Extraction of an oriental vessel of c. 1690 off Con Dao, Vietnam

Michael Flecker

Introduction
In 1991 the author participated as project manager in a joint venture with the state-owned Vietnam Salvage Corporation (Visal) to excavate an oriental shipwreck lying in 35 m of water in position 8°38′N and 106°48′E, 6 3/4 nautical miles east-southeast of the island of Hon Bay Canh, one of the Con Dao group near the southern tip of Vietnam. The surviving hull structure appears to be that of a lorchia, a Chinese vessel displaying marked Portuguese influence, and has been dated c. 1690. To the author’s knowledge this is the only example of such a vessel to be excavated. The ship was heavily laden with trade goods and was possibly bound for Batavia to transship the cargo of ceramics and to resupply the Chinese enclave there.

The wreck was inadvertently discovered by fishermen who, upon learning of the value of the porcelain cargo, recovered many pieces for sale in local antique shops. The Vietnamese Government soon got wind of these activities and put a stop to them. Visal was sent in to work the wreck in June 1990. They worked for 3 months, on and off, recovering several thousand porcelain items and a number of non-ceramic artefacts, much of which, considering the limited resources available, has been well preserved and skilfully displayed in a museum in Vung Tau. Some measurements were taken and a rough plan was drawn showing scantlings and spacings of the main timbers such as the keelson, bulkheads and the edge of the hull.

To assist with financing the salvage, Visal signed a joint-venture agreement with a Swedish company. This combined group returned to the wreck site in September 1990 and worked for a month or so, digging random holes and recovering as much porcelain as possible (approximately 3000 pieces). Fortunately, nearly all of the 1990 efforts focused on surface concentrations of porcelain, leaving the overall context of the wreck site virtually intact.

All aspects of the 1991 excavation, the hull structure, and the artefacts are covered here. However, owing to the quantity of information gathered and the numerous studies that are yet to be done, this report can only present an overview.

Setting out and excavation
On 23 March 1991 the joint venture group returned with the salvage vessel, Dai Lanh, in order to complete a systematic excavation of the entire wreck site.

Preliminary inspection dives revealed a 20 × 30 m area strewn with broken porcelain intermingled with intact pieces. This damage is not all attributable to past salvage efforts as one fishing boat alone is reported to have used ‘two tonnes’ (in other words, a quantity) of explosives on the site to catch fish.

The seabed is of slightly undulating sand, overlying a thin layer of hard packed shells and coarse sand which in turn overlies stiff clay roughly 60 cm below the surface. Visibility is typically in excess of 20 m but dropped to 0-3 m virtually overnight with the onset of the southwest monsoon in early June. Fortunately this improved to about 6 m a week or so later. During the excavations the current rarely exceeded 1 knot and the water temperature was a steady 29°C.

Most of the previous year’s excavation had been filled in by shifting sand. However, the edge of the hull with its row of frames and seven bulkheads was just visible. Amongst the chaos there was a definite order on one side of the wreck site. Visal’s sketch indicated that half of the hull, from the keel out, remained, and here there was a distinct pile of ballast stones, an
empty space, a row of large iron cauldrons, rows of square tiles, another empty space, and then more rows of tiles.

The sketch showed that the keel lay beneath the row of cauldrons and tiles. So, in order to set up a grid, a line was first run parallel to the edge of the hull which was straight for much of its exposed length, held at each end by angle iron stakes. The termination points were chosen beyond the scatter of surface porcelain, making the longitudinal lines 33.5 m long lying in a roughly north-south direction. The distance from this line to the estimated keel position was measured and selected as the longitudinal line spacing. Three more lines were laid west of the first, the width of the site, 23 m, also being determined by the surface scatter of ceramics. This later proved to be a sufficient area.

Transverse lines were not uniformly spaced. Working from the south, the first two lines were spaced at 4.5 m intervals, the same as the longitudinal spacing. Thereafter the line spacing was determined by the bulkhead positions. All line intersections were tied off to minimize the distortions inherent in a ‘soft’ grid system.

The grids were numbered 1 to 5 from west to east and A to I from south to north. Each grid had an identifying label tied to the north and east edges for easy recognition by divers.

Bearing in mind the quantity of overburden to be excavated and the difficulty in controlling the discharge in a constantly changing current, airlifts were ruled out as an excavation tool. Instead two 200 mm diameter water eductors fed from a three-way manifold were deployed. Apart from a few restricted areas in the hull where an air lift would have been preferable, the eductors proved to be perfect for the task. Excavation could be carefully controlled by hand fanning into the eductor which was placed well away from the work-face, whilst in the ballast stone area 150 mm diameter stones could be easily sucked away with the same device.

Excavation began 3 m south of the southern grid termination in order to train the divers to use the excavation equipment before reaching concentrations of porcelain or artefacts. With few exceptions the site was excavated from east to west or west to east across its full width before moving to the next grid north. Normally one eductor was allocated to one grid; however some areas, such as the ballast-stone pile, required two eductors in the one grid.

Pragmatic positioning and mapping of structure and artefacts was carried out as follows: ceramics, due to the enormous quantities, were simply allocated a grid number; small artefacts were plotted by divers on an enlarged grid plan on deck; large artefacts were plotted in situ by taking perpendiculars from the grid lines; structural elements were drawn and measured and then tied into the grid from various points to ensure correct scale and alignment.

Cross-sections were taken at bulkheads by pegging in a taut fibreglass tape athwartships and measuring offsets and vertical heights with a weighted tape. The angle between the thwartships tape and the bulkhead planks was measured by plumb bob and level to provide a datum level, the planks having been ascertained to be at right angles to the keel beforehand.

All significant objects were recorded in situ on both still and video film.

Dating the wreck
Three different types of Chinese coins were found during the course of the excavations. The earliest, and most plentiful, is dated Wan-Li (1573–1619). The next is Shun-Chih (1644–1661), and the latest is K’ang-Hsi (1662–1722), which puts the earliest date on the wreck of 1662.

The porcelain has been dated early Qing (Bich, pers. comm.). In 1677 the Emperor issued an edict prohibiting the use of his reign mark on the base of export porcelain. The absence of reign marks on the Qing Dynasty porcelain from the Con Dao wreck therefore brings the earliest date of sinking up to 1677.

