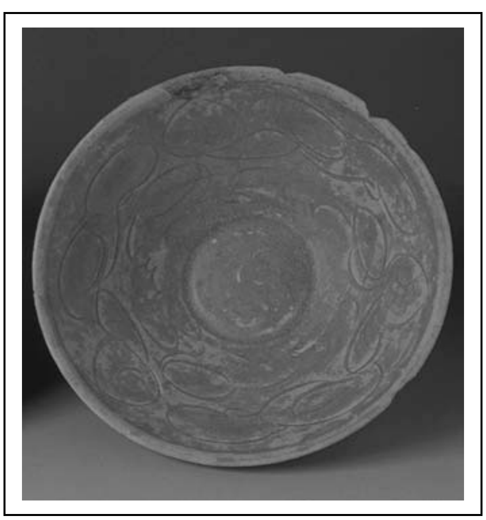
Wide and flaring, heavily potted, with a short carved footring, these are decorated on both the interior and exterior with cursive incised and combed designs perhaps imitating cloud forms or stylized vegetal scrolls. The center interior is delineated with a carved ring.

Examples: 3 intact, 30 damaged
Diameter: 24.5 - 25.5 cm



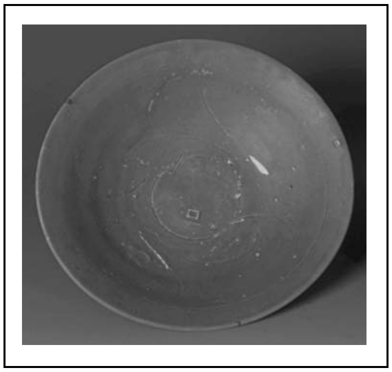
Deep and wide, these have a somewhat distinctive mouthrim that is short and curved. Decorated in a cursive style, with vegetal and cloud forms in carved and combed lines on both interior and exterior walls. There is a carved ring around the interior bottom and a short carved footring.

Examples: 5 intact, 25 damaged
Diameter: 24 - 25 cm



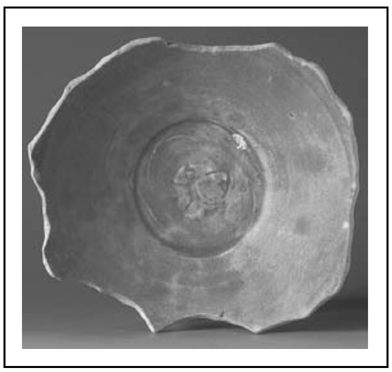
Wide, shallow and heavily-potted, this group is decorated on the interior with wispy carved and combed swirls and with an impressed Chinese mark within a circle at the center. The mark is *ji*, a commonly used character meaning "auspicious." Similar dishes found elsewhere often have two characters, *da ji*, a wish for good luck or good fortune, instead of *ji* alone (e.g., Southeast Asian Ceramic Society, 1979, No. 92, for the single character; and Dupoizat, 1995, Fig. 6, for examples with both characters).

Examples: 2 intact, 5 damaged
Diameter: average 22.5 - 24 cm



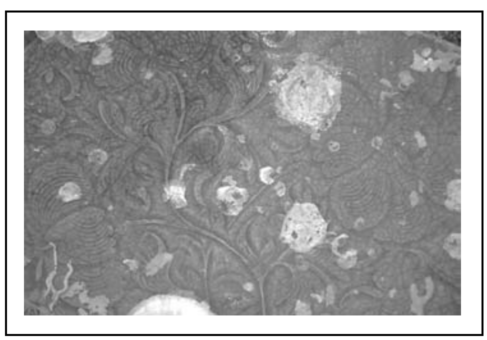
Carved with in inset base, and with prominent ribs and tiers of deeply incised lotus petals on the exterior. The interior is plain except for a small floral motif at the encircled inside bottom.

Example: 1 damaged
Diameter of fragment: 21 cm



DISHES

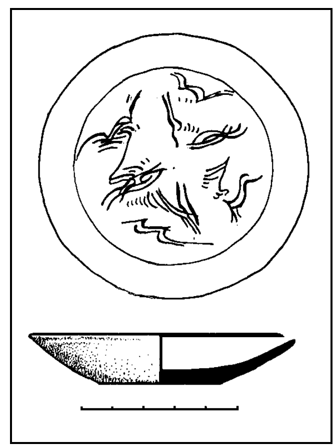
Widely flared dishes, intricately decorated with a carved dense design of peony blossoms and foliage on the interior and short carved curls on the exterior. With a short finely carved footring, unglazed on its rim and base. The clay is pale grayish.



Examples: 4 damaged
Diameter: largest fragment 23 cm

11.6 Decorated Green-Glazed Ware

These pieces do not fit into any clear categories of glaze type. Often they are simply called transitional ware, a convenient reference to the thirteenth century change from Song to Yuan dynasties. Although one basic glaze mixture was probably in use, varying firing conditions produced a variety of color shades from creamy white to pale to dark green. At some kilns, especially in later times, some of these variations would be codified and deliberately attained with more careful monitoring of material quality and control of kiln atmosphere, especially with the fine art of reduction control. Variations that appear accidental here include *qingbai* (bluish-white) and what would later be called *shufu* (cream white). Because the glaze is transparent, incised and carved decoration is more common than on the Longquan green-glazed celadon that became popular in the fourteenth century. In exhibition catalogs examples of the following ceramics have been dated from the tenth to the thirteenth century (Southeast Asian Ceramic Society, 1979 and 1983). The glaze on most of them ends at the lower walls; none has a glazed base. These ceramics are from several Fujian province kilns, all of which made fairly similar products. Five sites have been documented: Anxi, Tong'an, Nan'an, Quanzhou, and Putian. Most of the dish shapes are from Tong'an and Nan'an.



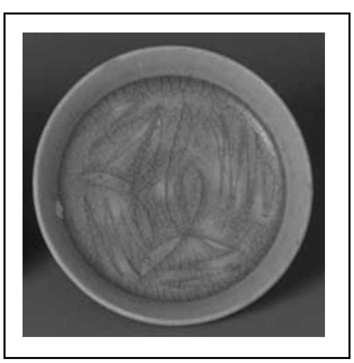
DISHES

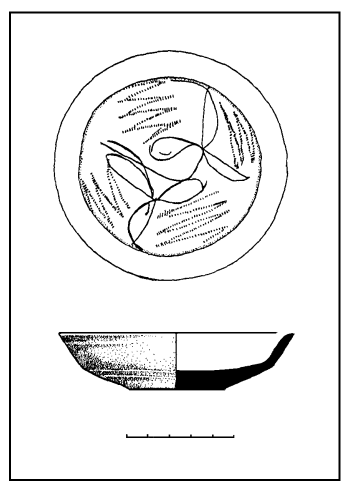
Small and eggshell thin, with a straight mouthrim and flat unglazed base; decorated on the interior bottom with lightly incised stylized four-petal star-like designs accented with combed marks; the clay body whitish with a sugary feel, a clay similar to the type used for the molded white wares; the glaze crazed and bluish-green in color.

Examples: 7 damaged
Diameter: 9 cm

Wide and flat, decorated on the interior with a cursory incised floral design accented with curiously distinctive zig-zags of short combed lines. The exterior walls are sharply angled to a small flat base. The green glaze pools on the interior bottom and at the sides of the base. Probably from the Nan'an kilns.

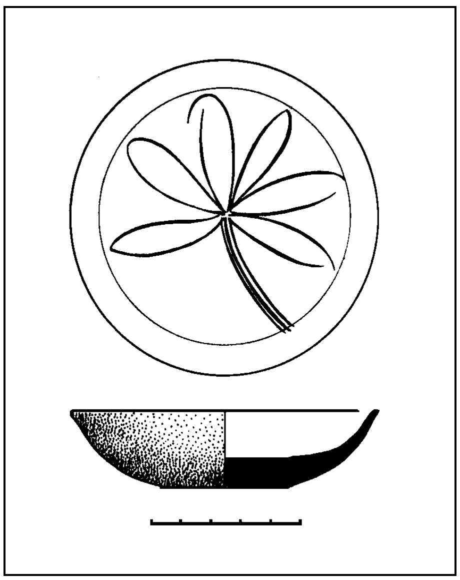
Examples: 4 damaged
Diameter: 11 cm

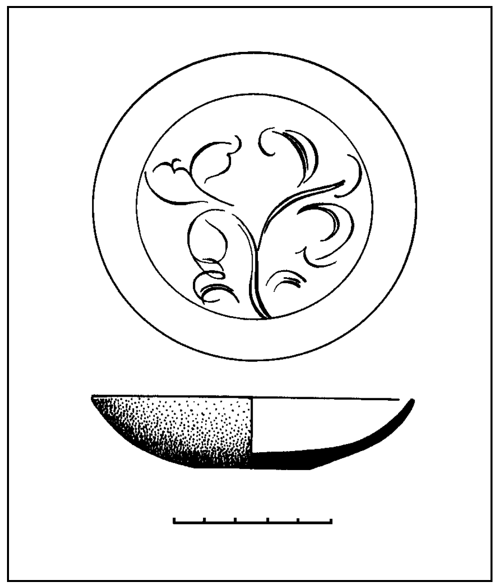


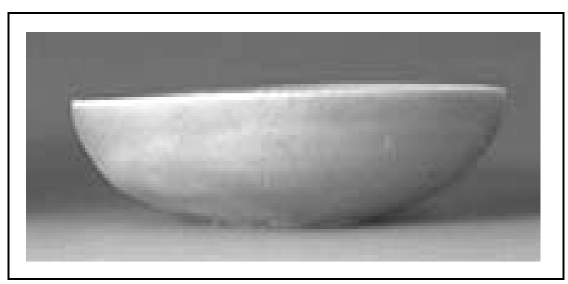


Small, with gently curved walls rising to a straight mouthrim. The base is flat, unglazed and very occasionally has traces of a kiln support scar. Decorated within an encircled interior medallion with a stylized, cursively incised floral spray. Covered with a somewhat runny glaze that usually fires without crazing to various shades of green, some very grayish and others more blue. The clay body is pale silver-gray and somewhat rough. In the fifteenth century dishes of exactly this shape and size, except for a base carved into the bottom, would appear among blue-and-white ware as the "hole bottom" dishes.

