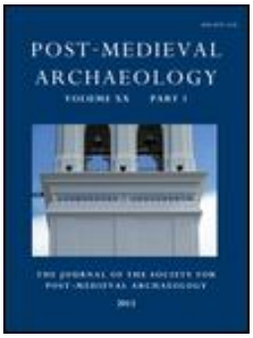

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The 'Gresham Ship': an interim report on a 16th-century wreck from Princes Channel, Thames Estuary

By JENS AUER *and* ANTONY FIRTH

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SUMMARY: The 'Gresham Ship' was found in Princes Channel by the Port of London Authority in 2003. Investigations culminated in the recovery in 2004 of the remains of a small to medium-sized armed merchant ship built soon after 1574, probably in East Anglia or Essex. The wreck provides archaeological evidence of the documented practice of 'furring' (rebuilding a ship to increase its breadth). The cargo included folded iron bars, lead ingots and tin ingots, and amongst the four recovered guns is a rare English early cast-iron saker, marked with the grasshopper motif and initials of Sir Thomas Gresham.

INTRODUCTION

The 'Gresham Ship', which takes its name from a gun thought to be from the Mayfield furnace of Sir Thomas Gresham (*c.* 1519–79), first came to the attention of archaeologists in July 2003. The wreck had been found by the Port of London Authority (PLA) in the course of surveying the Princes Channel in the Thames Estuary earlier in the year,[1] but as its potential importance was not recognized it was first subject to salvage and clearance procedures. The presence of a gun amongst the salvaged material prompted a call to Wessex Archaeology (WA). In 2003–04 a series of archaeological investigations were carried out, culminating in the recovery and recording of artefactual and structural remains of considerable importance both in a United Kingdom (UK) and European context. This article presents the interim results of the investigations in 2003–04, pending a full post-excavation programme that commenced in October 2007.

London is the UK's second largest port, comprising over 70 terminals handling over 50 million tonnes of cargo each year. The PLA is required to maintain the safe navigation of the Thames and has powers to carry out dredging works accordingly. Princes Channel provides a key route into the main channels of the Thames from the south, and was earmarked for dredging to make the channel accessible for a greater proportion of the tidal cycle. The PLA's obligations also include the removal of sunken wrecks if they might become an impediment to navigation, and it maintains specialist teams and equipment for such work, so its initial efforts to remove this wreck were not out of the ordinary. It is worth noting that the obligation to remove sunken wrecks does not require any form of consent comparable to planning permission, and it overrides any designation under Part I of the Protection of Wrecks Act (1973).

Princes Channel runs east to west from about 11km north-north-east of Margate, Kent, towards Oaze Deep in the main Thames approach (Fig. 1). The wreck was located about 15km north-east of Whitstable in a shallower area of Princes Channel that lies between the sand banks of Kentish Flats and Girdler, on the southern edge of Shingles. The area is charted at 5–6m below Chart Datum (*c.* 7–9m below OD),[2] the depth on site typically varying between 7m and 10m depending on the