A Chinese ink block decorated with recessed characters is marked on its side ‘Geng Ga...’ meaning number seven of an age or date. According to Bich (pers. comm.) this is the seventh year of a 60-year cyclic series which, narrowed down to around the estimated date of sinking, could be either 1630, 1690 or 1750. The coin dates eliminate 1630 and the date of the porcelain does away with 1750, therefore the Con Dao wreck went to the bottom in 1690 or shortly thereafter.

Hull structure
Due to the unusual depth of the keel the wreck has come to rest with a list of 26° to starboard,
with the longitudinal axis lying almost exactly north-south. The combined effects of erosion by sea and sand, the healthy appetite of the toredo worm, and sedimentation have resulted in a section of hull with a maximum width of three strakes to port to the first wale on the starboard side remaining buried and, apart from the exposed edge of the hull, in good condition. The keel is 25 m long and the width of the remaining hull at midships is 5.5 m. Just to the south of the hull lie two large sections of planking that are believed to be the two halves of the transom, with another extensive section of planking which appears to be deck lying off the starboard quarter (Fig. 1).

Keel

The keel was excavated for a length of 5 m at the stern and 4 m at the bow, the remainder being inaccessible under the surviving hull structure. Its complexity is only partly evident in Fig. 2.

Examining the stern first, the 1.2 m deep deadwood section extends 3 m aft of the remaining hull timbers which cant upwards at an angle of 17°. The port side reveals a laminated construction. The 70 mm thick false keel is overlain by a 60 mm thick plank which in turn is overlain by vertical planking. Due to a large iron concretion and severe erosion the end of the keel is difficult to interpret. However, at least three layers of timber can be discerned, vertical grained on the outside, then horizontal then vertical again. This degree of lamination does not extend far forward, for on the starboard side the outer planking has been eaten away, revealing two heavy internal timbers, the upper one being vertically scarfed 3 m from the stern. On top of this lie two more timbers of much reduced section with little remaining of the uppermost one. It is held in place by a heavily concreted iron bolt and is wedge-shaped forward, supposedly to slot under the now missing top keel section that is rebated for the garboard strake.

Moving to the other end of the keel, the timbers are much eroded. However, the abrupt change in angle at the prow is clearly evident. The horizontal portion is consistent with the stern, with a false keel, broken away slightly from the keel, underlying two main timbers. These are sheathed by two 60 mm thick longitudinal planks which unfortunately obscure the angled joint of the main timbers. The bottom plank is rebated to accept the angled section of false keel, which leaves the horizontal section of false keel oddly exposed. Two keel bolts, 1.6 m apart, protrude through the keel timbers which cant slightly to port, the opposite direction to the angle of heel and therefore probably the result of impact with the seabed. Unusual curved markings have been carved deeply into the outer planking.

The 300 mm thick keel has a 100 mm rabbet on each side to accept the 60 mm thick garboard strakes. The 40 mm thick outer planking butts up against this main keel timber and the keel sheathing plank in turn butts up against the outer planking, creating a very sound, water tight joint.

Keelson

For most of the length of the vessel the 300 x 300 mm keelson runs straight and continuous, unless there is a scarf hidden beneath the tiles or iron cauldrons, and is spaced between 140 mm and 170 mm above the keel. It is rebated for bulkheads and for frames and serves to clamp them to the keel with bolts passing through it at every frame.

The stern scarf occurs where the hull begins to slope upwards and is accomplished neatly between two frames. Aft of this scarf the keelson becomes deeper, passes through the almost bulkhead and has been eroded away at what can only be described as a three-dimensional scarf.

There is possibly another scarf just aft of bulkhead 6, but this is unclear. There is a definite man-made cut across the top of the keelson. However, at the base of this 100 mm deep cut there is only a thin horizontal crack running forward through the bulkhead and under the mast-step. A point of such high stress does not seem to be the ideal place for a scarf joint.

Forward of the mast-step the keelson starts to curve slightly upwards before the worms step in.

Rudder fittings

The sizeable iron concretion at the stern is created largely by two rudder gudgeons resting one on top of the other, and possibly a third at the bottom of the sternpost. The uppermost gudgeon has obviously collapsed from higher up the keel but the lower one could be in its original position. Both have 1.5 m long straps that wrap around the keel, one of which has broken off the
Figure 1. Excavation plan. Bulkheads are numbered from the stern.
lower gudgeon, indicating that they were attached to the deadwood. Further astern, lying loose in the sand, are four more rudder fittings, three of them gudgeons (Fig. 3). These are designed to wrap around the sternpost and fasten to a flat transom of some considerable thickness, as indicated by an 800 mm long, 36 mm diameter angled bolt still connected to one of the broken arms of a gudgeon. One exception, the furthest fitting from the hull, is like a pintle with a short pin in heavier section iron rather than a hole in a rounded protrusion, as in the case of the gudgeons. However, it fits the transom in the same manner. All of the fittings are heavily concreted although one section inadvertently gave way revealing a rectangular base-metal cross-section measuring $74 \times 12$ mm.
**Bulkheads**

Seven bulkheads remain in place, dividing the vessel into compartments measuring 2270, 1340, 2525, 2425, 1405 and 2455 mm, respectively, working from the aftermost complete compartment forward, measuring from bulkhead face to bulkhead face. An abrupt end to the forward stacks of tiles indicates that originally there was one more bulkhead there, giving an approximate compartment size of 2200 mm. If the aftermost cargo compartment was similar in size, which is likely as the cargo distribution makes the vessel bow-heavy without a large compartment aft, then there is a pattern of two wide, one narrow, two wide, one narrow, and two wide compartments within the ship.

The bulkheads are constructed from baulks of timber up to 470 mm wide varying in thickness from 90 mm to 110 mm. The bottom plank passes beneath, and is rebated for, the keelson, with the other planks edge-joined above that. Triangular notches have been cut 70 mm to 90 mm above the bottom of each plank at regular 400 mm intervals, staggered on both sides, so that iron spikes can be hammered through at an angle into the plank below (Fig. 5). The resulting recess is plugged with caulking compound. Treenails were not used for edge joins in any instance on this vessel.

The edge of each bulkhead butts up against the inner hull planking which is held in place by iron spikes driven through from the outside into the edge of the bulkhead. It was not ascertained whether spikes driven through the outer planking also penetrated the bulkhead. Although the bulkhead-to-hull joint is caulked, square timber holes on each side of the keelson make it very evident that they were never intended to be watertight.