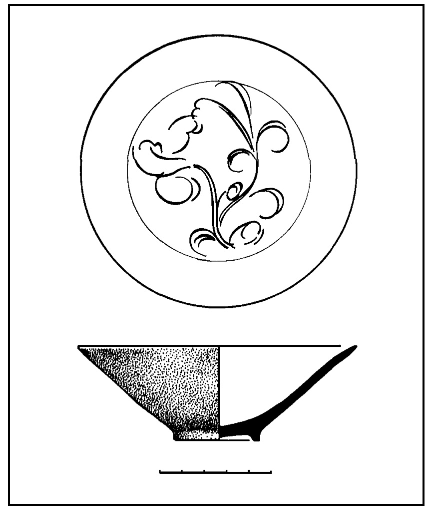
Examples: 600 intact, 300 damaged
Diameter: Average 10 cm, 1 larger example 12.5 cm





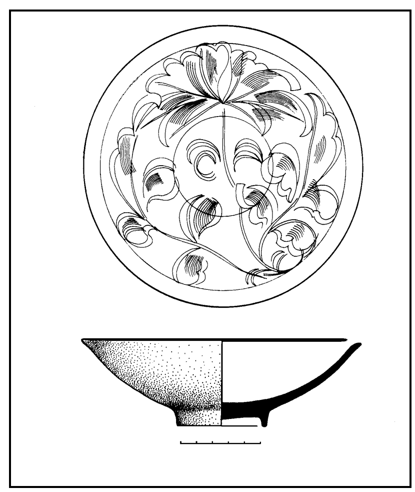


BOWLS



Small tea-bowl size, displaying the same designs, clay and glaze as the previous dishes, with conical walls and a short carved footring. The glaze runs unevenly onto the exterior of the foot. The interior floral design is encircled. They ring when tapped, clearly a sign of firing at an high temperature.

Examples: 150 intact, 50 damaged
Diameter: Average 12.5 cm



Relatively shallow, with a slightly everted mouthrim. A cursive floral spray on the interior runs over an encircled bottom upwards to a carved ring around the upper walls. The exterior is plain, and the base inside the footring is thick.

Examples: 100 intact, 50 damaged
Diameter: Average 18

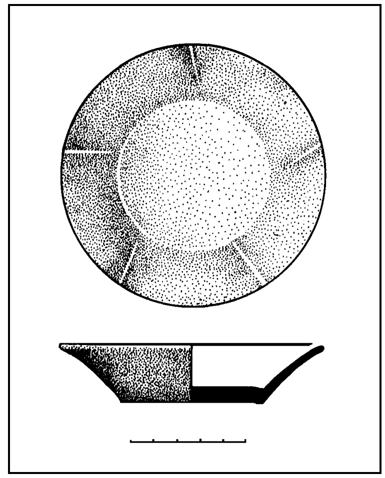
LOBED DISHES AND BOWLS

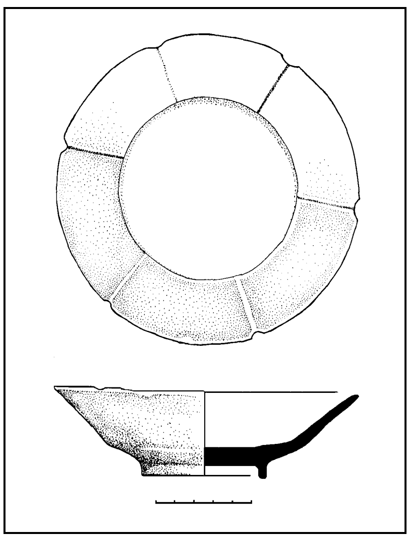
These display the same glaze and body characteristics as the previous decorated categories. The lobes of the mouthrim are further accentuated by single striations at each rim nick that appear to be made with thin lines of slip beneath the glaze; otherwise they are undecorated.

Dishes

Small, with flared walls and a wide flat interior bottom encircled by a single carved ring.

Examples: 10 intact, 10 damaged
Diameter: 11-12 cm

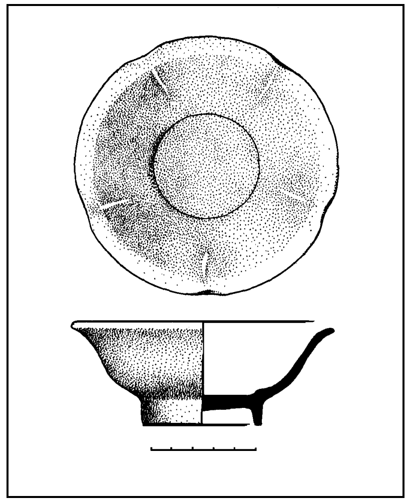




Wide and flared, with an encircled flat interior bottom that corresponds to an angled tier at the lower exterior walls. Wide dishes such as this, with a sharply angled exterior wall, are sometimes identified as brush washes, for use in Chinese caligraphy.

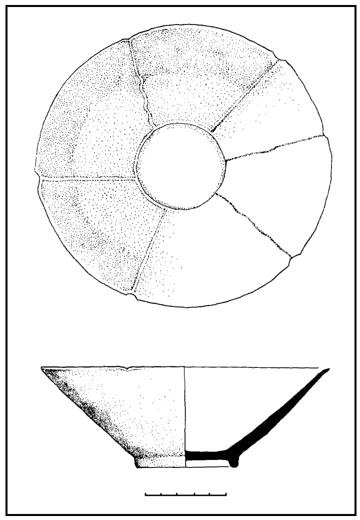
Examples: 20 intact, 10 damaged
Diameter: 16.5 - 17.5 cm

Bowls



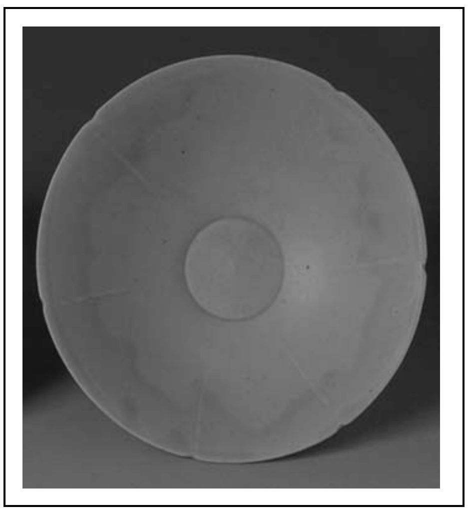
The curved everted mouthrim of these is nicked to form five lobes that are accented with a striation between each down the interior wall to a carved ring that encircles the bottom. The glaze is pale grayish-green. The relatively heavy footring is carved and unglazed. The clay body is pale silver-gray, with a rough surface. Some examples have an unglazed stacking ring carved on the interior.

Examples: 20 intact, 20 damaged
Diameter: average 12.5 cm



Another group is characterized by a straight mouthrim and six lobes.

Examples: 18 intact, 22 damaged
Diameter: 18 cm

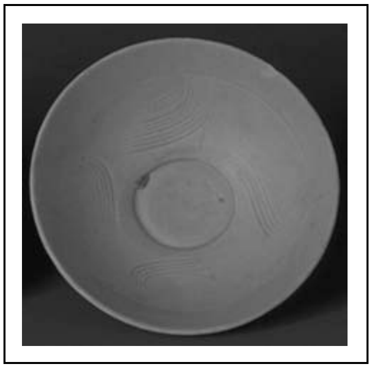


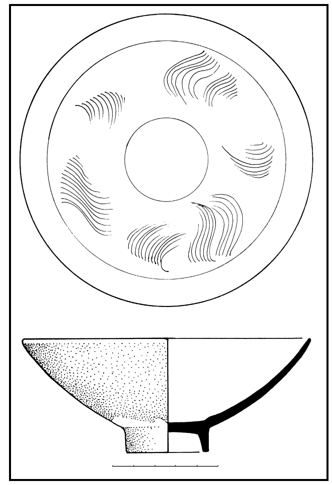
BOWLS WITH SIMPLE COMBED DECORATION

With a carved footring and plain exterior; the interior decorated with combed curls of decoration within a band between the carved ring encircling the interior bottom and an incised ring at the upper walls; the clay and glaze similar to the previous categories, with chatter marks often evident on the lower exterior walls and pin holes in the glaze.

Small-sized with a straight mouth and a wide ring at the bottom interior.

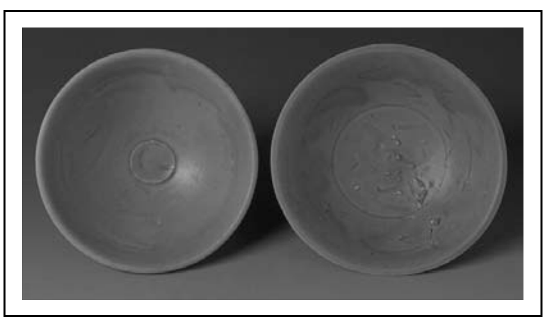
Examples: 20 intact, 10 damaged
Diameter: 12- 13 cm

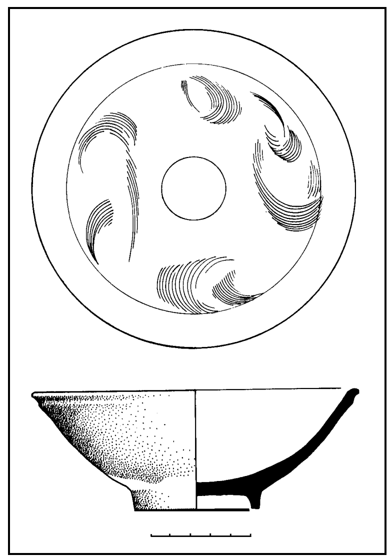




Medium-sized, with the mouth everted only at its lip. Some have a broader ring at the interior bottom.

Examples: 400 intact, 250 damaged
Diameter: average 15-16 cm





Large-sized, with a slightly everted mouthrim. Some have an unglazed stacking ring cut onto the interior, and some have bits of grit caught on the surface of the glaze.

Examples: 2 intact, 10 damaged
Diameter: 23 cm

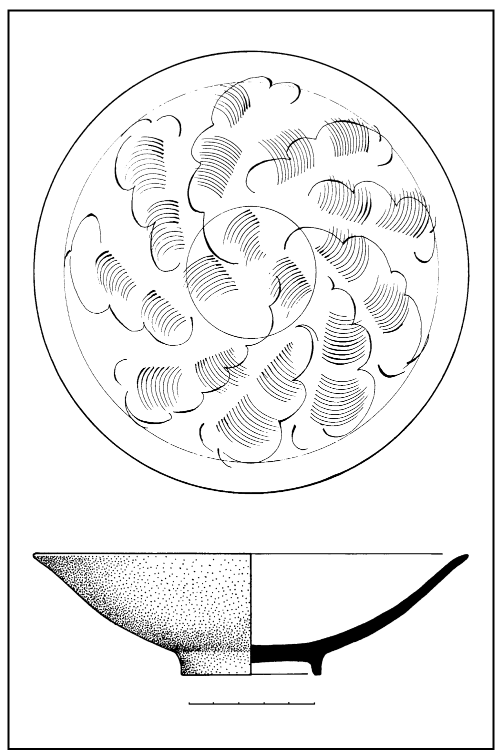
BOWLS WITH CLOUD DECORATION

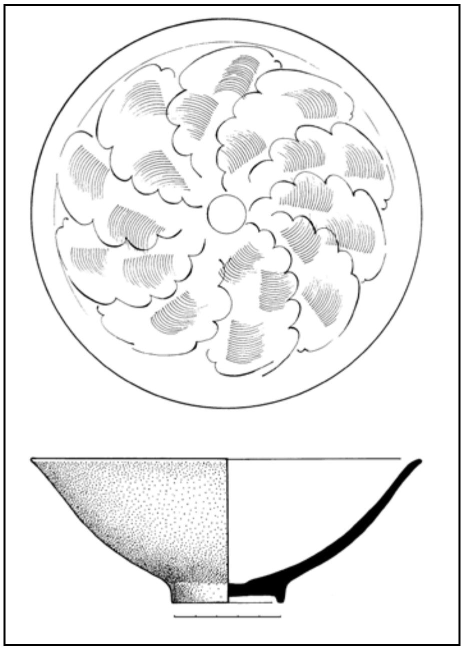
Bowls in a standard medium size, decorated on the interior with combed cloud-like motifs. The mouthrim is straight and the footring is carefully carved. The glaze is pale green to gray, and the clay silver-gray and slightly rough.