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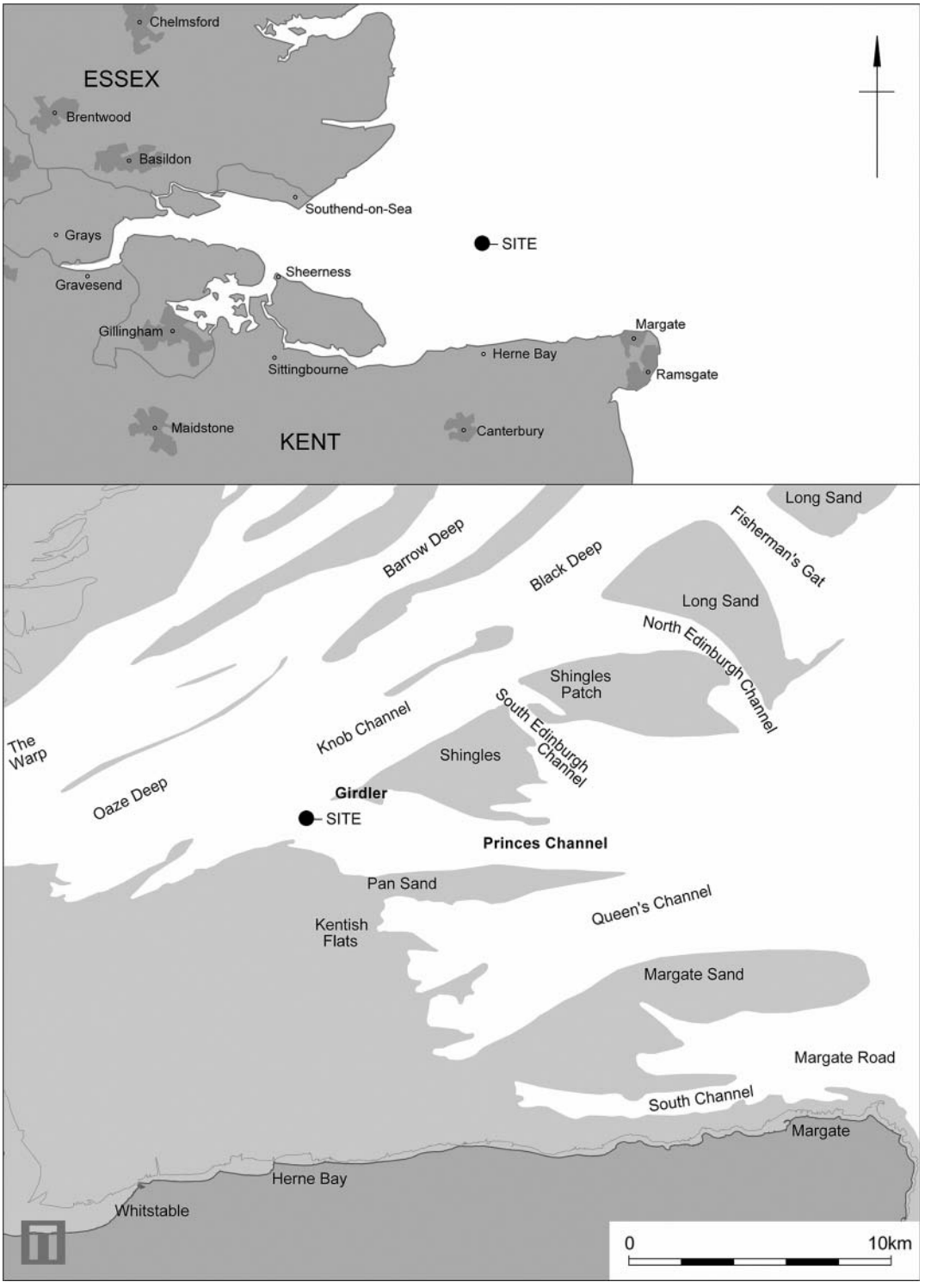

FIG. 1

The 'Gresham Ship': location of the wreck site, showing modern channels and sandbanks (drawn by Kitty Brandon, Wessex Archaeology).

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tide. The seabed in the immediate vicinity of the wreck consists of hard grey clay with a thin veneer of sand.

DISCOVERY AND INITIAL INVESTIGATIONS

The wreck was identified by the PLA from a magnetometer survey carried out in April 2003. It was inspected by PLA divers in May 2003, when it was recognized as the wreck of a wooden ship. In June 2003 some iron bars were recovered and an attempt was made to disperse the remains, but this proved unsuccessful. As a result, a grab barge was contracted to carry out wreck removal operations in July 2003, leading to the recovery of a large amount of timber, with iron bars, an anchor and a gun, which resulted in the call to WA. Following a brief inspection of the recovered material, which noted a possible second gun among the iron debris, WA was commissioned to carry out remedial recording of the recovered material. Forty-seven timbers from a carvel-built vessel were recorded and the presence of two guns was confirmed: one a cast-iron piece thought by the Royal Armouries to date to the late 18th/early 19th century, the other a wrought-iron piece thought to date to the first half of the 16th century.[3] At this stage WA was assured by the PLA that the site had been wholly cleared.

In October 2003 a hydrographic monitoring survey in Princes Channel identified a high spot about 30m from the wreck site. Inspection by a PLA diver established the presence of some wooden wreckage. WA carried out a diving inspection at this position in November 2003, confirming the presence of a coherent piece of hull structure, estimated as measuring about 6.5×3m. An impromptu sidescan survey showed this fragment, and also further wreckage to the west representing the original site. As the coherent piece was believed to be a hazard to navigation it was lifted in November 2003, with WA in attendance. The structure came apart during the lifting operation and — labelled Piece 1 and Piece 2 — it was transported to the PLA's Denton Wharf in Gravesend. The wreckage shown in the sidescan data at the original site was subject to diving inspection in December 2003, which enabled an initial survey of the remaining site. Both pieces were recorded by digital survey at Denton Wharf in January 2004.[4] On the basis of structural features recorded, a construction date in the 16th century and a possible Iberian–Atlantic origin or influence were postulated.