**Longitudinal bulkheads**

Two longitudinal bulkheads were observed, one between bulkheads 2 and 3, and the other between bulkheads 5 and 6. From their construction they appear to be cargo dividers rather than structural members. Each consists of a 50 mm thick plank held in position by 80 × 70 mm pillars approximately 120 mm outboard from the keel. Only the bottom plank remains and the pillars are eroded away below the overall erosion level so it is not possible to determine the original height of them. The pillars, exhibiting a wedge-shaped base, are fastened to the bulkheads with small spikes and do not penetrate the ceiling planking.
A 30 mm thick longitudinal plank between bulkheads 5 and 6 and inboard of the longitudinal bulkhead just discussed, is held in position by a single vertical round pole at each end and serves the function of cargo divider only.

Frames
The frame construction is very interesting and unusual in that little is added to the structural integrity of the vessel by their inclusion. There are two, three or four frames between each bulkhead, depending on the compartment size. Most are in fact half frames, scarfed and clamped at their narrowest section under the keelson, the point of maximum bending stress. The shallow V-construction of the hull is such that the half floor is virtually straight, becoming slightly larger in section moving away from the keelson.
The first futtock provides the turn of the bilge and it is not scarfed into the half floor but simply overlaps it with no visible evidence of lateral fastening, which, even if there, would make a very weak joint. Of the eight unobscured lap joints only one, in the aftermost frame, has any sort of a scarf and this is a rebate cut in the half floor only. Most of the frame joints are obstructed by the ceiling, but by measuring the bulkhead-to-frame spacing at the keelson and at the edge of the hull and comparing it with the frame width it becomes evident that all of the obscured futtocks are lap-joined with no scarf. The second futtocks are also lap-joined to the first (Fig. 7) but little remains of these. All the frame lap-joints throughout the vessel occur with the upper timber overlapping forward of the lower.

Frame size and spacing varies from 140 mm to 200 mm and 240 mm to 510 mm, respectively, with no evident pattern. In the largest compartment and the one apparently containing the heaviest cargo, there is one double frame, this being the only instance. The two foremost frames are composed of four timbers each (Fig. 8), overlapping both vertically and horizontally where they pass under the keelson, but appearing out of the other side of stacks of tiles as ordinary frames. Unfortunately the transition was not observed.

So from the weak joint at the keelson and the lap-joints from floor to first futtock and first futtock to second futtock it seems that the frames do little more than supplement the bulkheads in holding the hull planking together. The bulkheads provide most of the lateral support, although this was probably augmented by heavy deck beams. This type of structure is indicative of hull first construction.

**Hull planking**

The hull is carvel built and is constructed with two layers of planking, the inner one being typically 60 mm thick and the outer 40 mm. Between them is a layer of white caulking compound.

The inner planks are edge-joined in the same manner as the bulkhead planks with small triangular rebates cut to allow spikes to be driven through into the adjacent plank at an angle. Caulking compound has been liberally applied to the plank joints and in the triangular rebates. Only three scarfs were unobstructed by cargo or ceiling. One 440 mm long scarf occurs in the port garboard strake under the second frame from the stern. It is not duplicated on the starboard side. Another is only 400 mm long and occurs between frames, whilst the edge of a scarf on the outermost surviving plank measures 1650 mm long.

The outer hull did not receive the examination that it warranted partly because any undermining of the hull lead to its collapse. From a brief examination of some exposed sections of outer hull it seems that the inner planks are fastened to
the bulkheads and frames with two iron spikes per plank with white caulking compound covering the recessed head of every spike, but it is not known how the outer planking was fastened to the inner as the outer layer is so eroded around the periphery of the hull.

In the vicinity of bulkheads 3 and 4 a section of lower wale has survived. This is a half round timber protruding 130 mm from the outer hull planking. It is laid up against the inner planking and is held securely in place with iron bolts passing through the frames. The outer planking butts up against the wale from below.

Ceiling is installed throughout the ship, although in one small compartment, discussed later in this report, it may have been intentionally left out. From the keelson for a distance of approximately 1.2 m, 40 mm thick planks are laid above the frames, resting on ceiling support timbers connected to the bulkheads. Outboard of this is a very unusual feature. Two 50 mm thick planks, slightly inset into the frames, pass through the bulkheads and run the length of the vessel, providing additional longitudinal strength. Outboard of these two planks the inter-bulkhead ceiling continues but its thickness is reduced to 30 mm.

Mast-step

There is only one surviving mast-step on the vessel, located just forward of bulkhead 6 (Fig. 9). It consists of a massive slab of timber straddling both the keelson and a frame and fits snugly against the bulkhead. Between the mast-step and the hull planking is a lavish layer of caulking compound. Due to the angle of heel the port side of the mast-step has been largely eaten away. However, the starboard side remains in good condition, even to the extent of having some of the tabernacle remaining in the rebate for it.

No length has been spared in providing the mast-step with support. A 300 × 300 mm chock, the same size as the keelson, is bolted to it at every frame between the mast-step and bulkhead 7. The bottom two timbers of this bulkhead are 270 mm thick, nearly three times the thickness of the other bulkheads, before reverting to 90 mm thick planks higher up. Bolts run through the bottom two timbers of the bulkhead and the keelson to clamp them solidly in place. This very solid support forward compared with the support of a single standard bulkhead aft would seem to indicate that the mast was raked aft. However, the vertical bulkhead makes this impossible, so it was more probably a vertical mast.

To provide lateral support a heavy beam has been installed longitudinally to starboard, penetrating both bulkheads 6 and 7 and passing over the mast-step. A small eroded piece of timber lying athwartships just forward of the
mast-step and slotted into the lateral support probably continued across the keelson to enclose the base of the mast and tabernacle between it, the lateral support beam, and bulkhead 6. This set-up was with little doubt symmetrical about the keelson. Some additional support is lent to bulkhead 6 by the longitudinal bulkhead between it and bulkhead 5.