Examples: 1,000 intact, 250 damaged

Some have a ring of broad diameter at the interior bottom.

Diameter: 17 - 21 cm





Others display a small button-size encircled bottom and slightly higher walls. One example has four fish motifs scattered among the cloud designs.

Diameter: 17-21 cm

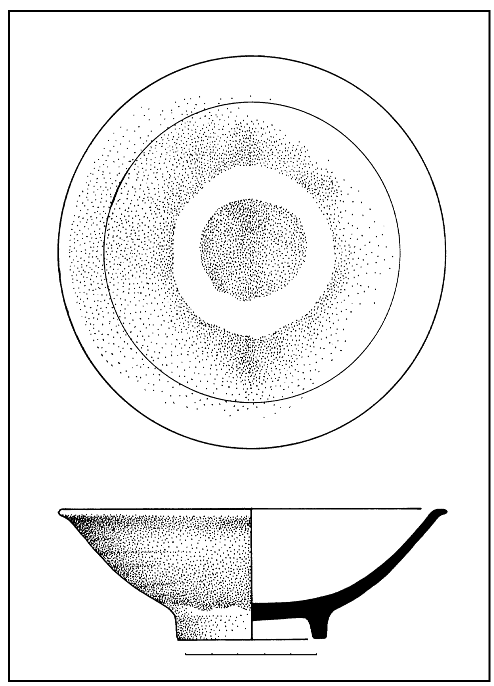
11.7 Undecorated Green-Glazed Ware

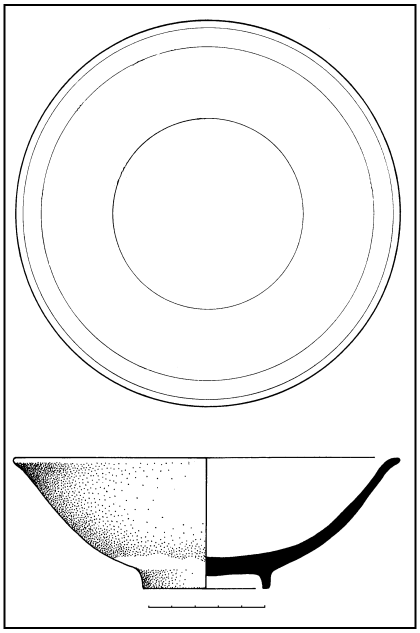
The glaze characteristics of these pieces are identical to the previous, decorated types. They probably come from the same kilns. Three to four qualities of ware were often produced from any single kiln firing. The following dish shapes seem to have been made for mass sales. The clay is a little more rough, there are often chatter marks on the exterior walls and pin holes in the glaze, and the footrings are not carefully carved.

<u>**BOWLS**</u>

With a slightly everted mouthrim, usually shaved flat on its upper surface, an unglazed stacking ring cut onto the interior bottom, incised rings at the upper and lower interior walls, and carved footring; often with bits of extraneous clay adhering to the surface at odd places, and with pin holes in the glaze.

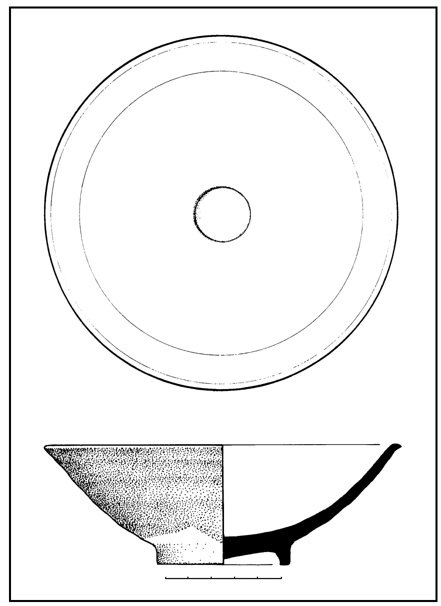
Examples: 1200 intact, 400 damaged
Diameter: 14-17 cm





Much like the previous category except with a more smoothly everted mouthrim, and without the unglazed stacking ring.

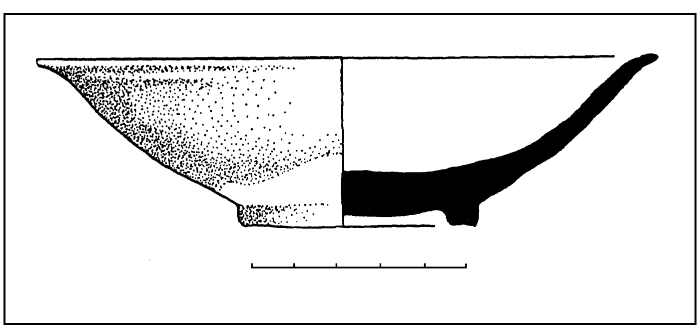
Examples: 120 intact, 60 damaged
Diameter: 14 -17 cm



Similar to the two previous categories but with a narrower ring carved in slight relief at the interior bottom.

Examples: 1800 intact, 600 damaged
Diameter: 14-17 cm

Wide and shallow, the bowls in this group are so heavily potted that they produce very little ringing sound. They have an everted mouthrim, a carved ring on the upper interior walls, and often chatter marks on the lower exterior walls.



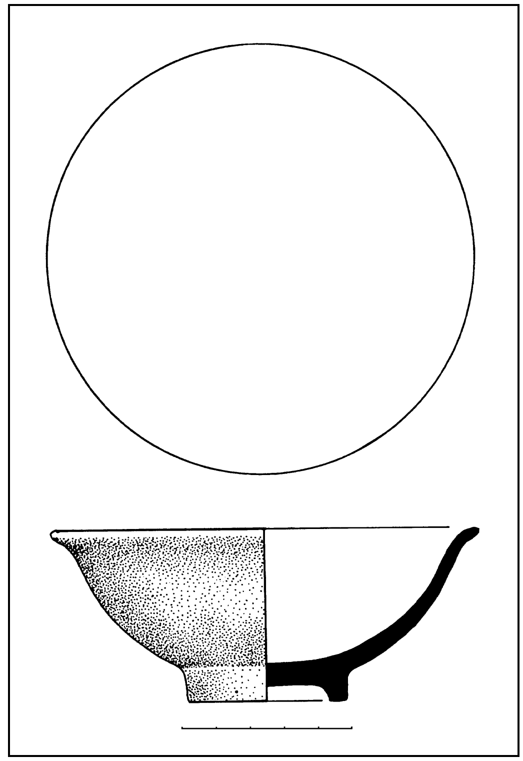
Examples: 180 intact, 30 damaged
Diameter: average 15 cm

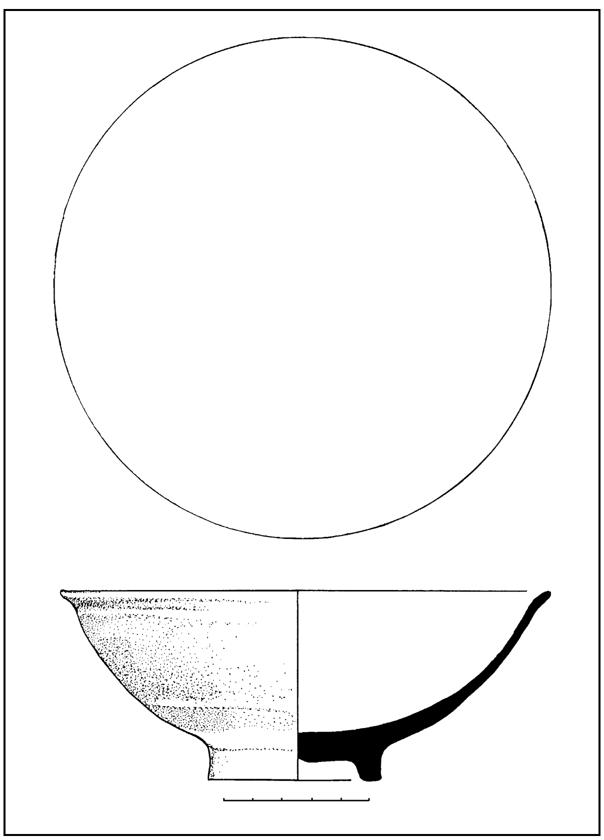
BOWLS WITH EVERTED MOUTHRIM

Heavily potted and plain, with a somewhat carelessly applied glaze that ends unevenly at the lower exterior walls. Chatter marks are often evident on the exterior. Unevenly carved footring.

Small-sized, some with an unglazed stacking ring on the interior.

Examples: 100 intact, 30 damaged
Diameter: 12-13 cm





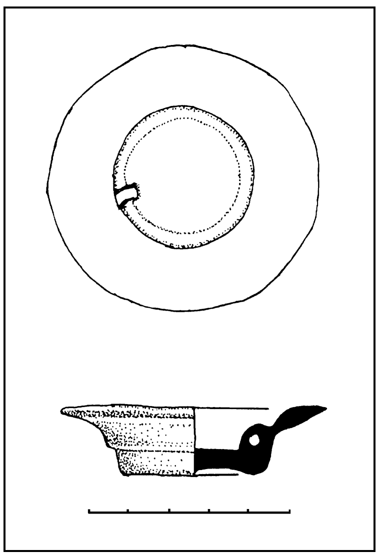
Medium-sized.

Examples: 100 intact, 50 damaged
Diameter: average 17 cm

COVERS

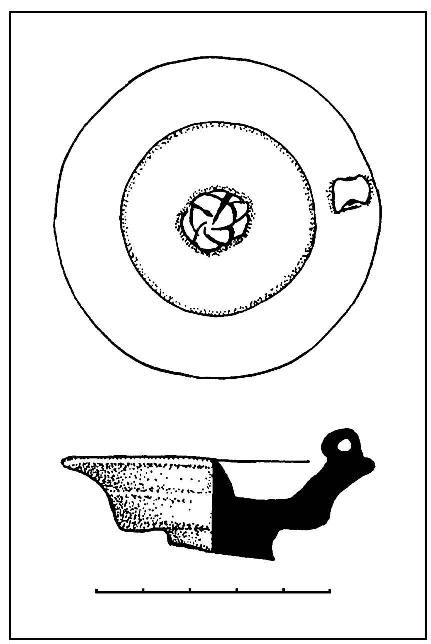
With a short solid stopper on the underside, and made in three vertical tiers, with a single perforation through the cover's wide flat mouth flang. Glazed on the upper surface only.