In order to provide a firmer basis for the development of mitigation measures, another series of investigations was carried out, consisting of dendrochronological sampling and geophysical investigation in May 2004, and further diving inspection in June 2004.[5] Dendrochronological analysis of twelve samples from framing timbers in Pieces 1 and 2 showed that the vessel was constructed soon after 1574, and suggested that the oak used for the vessel's structure originated in East Anglia or Essex.[6] The geophysical survey established the extent and form of surviving material, including surrounding debris, and also located the former position of Pieces 1 and 2. The diving inspection enabled a summary characterization of the site after the manner proposed by Watson and Gale,[7] identifying two further main structural elements: Piece 3 — part of the ship's side or lower hull — and Piece 4, part of the ship's bow or stern.

These investigations established the continuing presence of archaeologically important wreck material in an area where further dredging was required. They also provided sufficient basis for developing a project design for mitigation.[8] The work to date was rationalized as Phase I (remedial recording, July 2003–February 2004) and Phase II (evaluation, May–July 2004); the project design set out the terms for Phase III (excavation and recovery), as well as anticipating further phases from post-excavation assessment through to publication and archiving. Knowing that Phase III would have to be selective in its approach, due to both the environment and available resources, the project design included an explicit research framework to inform priorities and methods. Although the project was being carried out within the scope of the PLA's statutory powers and there was no formal requirement to obtain advice from archaeologists, the project design was nonetheless submitted to English Heritage, and endorsed by them.

EXCAVATION AND RECORDING

Phase III excavation and recovery took place in August–October 2004.[9] The aim of this phase was to excavate and subsequently remove the two remaining structural elements of the shipwreck, as well as all disarticulated artefacts on site.

The excavation was carried out by a combined PLA Marine Services and WA dive team; a PLA tug was used as diving support vessel. The exposed location of the wreck site in a busy shipping lane and the adverse environmental conditions with strong currents and low to very low underwater visibility necessitated the use of commercial surface-supplied diving equipment. Diving was generally limited to high- and low-water slack

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periods, and two divers were employed simultaneously to maximize time on site.

Diving tasks prior to full excavation included the tagging of all timbers with unique context numbers and the preparation of a pre-disturbance sketch plan. Because visibility was poor, the plan was drawn on the surface, based on observations and measurements conveyed by the diver through the underwater communication system. To keep the recording process as straightforward as possible, traditional offset measuring methods were combined with trilateration for objects located around the wreck site (Fig. 2). Airlifts were used to remove sediment from and around the surviving elements of hull structure. Mesh bags were fastened to the end of the airlifts to allow sieving of the dredged material for small finds. All elements of the cargo found inside the timber structures were recorded and subsequently lifted.

The timber structures were lifted by a PLA salvage vessel using an arrangement of lifting strops and bars. While the recovery of Piece 4, the bow section of the wreck, was unproblematic, the side of the vessel, termed Piece 3, broke apart while still on the seabed and had to be raised in two parts — Pieces 3a and 3b. Upon removal from the sea, the timber sections were either submerged in barges or covered and kept wet with leaky hose systems while the underwater work continued.

Shoreside recording of timber structures, timbers and finds took place in periods of poor weather during the diving fieldwork and after the completion of diving. All small finds were photographed and entered into a Microsoft Access database. Disarticulated timbers were sketched or drawn at 1:10, and photographed and recorded on paper, as well as in a database. The three structurally intact hull sections were left assembled and recorded in the same way as the previously lifted Pieces 1 and 2. A Leica TCRA 1105 reflectorless total station was used in conjunction with the software packages TheoLT and AutoCAD. While this method allowed rapid and accurate three-dimensional recording of the overall structure, it had to be supplemented by photographs, sketches and 1:10 drawings of selected elements, as well as timber record sheets for detailed recording.

DESCRIPTION OF THE HULL REMAINS

Altogether, five coherent hull sections of the Gresham Ship are preserved. They include the bow section of the wreck and an approximately 14m-long run of the port side, from above the keel to a level above the orlop deck (Fig. 3). All sections are of oak. The vessel was carvel-built; an outline description of carvel construction, explaining the technical terms, is set out as Appendix 1.