Transom
Two large detached sections of planking at the southern end of the site may be the two halves of a flat transom, although this would suggest that the transom timbers butted up against the sternpost rather than being continuous across the stern, a far stronger construction technique. They are of unusual construction with the end of the planking being cut at an angle, and meeting beams fastened to both sides of the planking at the same angle. A half round timber underlies the western section of planking and trapezoidal beams run along the back and pass through irregular-shaped heavy blocks which are joggled over the timbers. These blocks may have been the end of internal deck-support beams. However, they are far too eroded for certainty.

Decking
Lying off to starboard towards the stern is a 5 × 3 m section of planking. Beams of width 140 mm and spacing 700 mm underlie the 50 mm thick planks. There is a single upright plank of the same thickness along the northern edge which may be a hatch combing. The flat section of this planking suggests that it is decking. However, there is evidence of beams on the top of the planks (strips of white caulking compound and spike holes) that cast doubt on this supposition.

The reason for sinking
Fire sent the Con Dao ship to the bottom. It was probably the result of lightning or an accident on board, rather than pirates deliberately setting her ablaze since there is no evidence of plundering.

The bow has fared worst. Charred hull planking can be observed from bulkhead 5 forward. Bulkhead 8 and the hull planking forward have disappeared altogether, apart from three isolated outboard strakes upon which the location of the now-absent frames can be readily discerned by strips of clean wood in a blackened background. It appears that the ship went down bow-first, snapping the keel at the bow and twisting it to port on impact. With the shock of hitting the seabed the top layer of tiles stowed in the foremost compartment seems to have broken through the weakened bulkhead 8. A thin layer of iron concretion lies just below the sediment throughout grid 4H and in adjacent areas. It has been created by hundreds of iron fastenings that have remained after the charred planking disintegrated.
Ceramics

During the course of the 1991 excavation 48,288 ceramic items were recovered. Of these, approximately 60% were in perfect condition, the remainder being archaeologically intact. The fascinating and extremely diverse ceramics cargo of the Con Dao wreck will be the subject of a separate paper, so only the barest detail will be covered here alluding more to numbers and distribution than to style and provenance.

The ceramics can be divided into four broad categories: blue-and-white; 'kitchen Qing'; blanc de Chine; and stoneware/earthenware.

Blue-and-white

Blue-and-white was the most plentiful ware and can be further divided into the following types: vase, jar, jar lid, dish, teacup, saucer, box, box cover, teapot, flute, challis, kendi, flask, mug, wine cup, candle holder and incense burner. Many of these are in a variety of sizes and shapes; for example, the jars range from tiny (~40 mm), very small, small, medium, large to very large (~500 mm), and are straight, bulbous, cylindrical, twisted and hexagonal. As can be seen in the distribution graph (Fig. 11) the blue-and-white, and in fact the ceramics as a whole, were stowed more towards the stern of the vessel.

The mixing and breakage that resulted from the collapse of the hull is phenomenal. However, some trends can still be discerned. Very large jars and vases were only found well away from the remaining hull and were often encrusted with a thin layer of coral implying that they were stowed above most of the other ceramic cargo. From verbal reports on the 1990 excavation much of the blue-and-white porcelain was stored in wooden barrels. There were only two examples of this recorded during the 1991 excavation. In grid 2F a barrel lying on its side with the top half eroded away was found to contain more than 400 small and very small octagonal saucers stacked so closely that there appears to have been no need for packing material. The barrel was of unusual construction in that the staves were notched into the circular base and every second stave had a hole pierced through a flared section near the top through which a rope passed to hold the whole together. Alongside the keelson on the port side between bulkheads 5 and 6 lay the remnants of a 230 mm diameter barrel containing four medium cylindrical jars.
Remains of several empty barrels were found sitting upright in their original positions between bulkheads 5 and 6 and on the tiles between bulkheads 4 and 5. Without any evidence to the contrary it seems that the blue-and-white wares were packed in barrels rather than boxes, a less efficient form of packing but optimized none the less as will be discussed shortly.

Other blue-and-white finds of note include 1,695 tiny vases recovered from an area of less than 1 m², eight intricately decorated and fluted kendis all from 3C, and one very large jar found to contain four porcelain chalices. It was reported that a large jar found in 1990 was filled to the brim with tiny blue-and-white covered boxes.

Despite the wide variety of shapes, sizes and designs one particular piece stands alone. This is a small three-legged incense-burner, four of which were found, but unfortunately none completely intact. The design on the body of cross hatching surrounding an oval landscape scene is minutely detailed and one incense-burner had three pieces of gold leaf partially embedded in the glaze within the bowl. This was more than likely an item for private trade.

‘Kitchen Qing’ here refers to poor quality porcelain mostly with a washed out underglaze blue but in many cases with polychrome overglaze as well. Rarely do more than a few isolated patches of the primarily red polychrome remain. Various sizes of utilitarian bowls and dishes come under this heading, the bulk of them being rice bowls and small side-dishes.

Unlike the majority of the blue-and-white types the ‘kitchen Qing’ lends itself to stacking. Although individual pieces are found in great numbers, the presence of stacks of bowls and dishes throughout the site attests to the mobility of their packing containers during the disintegration of the ship, another piece of evidence pointing to packing in barrels. From the little evidence remaining in the hull it seems that the ‘kitchen Qing’ was stacked below the more valuable and fragile blue-and-white, a sensible procedure. There is also evidence, some dubious but some irrefutable, that the ‘kitchen Qing’ was held in so low esteem that pieces were stowed on board with no packing container whatsoever. Between bulkheads 2 and 3 bowls were found in horizontal stacks on the ceiling hard up against the bulkhead such that when removed an...
impressed ring was left in the wood. It is hard to imagine the packing wood completely rotting away when the adjacent ship’s timbers are in such good condition, or that the whole stack moved up against the bulkhead after the packing rotted. Even more convincing are the stacks of bowls jammed between the remnants of a barrel and a bulkhead in grid 4F (Fig. 12).

Much 'kitchen Qing' was stowed in the same compartment as the iron cooking pots as evidenced by row upon row of bowls and dishes held there in concretion.

Blanc de Chine
This ware was represented by bowls, dishes and covered boxes of various sizes, and by cups, saucers, spoons, very small impressed jars and figurines. The stowage trend for blanc de Chine is opposite to that for blue-and-white and 'kitchen Qing', with the bulk of the pieces being stowed up towards the bow, and the quantity is substantially less, not helped by the fragility of this finely potted ware.