Examples: 1
Diameter: 6 cm



With a depressed center, the lower portion of which was designed to fit into a vessel mouth, a wide flat mouth flange and a ring handle set to one side in the depression. Glazed on the upper surface.

Examples: 3
Diameter: 7.7 cm

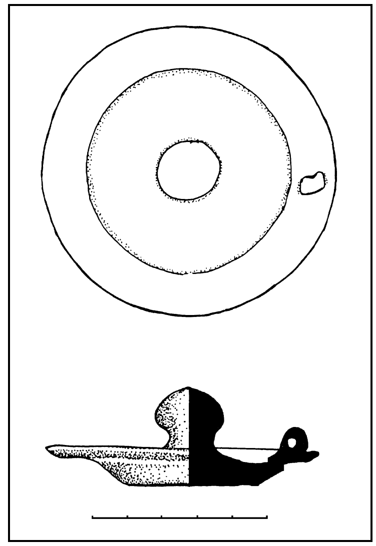


With a short solid stopper below a depressed center portion, a flared mouthrim with a ring handle to one side, and a small cross-hatched knob handle at the center. The greenish glaze is crazed.

Examples: 6
Diameter: 7.5 cm

With a wide flat mouth flange, a lotus-bud-shaped handle, and a retaining ring to one side.

Examples: 3
Diameter: 8 cm



Jar cover, heavily potted, with straight sides and a flared knob handle; covered on the exterior in pale green opaque glaze. The clay is silver gray and mottled, with beige undertones.

Example: 1
Diameter: 13 cm

Dome-shaped, with a wide flat mouth flange and short flat knob handle; glazed pale gray-green on its upper surface.

Example: 1
Diameter: 10.7 cm

Cover, probably from a covered box, sturdily potted from silver-gray clay, with a flat cover center angled downward to meet the straight sides.

Example: 1
Diameter: 5.6 cm

11.8 Brown-Glazed Ware

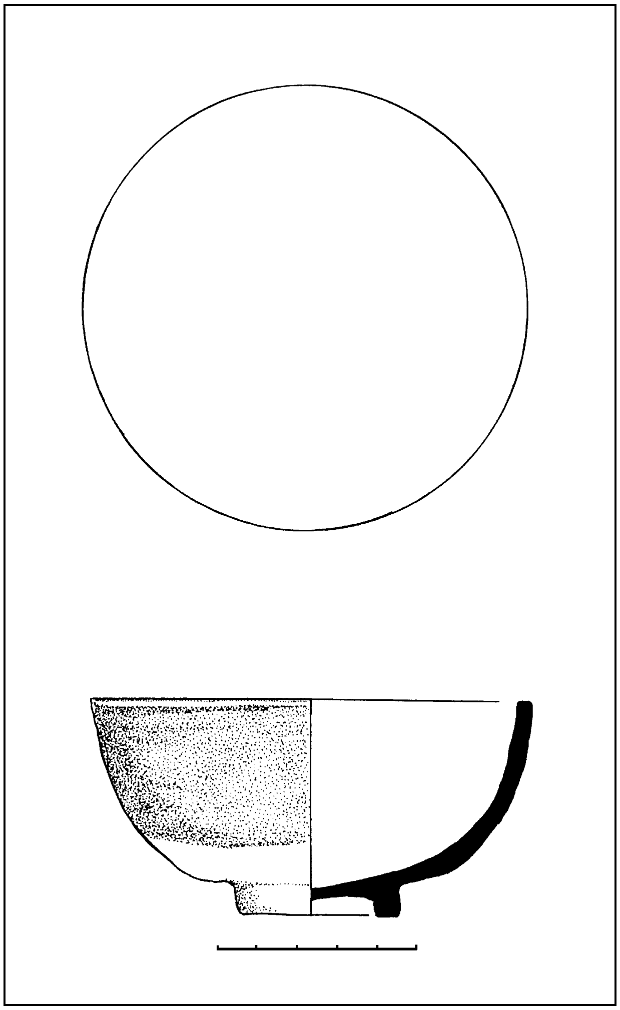
This group of ceramics contains a variety of shapes, although the majority of them are containers of one sort or another. They share several basic structural techniques and could perhaps be best described as a kind of utilitarian peasant pottery. Probably they are made from a mixture of clays, for the basic medium gray color of their fired body is faintly mottled with beige. Most of them were probably fashioned on a turntable, rather than on a true potter's wheel. Structurally, they begin with a solid disk of clay from which the walls are built upward with coils of clay. If the first coil was laid atop the clay disk, it became a solid foot; if the coil was begun from around the exterior of the disk, a separation between the initial disk and the walls is visible on the base. Because a turntable would not rotate as quickly as a wheel, the coils are never completely smoothed flat. These pieces were not, however, meant to be prized for their beauty; they have more practical purposes as containers for other products. The bowl is an exception. The glaze is usually thin, brown or greenish brown, and it rarely covers the whole exterior body. The interiors of the closed shapes are only occasionally glazed.

Most of these pieces possibly came from the kilns at Quanzhou itself, the port from which the ship most probably sailed. Eleven kilns, known for having produced low-fired utilitarian ware, were sited at the east gate of the city.

BOWL

Lotus-pod shaped and thinly potted, with a carved footring and straight mouthrim. Glazed brown or blackish to the middle or lower exterior walls. The clay is silver-gray with beige undertones.

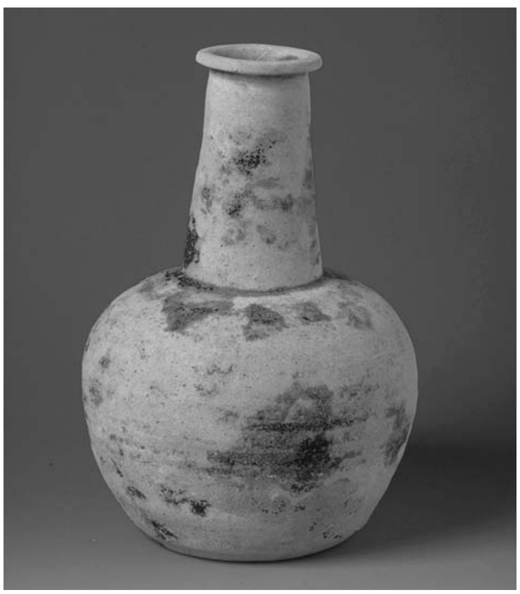
Examples: 4 intact, 2 damaged
Diameter: 11.5 cm



BASIN

Heavily-potted, with a flat, usually slightly concave base and thickened mouthrim. The walls are roughly conical, with horizontal potting grooves. Originally glazed brown on the interior and onto the upper exterior wall. The clay body is mixture of silver-gray with beige undertones. One basin has impressed stylized floral motifs on the inside bottom.

Examples: 7 intact, 7 damaged
Diameter: 24.4 - 26 cm
Height: 10 cm



BOTTLE

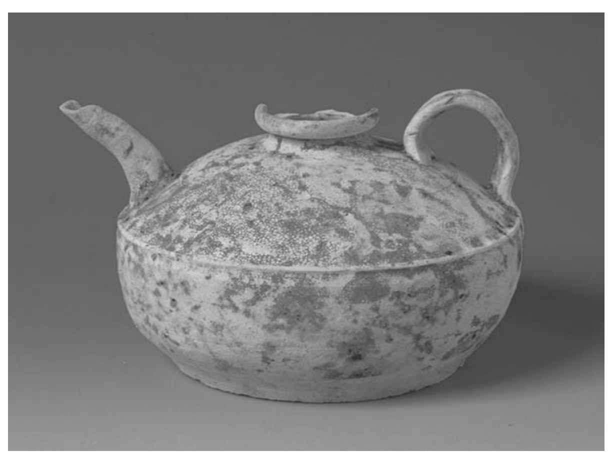
With bulbous body, a tall conical neck, a rolled mouthrim, and flat base; brown-glazed from a couple of centimeters within the mouth to the lower body; the clay body relatively lightweight.

Examples: 15 intact, 14 damaged
Height: 24 cm, one 30 cm

POURING VESSEL

This one is an unusual shape, perhaps for wine, documented elsewhere only among twelfth-century Cambodian stoneware. Thinly potted, with a relatively short but wide, bulbous body and flat base. The short neck curves outward into a cup-shaped mouth, into which a cover was probably meant to sit. Brown-glazed to the lower exterior walls.

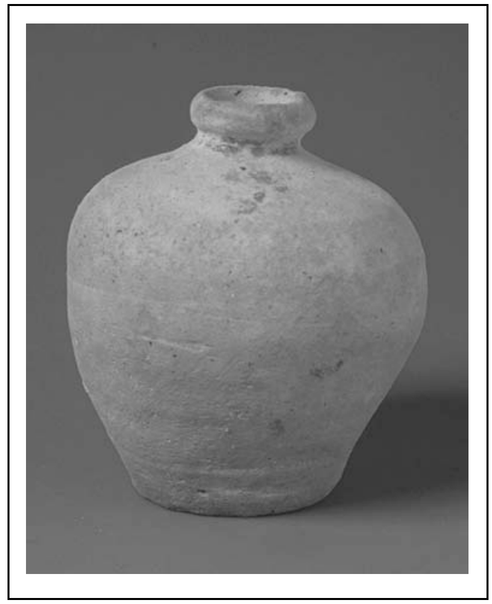
Examples: 5 damaged
Diameter: one 17 cm, others 14 cm

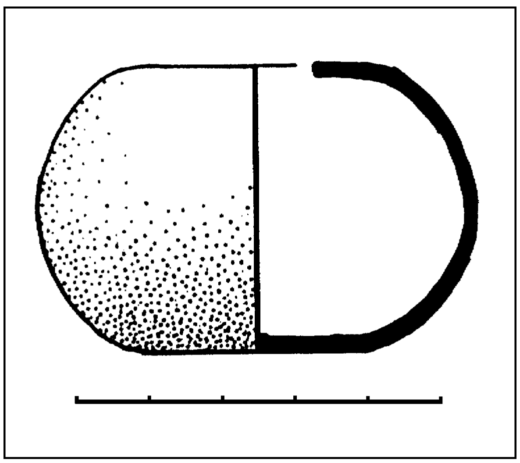


JARLETS

Bulbous, with a short narrow neck and rounded mouthrim. The flat base is slightly concave. The clay is lightweight and silver-gray, and the glaze is completely eroded away.