The bow section, termed Piece 4, has a height of 4.9m and a length of 2.2m. It consists of a fragment of the keel which is joined to the stempost. Stemson and apron are partly preserved. Two V-shaped square rising floor timbers are *in situ* on the inside of the section and a single futtock survives on the port side. Broken treenails and treenail holes indicate the positions of further frames, as well as breasthooks. Seven strakes of outer planking, including the garboard strake, are present on the starboard side. As this side was covered by sediment, the planks are well preserved and still show signs of a white protective surface covering. The port side is less well preserved, with six heavily eroded strakes from the garboard upward *in situ*.

Pieces 3a and 3b form the foremost part of the port side. Piece 3a, the lower part, measures 8.2×2.23m. It consists of six strakes of outer planking. On the inside, the surviving upper ends of the floor timbers are joined to eleven futtocks; they were all broken where Piece 3b had joined Piece 3a. Filling frames were inserted between floor timbers and futtocks, presumably to strengthen the turn of the bilge. Two ceiling planks survive *in situ*.

Piece 3b represents the remainder of the ship's side from just above the turn of the bilge to the level of the gunports on the orlop deck. It measures 6.3×3m. On the outside, four strakes of planking lead up to a wale composed of five strakes. Above the wale, a complete gunport is visible, with the edge of a second gunport preserved 2.5m aft of the first. On the inside of Piece 3b, the orlop deck construction is apparent below the gunports. Deck beams and planks are missing, but the beam-shelf as well as a half-beam clamp and part of the waterway survive. A sandwiched stringer provides longitudinal strength at the level of the orlop deck.

Pieces 1 and 2 form the aftmost preserved part of the ship's port side. The two sections were originally joined, with Piece 2 at the top, but they broke apart during recovery. Piece 1 measures 7.48×3.34m; eight strakes of outer planking are preserved. On the inside, the upper ends of three floor timbers remain *in situ*. Two first futtocks and a number of filling frames are also visible. Piece 2 measures 6.11×2.29m. It is composed of five strakes of outer planking, two of which form part of the wale, and was joined to Pieces 1 and 3b. As in Piece 3b, the orlop deck construction is visible on the inside of this section. The only preserved end of a deck beam is located on Piece 2.