Most of the intact cups were recovered from between the ceiling and the inner hull planking in grids 4F and 4G, and the majority of the ceramics found in grids 3H and 4H were spoons and covered boxes. Elsewhere the blanc de Chine was vastly outnumbered. The figurines were scattered far and wide, although most seem to have originated from between bulkheads 5 and 6. A woman with child is the most common form, but lone figures, serpents, dogs, and crabs, amongst others, are represented. All were moulded and few have survived intact.

Stoneware/earthenware
This ware was represented primarily by small heavily potted jars with a pale green to pale blue glaze, often crazed. Scattered throughout the site, 891 were recovered, and from the distribution graph it seems that they were stowed aft of bulkhead 3 and forward of bulkhead 6. Reports of the 1990 excavation indicate that these jars were packed loose between the barrels of porcelain and during the 1991 excavation they were found to fill conveniently the gap between the tiles and the turn of the bilge forward of bulkhead 6. It seems that some, if not all, of the jars had contents as two were found with remnants of an organic cover held in place with thin strips of rattan wrapped twice around the neck (Fig. 13). Within was a black rubbery skin, rough and matt on the exposed surface but smooth and shiny where it was in contact with the jar wall. Samples were taken but have not yet been analyzed.

Two sizes of simple earthenware oil lamp were recovered, mostly from forward of midships. They are in the form of a shallow bowl with a small flat handle which has been pressed on leaving the fingerprint of the potter in many cases.
Maritime Explorations

Figure 13. Remnants of the cover and binding on a glazed stoneware jar.

A number of small stoneware cooking stoves were found well scattered. All but one are of a simple design with a slender tapering body incorporating a concave perforated ‘grill’ and a rectangular aperture in the side for filling with coals. The odd one had an elaborate revolving gate within, open on one side for filling with coals and exhibiting a pierced swastika design on the other to hold the coals in without restricting the air flow.

Six very well potted unglazed teapots were found, all aft of midships. Two rows of perfectly stacked concave lids, 217 in all, were found just to starboard of the keelson between bulkheads 5 and 6 with no sign of their packing container. They appear to fit the teapots, and are certainly not compatible with any other item found, but their number is markedly disproportionate.

Miscellaneous ceramics
Recovered in grid 2C were 40 crudely-made figurines of naked males and females with enlarged genitalia and a metallic glaze. Also located were three unglazed porcelain disks thought to be supports on which bowls rested in the saggar during firing (Green & Harper, 1986). These have been found on several other wreck sites of the period (Mathers et al., 1991).

Packing
Strips of wood, many obviously barrel staves, were found amongst the ceramics all over the site. Although the loose fibrous material typically used for packing within the packing containers does not lend itself to preservation, many examples have survived on this site. They are as follows: yellow straw-like vegetable matter; cloth, found in several instances in between bowls in a stack; thick wads of what appears to be burnt paper, often conforming to a shape; and possibly woven matting.

Cooking pots
The centre of the wreck site resembles a tiny tropical reef when not obscured by dense shoals of fish. The basis of this oasis is a mass of iron cooking pots and ballast stones, all perfectly confined between bulkheads 3 and 4.

Standing well proud of the bottom with remarkably little concretion or growth are three stacks of 800 mm diameter cauldrons, 12, 13 and 11 per stack, respectively, from the bow. Prior to disturbance in 1990 all three stacks lay upside down on a layer of ballast stones directly along the keel. The port side of the ship has collapsed leaving three long rows of concreted woks lying in the sand. The starboard side, however, is very much as it was originally stowed, although much of the material is undiscernable under a mass of concretion and coral growth. On the ceiling at the outer edge of the compartment lie several longitudinal rows of concreted woks that were initially thought to be old iron cannon used as ballast. Above this aft are transverse rows of woks, and more with handles vertically stacked forward. The handles are made from separate tapered hexagonal pieces that have been cast into the rim of the woks. These woks have been stacked with the open-ended handles helically offset creating a most unusual looking object under a light layer of concretion.

Tiles
A major component of the cargo and an ideal form of ballast is the utilitarian floor tile (Fig. 14). Measuring 320 x 320 x 25 mm, these orange tiles are identical to those still being used today in Vietnam, primarily for rice drying platforms. They lie neatly stacked in longitudinal rows between bulkheads 4 and 5. At their outboard edge there are short rows of tiles stacked in the opposite direction and over the keel they are double stacked.

More tiles are stowed between bulkheads 6 and 7, and 7 and 8. These are similarly stacked, although between bulkheads 6 and 7 the second layer is stacked athwartships and the tiles do not encroach on the mast-step area but rest against
the mast-step lateral support. The tumbled mass of tiles in the adjacent grids mirrors the stowage within the remaining hull except in the southern half of grid 3G where there is a noticeable lack of tiles, implying that they may have been stacked on the starboard side only in the compartment between bulkheads 6 and 7. It is not obvious what cargo item counterbalanced the tiles here. Outboard of the longitudinal bulkhead between bulkheads 2 and 3 there was a shallow layer of small rounded stones varying in diameter from 20 to 50 mm. It is possible that these represent the smaller fraction of ballast stones that occupied this compartment on some previous occasion, although it is strange that there are none inboard of the longitudinal bulkhead.

**Ballast stones**

A feature of the compartmentalized ship is that ballast stones can be distributed where necessary rather than being spread along the whole length of the bilge as is the case with contemporary European vessels. On the Con Dao ship the compartment between bulkheads 1 and 2 was filled to a level of at least 1.5 m above the keelson with well-rounded river rocks, varying in size from pebbles to stones weighing in excess of 30 kg. During the course of the 1991 excavation all the ballast stones were removed from this compartment to reveal the underlying hull structure and a number of small artefacts that had filtered down through the stones.

As previously mentioned, ballast stones were also recorded between bulkheads 3 and 4 under the cooking pots, but this was only a thin layer. Interestingly the small area forward of the mast-step and between the lateral mast support and the keelson/chock also contained several large ballast stones and no items of cargo. Outboard

**Supplementary cargo**

A multitude of artefacts was recovered from the Con Dao wreck. Many of these formed part of the diverse cargo of this vessel, an assumption based on the quantity of similar artefacts recovered. From their distribution it seems that most were stowed in the stern compartments, or in the superstructure, and in the compartment between bulkheads 5 and 6.