Examples: 2
Height: 6.5 cm





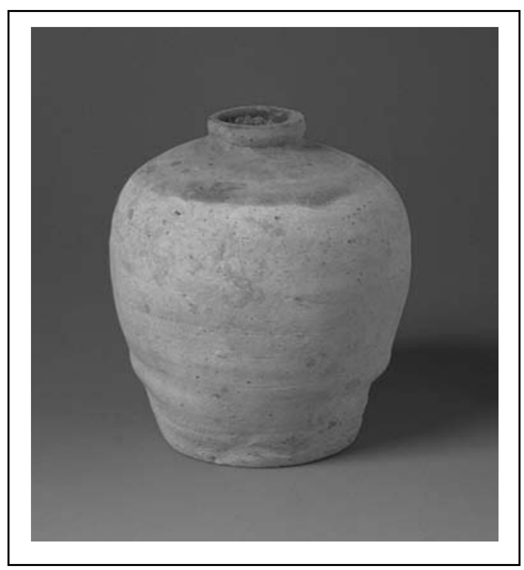
Squat and bulbous, with a mouth cut directly into the upper surface, covered in an uneven line to the lower walls in brown glaze. The clay body is gray. This single example is chipped at one side of the mouth, perhaps deliberately in order to be used as a lamp, with the chip providing a place for the wick.

Example: 1
Height: 3.8 cm

JARS

Relatively small in size with a flat base, narrow mouthrim, and potting grooves evident around the walls. Glazed only on the upper shoulder and mouth. The clay is silver-gray with beige undertones.

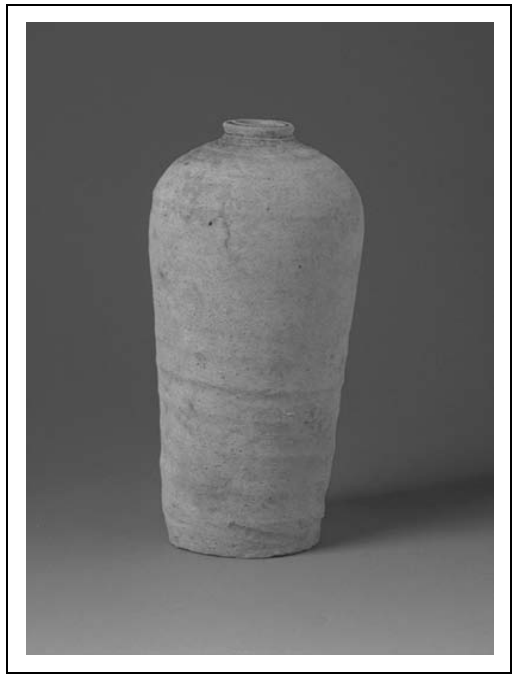
Examples: 1
Height: 11.6 cm

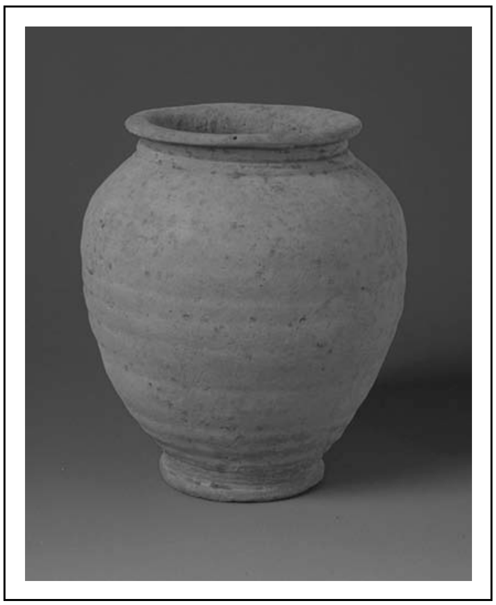


Tall and conical, with a narrow rounded mouthrim and flat base; glazed only at the upper shoulder and mouth. The clay is silver-gray with beige undertones. These "small-mouth" jars are believed to have held mercury, a substance said to have had medicinal uses.

Examples (medium): 4
Height: 18 cm

Examples (large): 2 intact,
1 damaged
Height: 30 cm





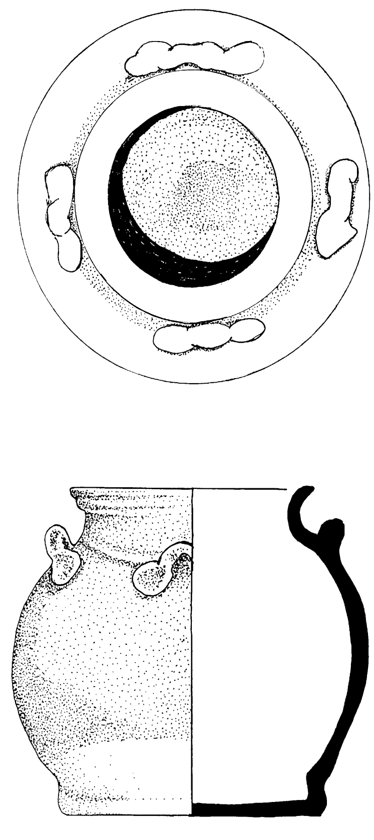
Bulbous, with a curved neck and everted rounded mouth; the foot flat. Some are glazed greenish-brown on the interior, otherwise they may be glazed only on the exterior to the lower walls; in various sizes.

Examples: 8
Height: 8.6 - 16 cm

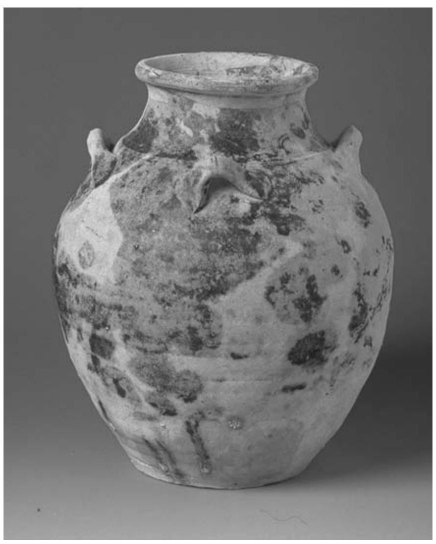
Squat, with a wide body drawn into a short narrow neck with flared mouthrim; the base flat; the clay pale silver-gray; glazed dark brown.

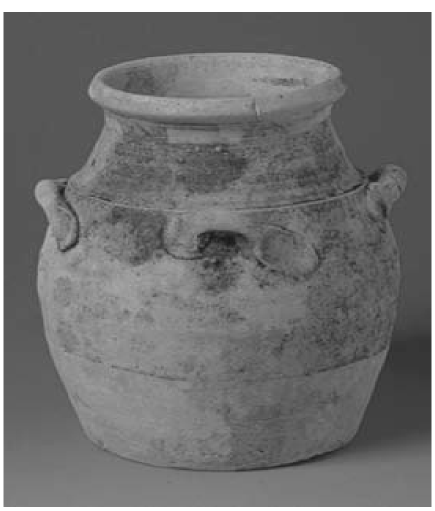
Examples: 60 intact, 20 damaged
Diameter: 9-16 cm

These jars appear in various sizes and proportions but all of them have four applied strap handles around the shoulder, and a flat base or flat rudimentary foot. They were originally glazed from inside the mouth to the lower walls, usually in greenish-brown glaze. The clay is medium gray, sometimes heavily potted and sometimes lighter in weight. Many examples show a circular stacking scar on the base. The largest size sometimes has a single incised wavy line around its mid section, and a series of carved rings at the neck. Occasionally there is a Chinese mark within a vertical rectangular border stamped at places around the upper shoulder (see following page).

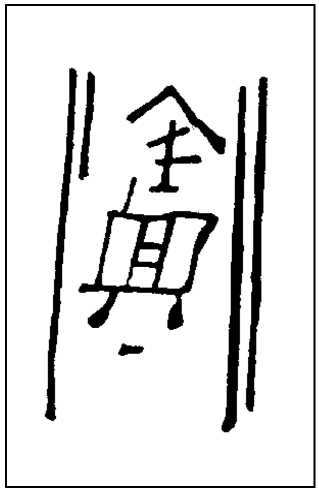


Examples: 80, some with minor damage
Height: 12 - 37 cm



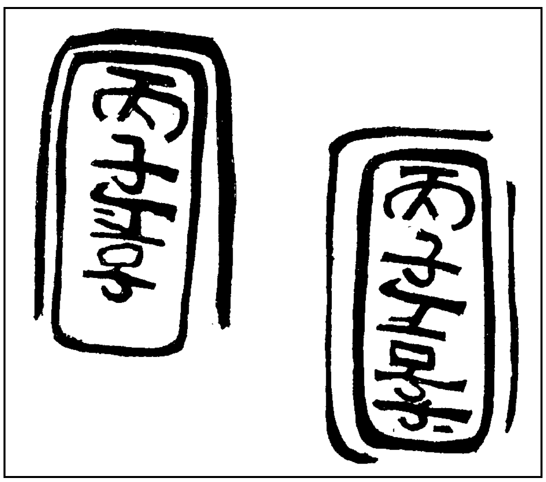


Gong Zi Hao □trademark of Gong □stamped on a storage jar

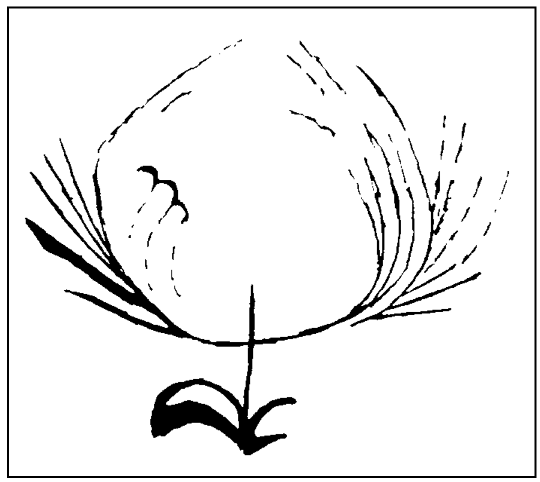


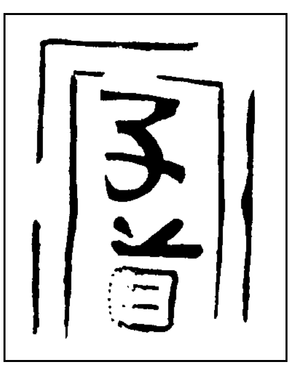
Chuan Xing □ name or trademark □ stamped on a storage jar

Bing Sheng □ a cyclical date/60 year cycle □ stamped on storage jar

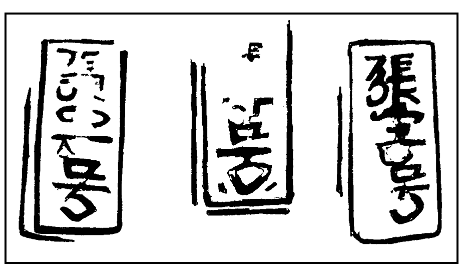


Bing Zi Nian □ a cyclical date/60-year cycle □ stamped on storage jar shard

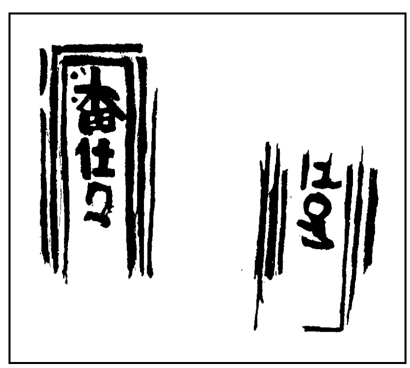




Zi Shou □a surname — stamped on storage jar



Chang Zi Hao □trademark of Chang — stamped on storage

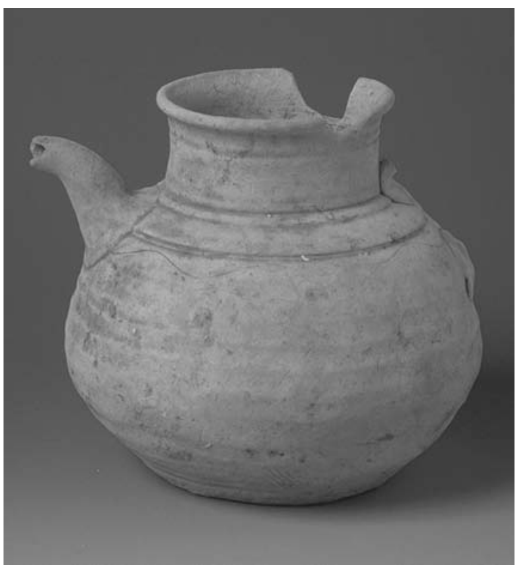


Zi Hao □trademark of...— stamped on storage jar

COVER

With a slightly domed center surmounted by a handle in the form of a strip of curled clay, a wide cover rim, and a vertical flange below which would fit within the mouth of a vessel.

Examples: 2
Diameter: 6-7 cm



EWERS

Bulbous, with a wide neck and everted rounded mouthrim. A strap handle is applied to one shoulder and a curved spout at the opposite side. A single wavy line at the upper body is similar to ones seen on some of the four-strap handled jars. Roughly potted and originally glazed to the lower exterior walls.

Example: 1 damaged
Height: 15.6 cm

Large and intricately modeled with an unidentifiable animal at the spout, possibly with a long snout and the horns of a ram, and with a wide sturdy strap handle at the opposite shoulder. The wide flared neck and ringed everted mouthrim were made separately and luted to the main body. Covered in runny brown glaze.

Example: 1, a fragment
Height: 15.5 cm

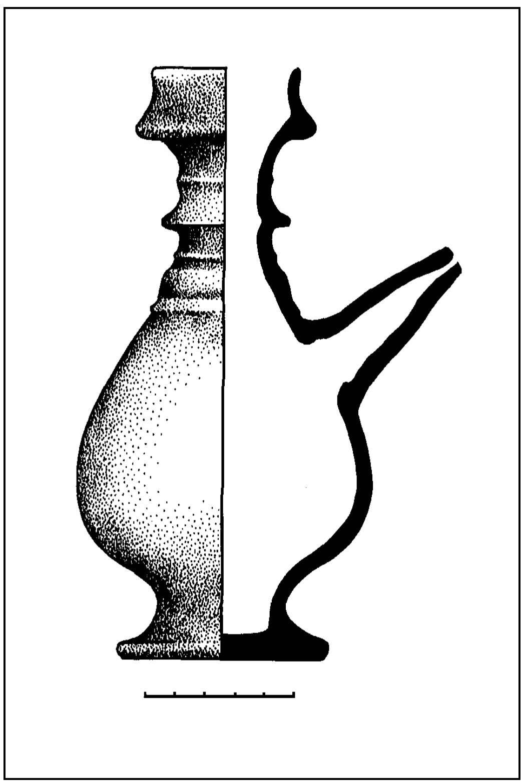
11.9 Indian-Style Earthenware

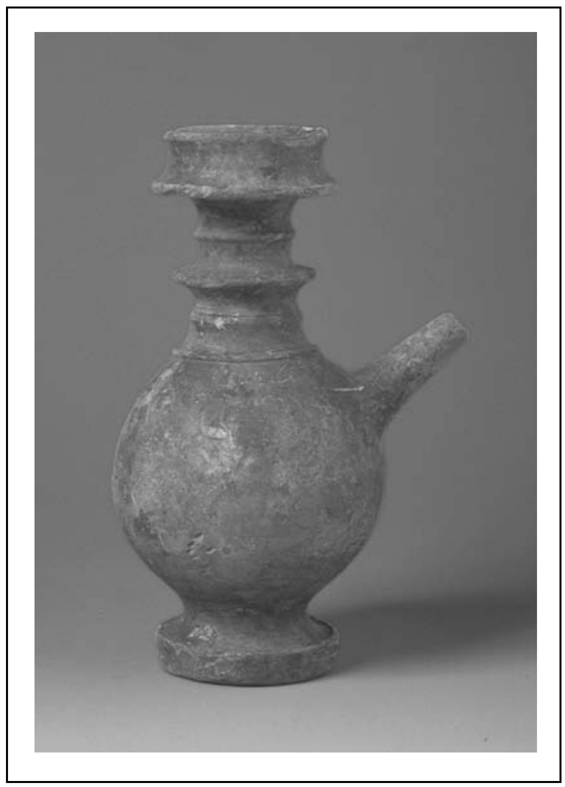
All the vessels of this unusual ware are elaborately modeled. Their style suggests a southern Thai origin. This is strongly supported by comparative X-ray florescent analysis (see Section 9.8). They were probably used in Hindu-Buddhist rituals, for similar shapes are sometimes seen in religious sculptures and bas-reliefs. Some of them, like the wide-bodied kendi, may also have been employed in the brewing of medicines and medicinal teas. Each of the pieces is unique in its exact proportions, an indication that each was made individually. Some are kundika, an ancient Indian shape that was copied into some Chinese wares during the early Tang dynasty (A.D. 618-906). The kundika shape is believed to precede the kendi, which probably evolved in Southeast Asia, most likely in Indonesia, the destination of this cargo. The original surface of these vessels appears to have been burnished to a brownish-red, traces of which remain. Now they have a mostly bare surface and are colored orange-brown; recent breaks in smaller examples show a slightly yellowish ivory-colored clay, slightly porous, with a feel something like fresh-carved ivory. Where the clay is more thick, breaks show a black core in profile. The clay may have originally been gray. Altogether there are about 360 examples of various kendi and kundika, all of them with some damage.

<u>KUNDIKA</u>

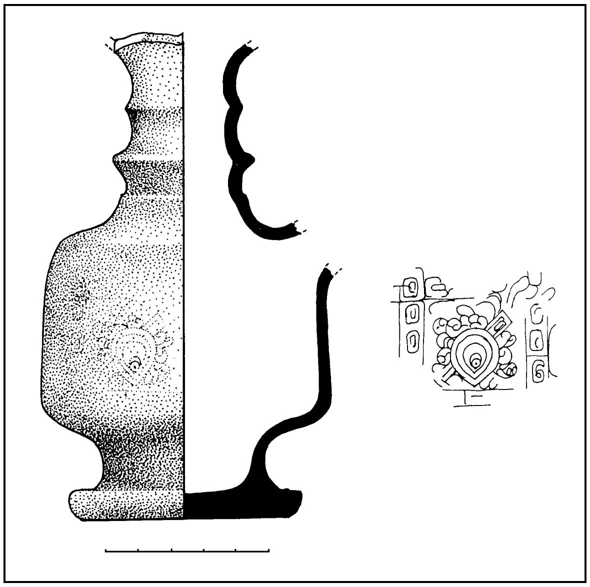
This basic shape features an oval, sometimes egg-shaped body set on a flared flat foot. Sometimes there is a carved band at the lower body that appears to simulate an original pot set onto a stand. A straight conical spout is set, pointing dramatically upward, at the upper shoulder. The tall neck, where one would grasp the vessel, is ornamented with horizontal bands, bulges and flanges.

Height: 12-17 cm





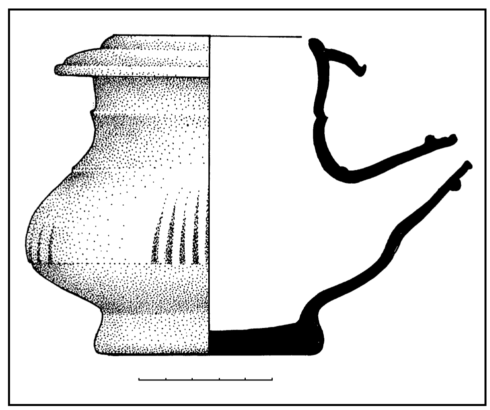
One kundika has a more angular body and cylindrical shape, with traces of faintly incised (possibly mystic) designs around the lower walls.



KENDI

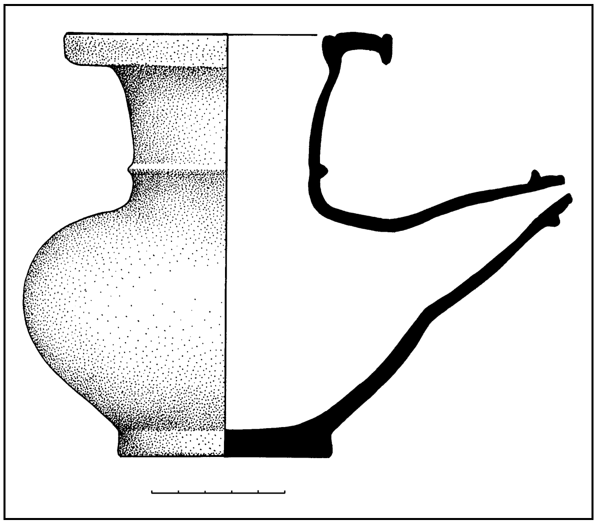
Wide-bodied, with a wide straight neck and everted flanged mouthrim; decorated with carved rings and with striations around the main body. The spout is short and bulbous with a flange at its tip. The foot is flat.

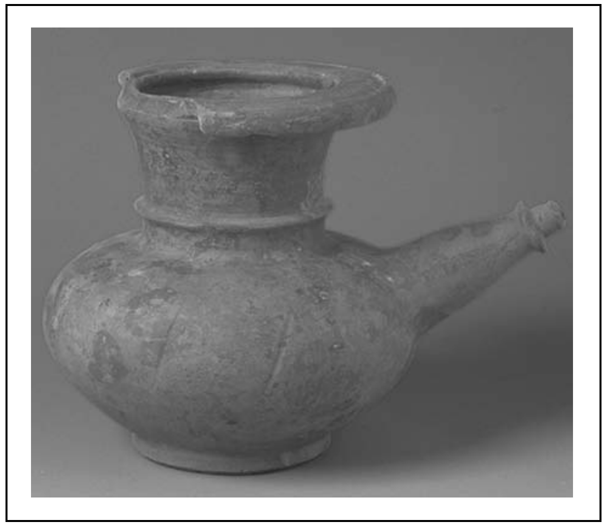
Height: small 11 cm
large 14 cm



Wide-bodied, with a wide straight neck, an everted flanged mouthrim, a long bulbous spout with a flange at its tip and a flat foot. This type is undecorated except for a small flange at the lower neck.