**Between bulkheads 5 and 6**

A very small segregated area in the middle of the compartment between bulkheads 5 and 6 has been used to store an amazing variety of valuable trade goods. For some reason there is no ceiling in this area so consequently the bulk of the artefacts were recovered from between the frames on both sides of the keelson.

On the starboard side, fitting snugly between bulkhead 6 and a frame, were two medium-sized stoneware flasks. Between bulkhead 5 and a frame was a stoneware storage jar filled with
pits of an origin yet to be determined, and the remains of a small barrel with a wooden bung jammed into a hole in the barrel top indicating that it had held liquid (Fig. 10).

Next to the keelson in a jumbled heap intermingled with straw packing lay eight figurines intricately carved from soapstone. They are in the form of a water buffalo, a standing man, an old man with a stick, a man seated with a dragon, a man with a dog, a woman with a raised knee, a man in a lotus position, and a woman in a lotus position with an elaborate backing. Some have the remnants of paint still adhering and nearly all have separate soapstone stands.

Lying amidst these was a 290 mm long split wooden container in shape resembling a violin-case. It was later opened to reveal a set of weighing scales consisting of a cross-bar of bone or ivory, graduated with three systems of dots, a brass pan with four wire loops for hanging, and a cubic brass weight. Chinese characters branded into the wood on the inside, “guang zhu...” translate as ‘widely made...’, a trade mark.

On the port side of the keelson lying in a tangled heap were 98 tiny tweezers/ear pick/car pick cleaner sets, all tied together by very fine copper wire. The same type of grooming sets are still being used by the Chinese today. Also found in grid 4F were 52 pairs of tweezers with a sliding pin to adjust the pincer opening and a pivoting D-ring at the other end.

Many pieces of very small brass chests were recovered from this compartment in a fine state of preservation. Four complete chests have been reconstructed. They are only 78 mm long, 54 mm wide and 50 mm high, and are complete with hinges, side handles, lockable latch and internal dividers. From their size they would seem to be a cargo item in themselves and are unlikely to have had any contents. Three very small hexagonal boxes were also reconstructed from many loose pieces found in the same compartment. They are only 40 mm across and 24 mm high and have a hinge and a latch.

Hundreds of tiny copper-alloy spherical buttons, most concreted together, were located between the frames on the port side. The loop of the buttons is made of doubled wire and the extremely thin wall of many of the buttons appears to be gilded. Two disc-like buttons of 13 mm diameter were also found in this compartment.

Other items found around the small midships compartment between bulkheads 5 and 6 include the following: 23 Chinese copper cash; fragments of tiny lacquered combs, some with gold-painted floral designs and some with inlaid mother of pearl; one small dice; a copper-alloy fish hook; four different paint pigments, white in the form of chalky lumps, yellow in sulphur-like chunks, black as a soft block, and red as a solid lump conforming to the shape of the bag that originally contained it; eight wooden rings that resemble the rollers of a panel; a wooden peg with a turned end; three gold-thread tassels; a small decorated bronze mirror; three very small stoneware bowls, one with a deep brown glaze, one with a greenish white glaze, and one with a brown glaze and two tiny lug handles; and two moulded ink blocks with recessed gold painted characters on one side and a detailed landscape scene on the reverse (the characters translate to ‘This is the poem of Xiu...’).

Evidence of original packing abounds in and around this compartment. There are barrel staves, strips of wood with precision tongue-and-groove joinery, a copper alloy hinge and a key-hole plate from a chest, and six Chinese locks of various sizes and sections. One of the locks is still attached to a thin copper-alloy latch.

As previously mentioned, there is a longitudinal bulkhead in this compartment and a dividing plank inboard of that. All of the above mentioned trade-goods appear to have been stored inboard of this dividing plank. Between this plank and the longitudinal bulkhead there were two rows of stoneware storage jars, eight in all, and sherds of jars that indicated that they were probably double-stacked. Most of the jars were broken. However, they still retained the remnants of their original contents and some still had wooden lids in place. Half of the jars were filled with minute fish bones and half contained the shells of small bivalves. From their location it might be suggested that they represent dried fish and pickled shell delicacies carried as cargo rather than ship’s stores.

Other trade goods
At the south end of the site, primarily in grid lines A and B, several pieces of thin lead sheet were recorded. The sheet was seam ed and straight-edged in places and it is possible that it
was used to line boxes of tea, as was the practice of the day (Jorg, 1986).

Eight dice were found in grid 4C and seven more were recovered from grids surrounding this. They are of two basic sizes, the larger variety tending towards black and the smaller towards white, suggesting two different materials. Some of the small ones were broken revealing a fibrous interior, perhaps bone or ivory.

Ink-stones form another cargo item although there were obviously two different consignees as six were found around the aft end of the hull and five were located in 4H. These are known as Duan ink-stones, taking their name from the Duan River, Guangdong Province, where the magnificent purple stone used for the ink-stones was originally quarried. It developed as a functional object in the early Tang Dynasty but assumed aesthetic meaning in the Ming and Qing Dynasties when it was produced in a great variety of forms (Anon., 1991). Most of the ink-stones from the Con Dao wreck are plain and rectangular in form although one from 4H is oval-shaped and one from 5D is elaborately decorated with a dragon design.

A second consignment of adjustable tweezers was stowed in the stern compartments as evidenced by 11 pairs found in that region. Hidden in the sediment between the inner hull planking and the ceiling in grids 4C and 4D were 41 tiny split bamboo combs which were originally held together at each end with iron pins. Many are still intact and some display the remnants of a varnish-like coating. Also found aft were a number of plain rectangular blocks of ink and two lozenge-shaped blocks with impressed Chinese characters (Fig. 15). On the front, ‘Wu Jin’ which means ‘Black Gold’, on the back ‘Fa, Shi, Min, Tian, Yi, Shi’ literally translating to ‘’, Time, People, Sky (heaven), One, Addressee’, and on the side ‘Geng Gan’ which is number seven of an age or date (cyclical year). Of a more utilitarian nature are three stone pestles and two stone mortars found in grid 4C and one additional mortar lying nearby in 5C. These were all much the same, the pestles being 160 mm long and the mortars 170 mm diameter and 100 mm deep.