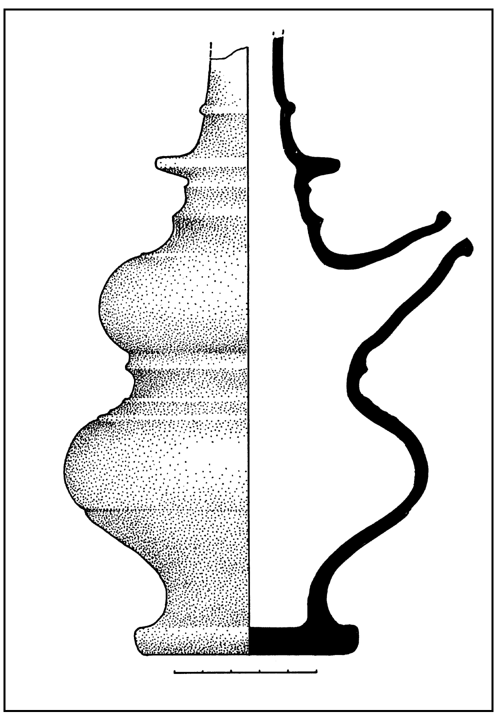
Height: 15 cm

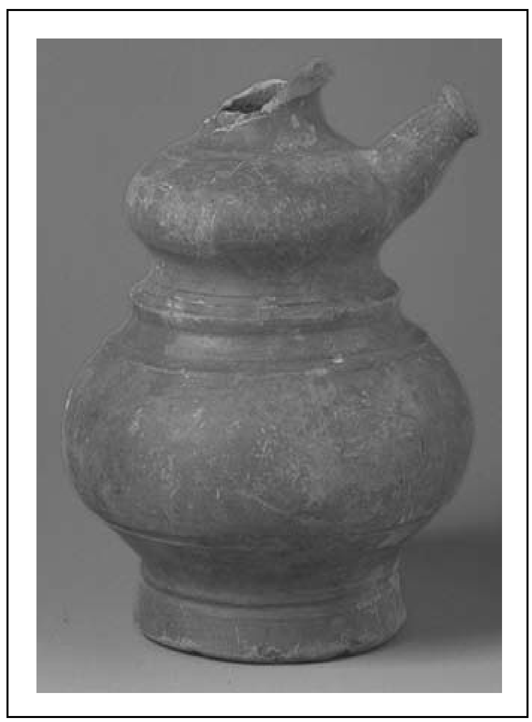




Gourd-shaped, with a wide flared foot, a flange and multiple bands at the mid-section, and a bulbous spout set into the upper section.

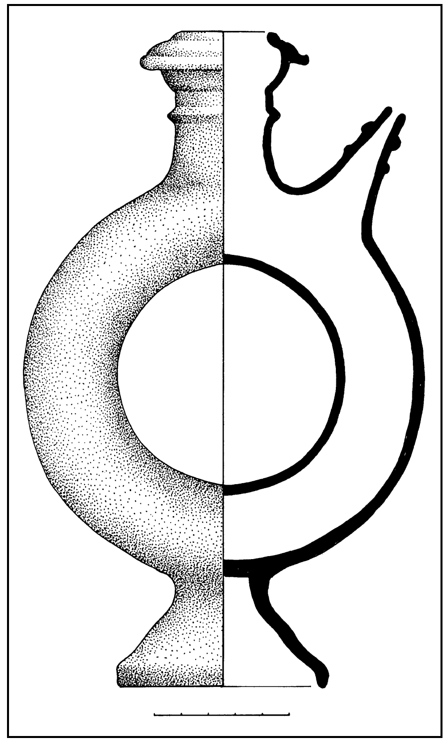
Examples: 10 damaged
Height: average 16 cm





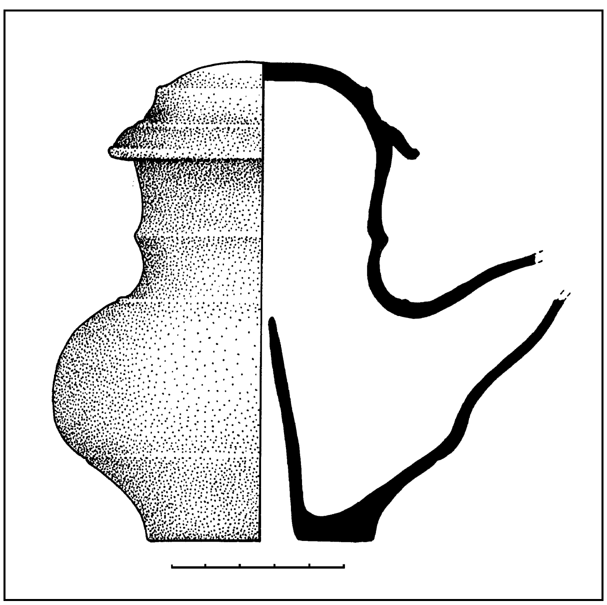
Toroid shape, with a spout at the upper shoulder of the tubular ring that forms the body, and an attached foot.

Examples: 13 damaged
Height: approximately 25 cm



Kendi Maling or "Thieves' kendi" in Indonesian. The body is squat, with a wide banded neck, and the cover is totally sealed. A funnel leads into the interior of the vessel from the flat base. This is a traditional shape in Indonesia, where it is still made today (Adhyatman, 1987, No. 141-142).

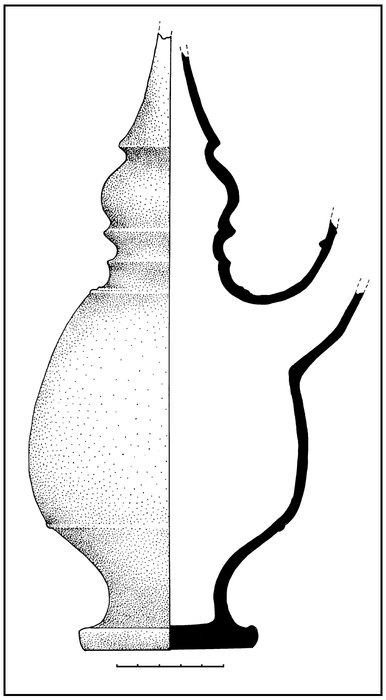
Example: 1 intact, 2 damaged
Height: 12.7 cm

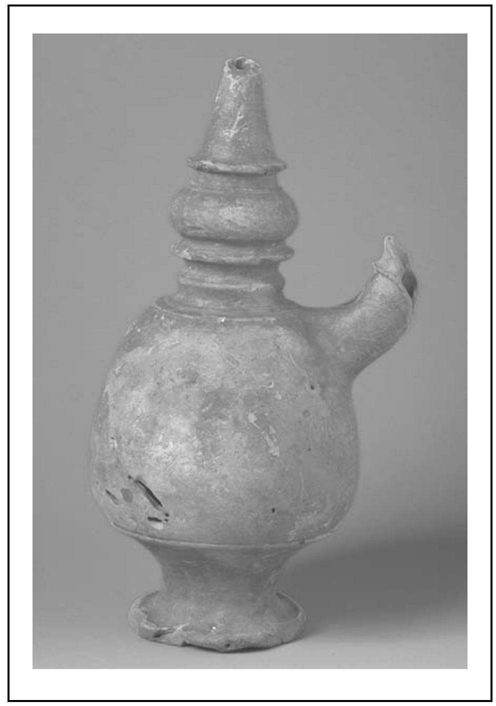


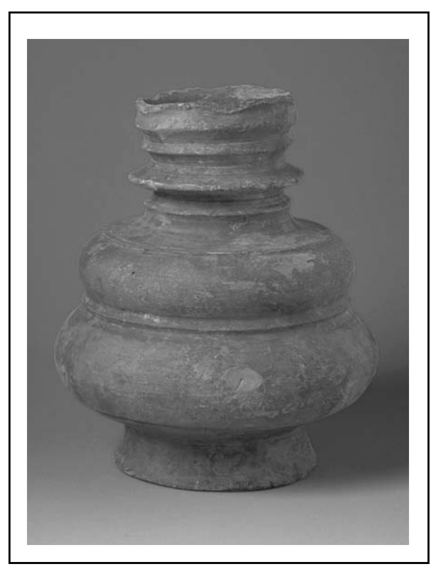
HOOKAH

This shape has an ovoid body, flared foot and flat base. It resembles an Indian or Middle Eastern vessel used for smoking. The shoulder is surmounted by a long neck with bulbous sections and flanges that seem to terminate in a small narrow mouth (its tip broken). The spout-like appendage is sharply curved upward. If this were in fact a smoking device, the smoked substance would sit (probably together with a bit of charcoal to provide heat) within the top of the spout and the smoke would be drawn through the water-filled body up into the mouth tip.

Examples: 1 intact, 3 fragments
Height: 28 cm







BOTTLE

With a wide, flared flat foot, hollow on its inside; and multiple carved bands and flanges between two bulbous body sections and at the tall wide neck.

Example: 1
Height to broken neck: 19.6 cm

RICE POT

Wide and squat, with a rounded base, and tall wide neck with a wide-flanged everted mouthrim, decorated with carved rings, angular bands at the neck and striations down the walls of the mid-section.

Examples: 10
Diameter: 20 cm

COVERS

Probably for a rice cooking pot. It is heavily potted and with a circular vertical flange as a handle, curved on its underside, and one centimeter thick.

Example: 1
Diameter: 12.5 cm

Wide and tall in a roughly gourd shape, with both angular and bulbous tiers rising upward to a lotus-bud-shaped, knob-like handle; the interior is hollow.