Before discussing artefacts scattered further afield the packing of these trade goods in the stern must be covered. A wonderfully preserved brass latch was found in 4C. It displays three radially striated dials on the face, the centre one incorporating a large key-hole, but this is only for show. One of the smaller dials on the side slides sideways to release a catch on the back. It does not, in fact, lock. However in the same grid were four Chinese locks, two of them complete with key, suggesting that these had been opened prior to the ship going down. Nearby in 5D was one more small lock still attached to a chest latch. Four keys, two from Chinese locks and two conventional, were also recovered from this region (Fig. 16).

Scattered fairly randomly along the east side of the hull were seven small glass funnels approximately 65 mm long, some purple, some deep green and some clear. Their function is unknown. In 5G, tucked under the edge of the hull in a very fragile state were dozens of wooden fans. Only the base of the blades remained in most cases and these disintegrated with the slightest disturbance to leave only the copper alloy pivot pin with its two domed ends. Gridstones were another cargo item. These are spread far and wide suggesting that they have been stowed wherever space was available. One was recovered in 1990 and two in 1991. One of the latter is 297 mm in diameter and had square-section holes in the centre on each side, whilst the other is 303 mm in diameter, has a small round hole in the centre on one side, a hole all the way through off-centre, and two opposed square section holes in the side. Two other stones that appear to be associated are semi-circular and have two tapering square holes all the way through. Finally an interesting item of cargo that would have been sadly missed as a result of the sinking comprises two column bases, as used in Buddhist temples, which have come to rest in grid 5G after sliding out of the foremost compartment where they must have been stowed above the tiles. The 730 mm diameter bases are carved out of granitic stone and display an encircling lotus leaf design (Fig. 17).

Personal belongings
Some artefacts obviously belong under this heading whilst others are less certain.

(i) A pocket sun-dial recovered from between the hull planking and the ceiling in 4C (Fig. 18). This is a beautiful artefact, 54 mm in diameter, with a lid that unscrews to reveal a fold-up vase
and a calibrated rim. The calibrations are in Arabic numerals making it the only artefact on the Con Dao wreck that is definitely of European origin. In fact, a very similar piece was found on Kronan which was lost off Sweden in 1676. That one has the initials 'BH', those of Barrent
Hendricke, which indicates a date of manufacture around the end of the 16th century (Einarsson, pers. comm.). The Con Dao sun-dial is devoid of a maker’s mark. However, like the dial from Kronan it contained remnants of glass and a compass-needle socket. Sun-dials are designed for use in particular latitudes, but as yet the polar height, and hence the intended area of use, of the Con Dao sun-dial has not been determined.

(ii) Three Chinese chops were found. The most elaborate, discovered in 4B, was of porcelain topped by a lion that has unfortunately broken off above the feet. The other two are simply rectangular blocks with different chops at each
end, and were found well away from the hull in grids 1D and 2C, perhaps indicating that they were originally in the superstructure. Lines of poetry were often chosen for personal chops (Miksic, pers. comm.) but these particular examples cannot be found in the literature.

(iii) A Chinese mirror decorated with blossoming trees and a single large character was recovered from 5D (Fig. 16). Small characters cast to the side of the design, 'Yuan Zou ...' mean 'Made by ...'. One more mirror, a small deteriorated one, was found in 3E.

(iv) An octagonal copper cash from the Shun Chih period (1644–1661) was found in 4C, the only coin of this type and the only one from the southern half of the site. Two more copper cash were excavated at the northern end of the site in grids 4G and 4H.

Other artefacts that may be personal belongings include (v) a copper alloy spatula found well forward in 4G, (vi) the sole and part of the uppers of a very small shoe in the extreme north end of the site in 4H, (vii) the porcelain end of a wooden pestle that was recovered from 5C.

Food stores
Under the protection of the sand and silt a variety of foodstuffs have managed to survive. Owing to their low specific gravity and original quantities examples of the various types have been scattered throughout the site to the extent that their provenance cannot be surmised.

Best preserved are walnuts and persimmon. The persimmon had been dried and stacked, many of the stacks remaining intact. Their present hard brittle condition may be due to the fire that sank the ship, which left them in a carbonised state and consequently less likely to decompose. Also fire-affected are chunks of what appears to be blackened rice, some conforming to the bag in which they were stored.

Several pieces of molten lead have grain imprints.

In bad condition, but large numbers, are lychee, or possibly longan, pits. Part of the skin of the fruit has survived in one case. Two other types of nuts or pits are well represented but have yet to be identified.

Ship's gear
All items that would normally be stowed onboard ship, be they ordnance, bosun's stores or from the galley, come under this category.

In 1990 two small bronze breach-loading swivel guns and one breach block were reportedly recovered from the southern end of the site. They are said to be of Portuguese origin (Westenberg, pers. comm.). During the 1991 excavation two additional breach blocks were located, well away from the stern, one on the keelson between bulkheads 5 and 6 and one outboard of this (Fig. 19). The first has a semicircular scrolled handle, a diamond-shaped touch-hole and a bore of 23 mm, whilst the second is of generally thicker section, has a lower handle, a round touch-hole and a bore of only 20 mm. In both cases the small slits from the casting mandrel supports are clearly discernible. There are no surviving markings on the breach blocks nor on the swivel guns. No shot was found on the site.

A sounding lead 284 mm long and weighing approximately 9.5 kg was found in the after end of the vessel in 4C. It has a square hole for fastening a rope but does not have a tallow hole.
Two short lengths of hawser remained preserved under the sand, one well aft in 2A and the other spanning 5F and 5G. They are both 80 mm in diameter and are of a 3 × 42 left hand lay. The excavations did not reveal any anchors.

Much evidence points to a stern galley. A number of coarse bricks were uncovered in 3A and a lone iron wok of 500 mm diameter was found in 1B. Associated artefacts in the same area include a copper kettle and a copper kettle lid with a short length of chain from the handle (from a different kettle), a copper-alloy ladle, a porcelain bottle with a green glaze, a small copper-alloy bowl, and a stoneware jar complete with wooden lid.

**Discussion**

**Hull design**

Figure 20, a sketch from the Karabune E-maki, a set of Japanese scrolls depicting foreign ships (date unknown), would seem to illustrate the Con Dao wreck perfectly. The following features are identical in both cases: a single mast stepped on the keel a distance of 0.3 times the keel length aft of the bow (the foremast being stepped above the keel); a marked angle where the stem-post
meets the keel, a false keel jutting out at the bow in a remarkably exposed position; substantial deadwood astern; a flat transom; a fixed rudder attached to both the deadwood and the transom; wales that curve down to the waterline.