Example: 1
Height: 13 cm (broken at the mouth section)

UINIDENTIFIED

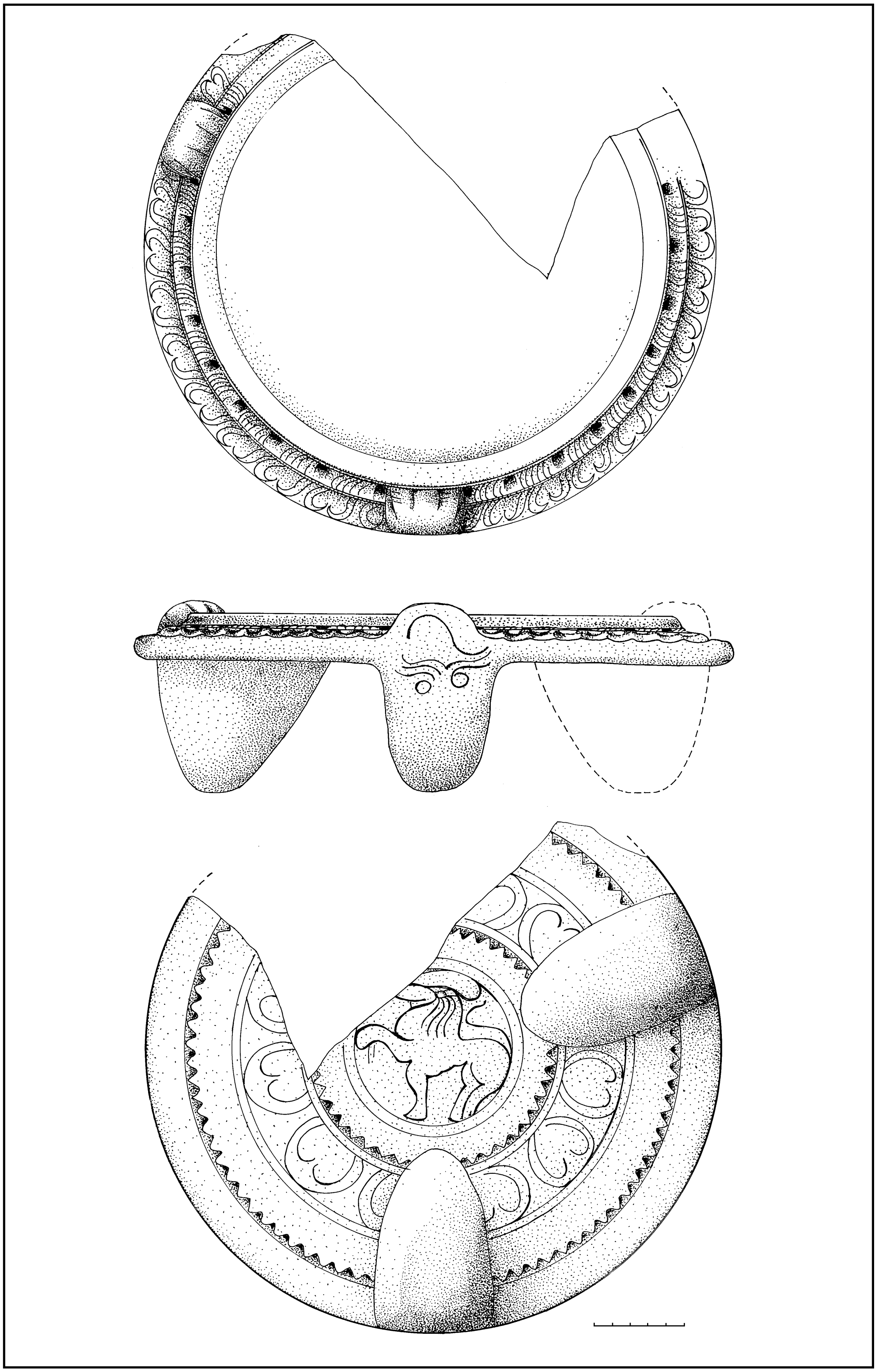
Probably for religious ritual use, perhaps a stand upon which another vessel was set. The hollow within the wide, tall flared footring extends upward to the wide mouth at the upper cylindrical portion, with a bowl-like section surrounding the center column.

Example: 1
Height: 13 cm

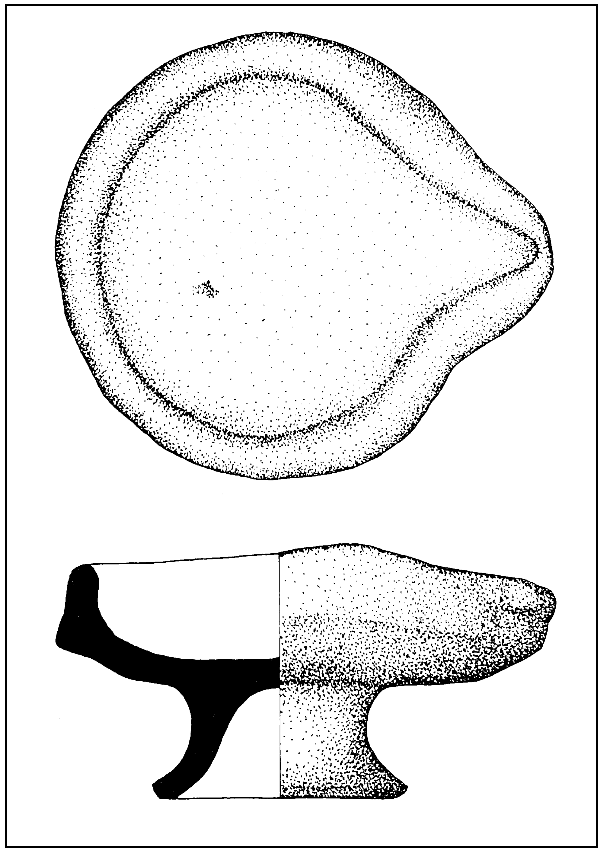
11.10 Miscellaneous Ceramics

Table or stand, probably made from a heavy, now gritty earthenware clay (or possibly carved from a stone such as sandstone). Circular, with three solid legs (one missing). Carved on the underside with an unidentifiable animal (perhaps a lion) in a center medallion encircled with two bands of sawtooth design separated by another band with lotus panels. The central portion of the upper side is plain and flat, with carved borders around its circumference.

Example: 1
Diameter: 31.5 (in fragments, with one portion missing)



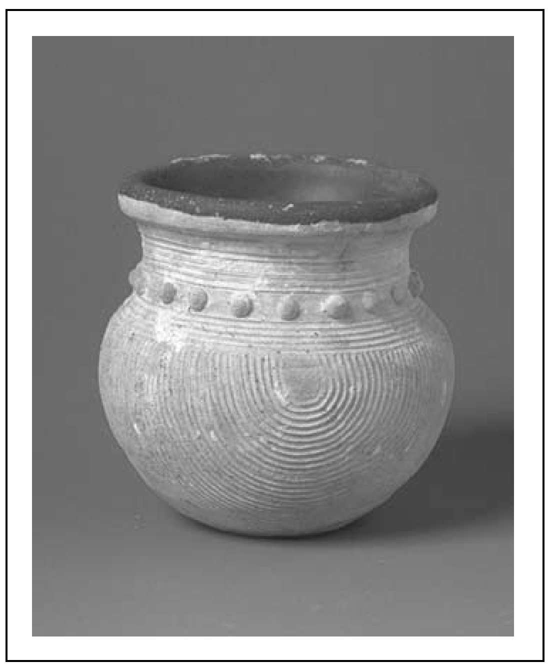
OIL LAMP



Oil lamp, thickly potted and pinched outward at one side, with a flared foot. Similar ware is known from Majapahit-Java (Miksic & Soekatno, 1995). The find of a single example implies this was used onboard the ship and was not an item of trade. Sandy dark grey clay.

Examples: 1
Diameter: 8 cm

RICE MEASURE



The interior is glazed brown with no glaze on the exterior. Decorated with a carved fingerprint-like design and appliqué dots around the neck. It copies an archaic Chinese shape.

Examples: 1
Height: 5 cm

DISK

Low-fired and made from clay pressed into a mold. It depicts four women, each with a basket in the left hand and stick in the right, walking over a bridge.

Example: 1
Diameter: 9 cm

12.0 CONCLUSION

The nature of the Chinese ceramics cargo, and radiocarbon dating of a resin sample, suggest that the Java Sea wreck should be dated to approximately the middle of the 13th century. Although other wrecks of approximately the same age are known in Indonesian waters, no data on the precise location, composition of cargo, or nature of structural remains has ever been published.

The location of the ship, in the Java Sea, half way between Bangka and Jakarta, is the first archaeological evidence for the use of what is now a busy modern shipping lane. From the position alone, the ship may have passed through either Bangka or Gaspar Strait. But given the nature of part of the cargo, it is most probable that Bangka Strait was used.

The array of artifacts, representing non-ceramics trade goods, constitutes the first reliable information on pre-European trade in Indonesia. Only with such information, and more like it, is it possible to evaluate the relative importance of maritime trade in the economies of Indonesia and her trading partners during this early period. At present, scholars are unable to draw precise conclusions on the contribution of foreign trade to the ancient Indonesian economy, in comparison to agriculture and cottage industry.

Given the complete absence of cohesive hull structure, it is impossible to establish the origin of the ship firmly. However, wood identification, internal layout (as determined from the iron concretion disposition), fastening details, and anchor type, provide sufficient information to conclude that the ship was not constructed in China. Whether the ship was built in Thailand or Indonesia remains open to conjecture. The existence of bulkheads tips the scales in favor of Thailand, whilst the presence of Javanese-type bronze artifacts might indicate an Indonesian origin.

The wreck contains a wide variety of ceramics, as well as other commercial commodities including iron, ivory, resin, glass and bronze ware. Most of the ceramics were manufactured in China (mainly Fujian). The iron cauldrons and bars that made up the bulk of the cargo were produced in China. The earthenware kendis are probably from southern Thailand. Resin and ivory are likely to have been obtained from Sumatra. Glass is mainly from China. The bronze ware is typical of Majapahit and pre-Majapahit craftsmanship, and may have belonged to the Indonesian crew, or remained on board from a previous trip to Java. This range of artifacts from various ports is consistent with theories regarding the "peddling nature" of some Southeast Asian commerce during this period, somewhat reminiscent of an early twentieth-century tramp steamer.

Trade in iron is mentioned in several ancient texts, but until now, there have been no documented archaeological sites to confirm just how important the Chinese iron trade was. We can now begin to judge the relative importance of iron in the two-way trade and the precise forms of the artifacts involved.

The vast majority of the ship's ceramics cargo was from China. Interestingly, none of the many varieties of ceramics seems to have come from Longquan, one of the more productive kilns of this period. Many of the forms (the qingbai ewers, conical bowls, covered boxes, and vases), are well known to students of Chinese ceramics of this period. Some varieties, however, such as the qingbai dishes with heavily molded bodies, are quite unusual. The high frequency of boxes with inscriptions on the bases are another particularly interesting find, since vessels of this type are not common in Southeast Asia, although they have been studied in China. The green porcelain seems to belong to well-known types from Fujian, principally the Tongan kiln complex.

The larger storage jars are also in general from known types, but the high frequency of jars with stamped characters on the shoulders is unusual. The elaborate ewers, boxes, and bowls with white floral motifs on a background of brown glaze are very rare. In general their clay and decorative motifs are similar to those associated with the Cizhou kiln complex, but examples in which brown floral decorations were placed over a white background are thought to be unknown. The reverse process, with the possible addition of green overglaze, in complex decorative compositions, is a most surprising and intriguing discovery which will excite the attention of ceramic connoisseurs.

The large numbers of kendis from southern Thailand are the first indication that earthenware was traded between Southeast Asian countries, an item completely absent from any surviving documentary records. There are several unprecedented shapes. The toroid kendis, in particular, were previously only known from Chinese versions made during the Ming period.

In summary, the archaeological results of this project have yielded considerable data, both qualitative and quantitative, which will add to the knowledge of many aspects of early trade between China and Indonesia, and, equally important, the intra-Southeast Asian trade. This significant topic has received little attention compared to trade between Southeast Asia and other regions. It is hoped that the discoveries made on this site will stimulate a reconsideration of this field of study.

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