The Chinese script in the top left of the sketch translates as ‘Ningbo Ship’ (Lu Yaw, pers. comm.). Worcester (1947; 375) comments on a lorchia, a Chinese vessel of considerable Portuguese influence. In his words ‘Previous to the colonization of Macao the early Portuguese settlers had in 1517 arrived first at the port of Tamou..., and later at Liampo, or Ningbo, where they established themselves in such force that it became their wealthiest settlement in Asia with a community of 1,200 Portuguese. Allusions to ‘Portuguese trading junks’ of this period make it seem feasible to suppose that the newcomers had at this time, and probably at Ningbo, built for themselves speedier adaptations of the useful and seaworthy Chinese junk which, while retaining the handy Chinese style of rig, would by means of its finer western lines expedite the delivery of merchandise, which was the basis of the flourishing trade carried on by the Portuguese with Japan, Malacca, India, and the China coast.

Figure 20. Sketch from a Japanese scroll depicting foreign ships, probably similar to the Con Dao wreck.

The ‘Ningbo Ship’ illustrated clearly fits Worcester’s criterion of a western hull and Chinese rigging, and the additional western influence of a canvas topsail above the Chinese battened, matting sail confirms that this is indeed a lorchia. This is a far cry from the Chinese vessel typified by Needham (1971) as being flat-bottomed and devoid of stempost, sternpost and keel, having an approximately rectangular cross-section, and having a detached, raisable rudder. The conspicuous absence of this type of vessel in Asian shipwreck sites would seem to indicate that this is more typical of river or inter-coastal trading craft. However, Needham states (4, 3: 430), ‘But Chinese ships were not always flat bottomed; though lacking any true keel, their sides sometimes rose up in a quite rounded way from the lowest main longitudinal timbers. ... all the sea-going junks of the south exemplify it.’

Worcester describes a ‘standard size’ lorchia found at Ningbo at the time of his writing, which is similar to the Con Dao wreck although it is a little longer and has an overhanging transom (the dimensions of the Con Dao wreck are in parentheses): a keel length of 30·0 m (25·0), a beam of 7·3 m (~ 7·7), a depth of 2·1 m (~ 2·2),
eight bulkheads (8), frames spaced at appropriate intervals, bulkheads thickness from 100 to 125 mm (90 to 110), frame thickness of 178 mm (140 to 200), and 'of light draft and with flat bottom, though with a light keel'.

It is of course not to be implied that the Con Dao ship was constructed in Ningbo. The Portuguese colonized Macao in 1557 and consequently the majority of lorchas were built there, although the supply of wood and shipwrights and the continued Portuguese presence in China would have ensured their ongoing construction in southern Chinese ports. Nor can it be said that Portuguese owned or even crewed the vessel. Worcester points out in later years that lorchas operated under American, English, Dutch, German and Spanish flags as well as being entirely owned and operated by Chinese. The cargo of the Con Dao wreck, in fact, points to its being a Chinese-owned vessel.

Green & Harper (1987) list shipwrecks of Eastern origin and summarize their construction and cargo. Of the 18 ships listed not one is similar to the Con Dao wreck. Southern Chinese ships are typified by bulkheads, multi-layered planking and iron fastening. In the case of the Shinan wreck (Green, 1983a) the hull is of rabbeded clinker construction, whereas the Quanzhou wreck (Wen Wu, 1975; Green, 1983b) is a complex rabbeded clinker and carvel hull. Another type of vessel, of South-east Asian origin, which is well represented by many of the wrecks located in the Gulf of Thailand and by one recently found off Phu Quoc Island, Vietnam (Blake & Flecker, in preparation), is typified by closely spaced bulkheads (up to 15 in number), frames adjacent to the bulkheads, and a multi-planked hull, edge-joined with treenails. The feature that sets the Con Dao wreck apart is the use of multiple frames between bulkheads, a very vivid display of combined eastern and western construction. 'These hybrid craft were not only faster than the junk, but for their size had a greater cargo capacity, an advantage achieved with no sacrifice of strength; indeed, they were probably stronger than the junk.' (Worcester, 1947, 2: 381.)

**Caulking**

Samples of the white caulking compound used throughout the Con Dao ship were taken but have yet to be analyzed. However, its appearance suggests that it is tow mixed with t'ung oil and lime (Needham, 1971). Li Guo-Qing (1989) discusses the use of this mixture, called chu-nam, on a 13th century Chinese wreck known as the Quanzhou ship. When the caulking mixture does not contain tow, typically jute fibres or shredded bamboo, it is simply t'ung putty which is employed in nail recesses to protect the iron fastenings from corrosion and to fill irregularities and gaps in the surfaces of hull planks. This use of the putty is very evident on the Con Dao wreck, particularly in the triangular recesses left when edge joining bulkhead and hull planks, and along grooves and cracks in the hull planking.

*Chu-nam* has been used liberally to pay the hull seams of the Con Dao ship and, in fact, can be found thickly applied wherever there is timber contact, whether there is a need for a water-tight seal or not, attesting its importance in protecting the iron fastenings. In many cases where a frame or beam no longer exists a strip of chu-nam points to its former position.

The varied uses of t'ung putty and chu-nam on the Quanzhou ship can be paralleled on the Con Dao wreck.

**Cargo**

From the form of many of the blue-and-white pieces such as teapots, mugs, candle-holders and the like, and decorations, such as European buildings, probably Dutch, on the very large vases, it is almost certain that these items were destined for transhipment to the European market. The finely potted blanc de Chine, was likely to follow the same route.

But without exception, all other trade goods loaded on this vessel were Chinese in origin and Chinese in use, and all point to the resupply of a Chinese enclave. Building materials such as floor tiles and column bases, cooking utensils such as woks and mortars, and agricultural equipment such as grindstones indicate that the settlement was in need of the basics. But the high side of society was also well catered for with ink and ink-stones for the intellectuals, combs and fans for the ladies, and delicacies for the gourmets.

Batavia is the most likely candidate, particularly if the ceramics were destined for Holland.

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