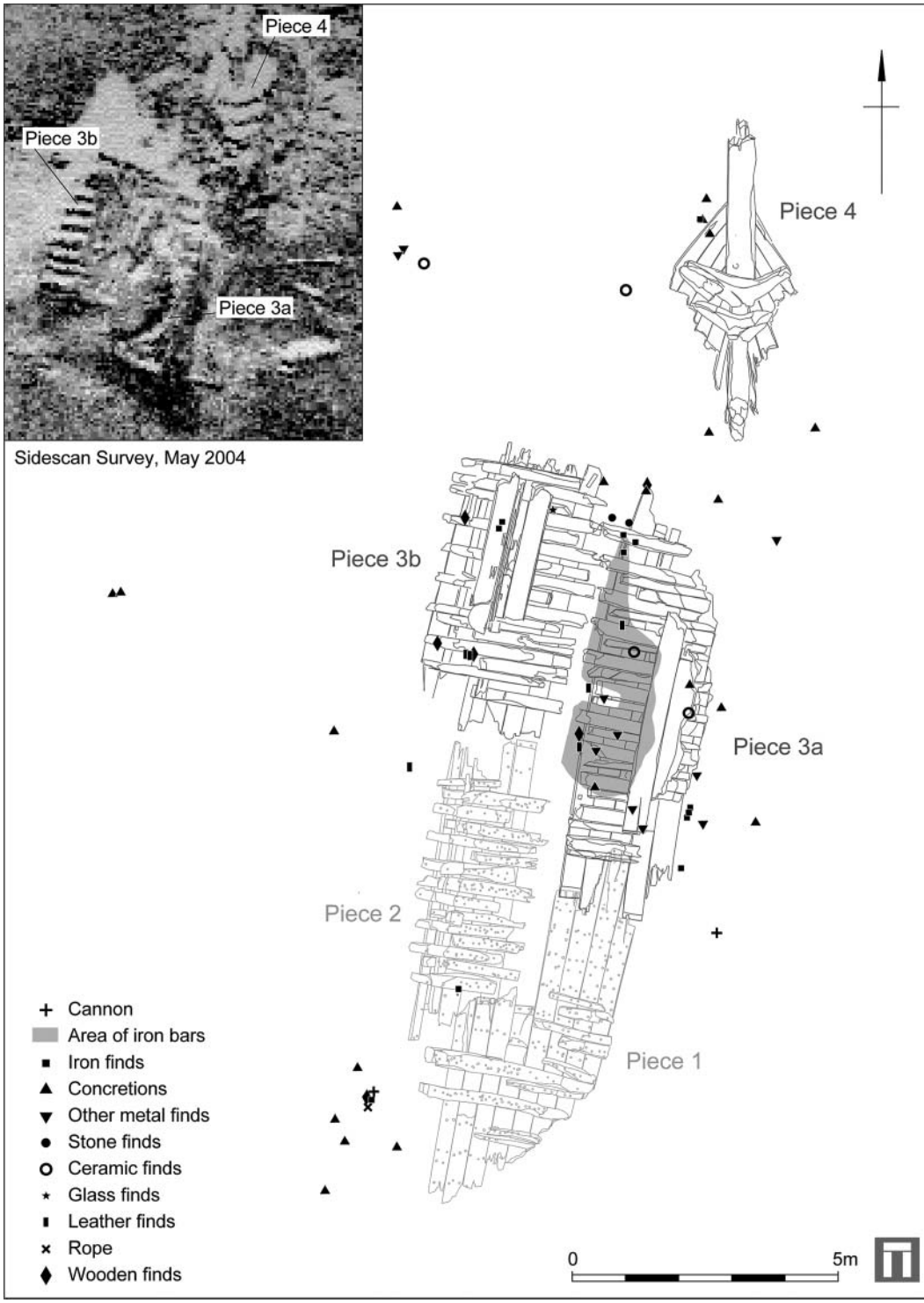

FIG. 2

The 'Gresham Ship': underwater site plan based on diver measurements and land-based recording of the timber sections (drawn by Kitty Brandon, Wessex Archaeology).

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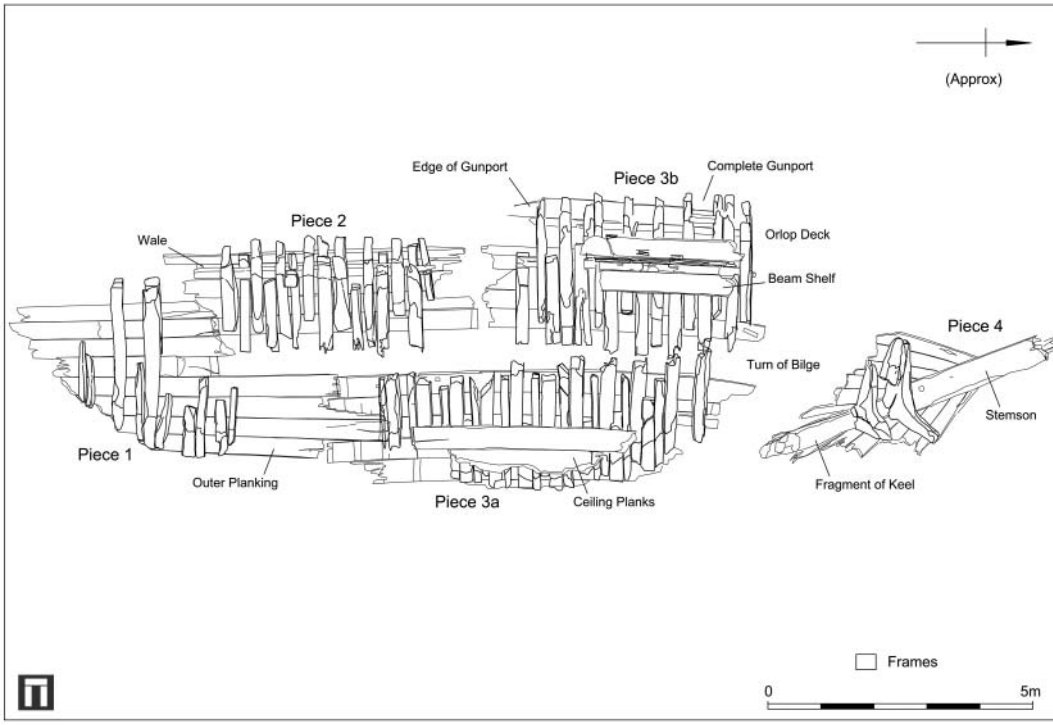

FIG. 3
The 'Gresham Ship': overview of the preserved hull sections of the wreck (drawn by Kitty Brandon, Wessex Archaeology).

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THE CONSTRUCTION OF THE GRESHAM SHIP

FURRING

The most noticeable feature in the construction of the 'Gresham Ship' is a doubling of all framing timbers from the turn of the bilge upwards. The double frames taper from their full moulded dimension to *c.* 50mm. They rest on a plank, triangular in section, which fills the gap between the heel of the outer framing timber and the surface of the first futtock and thus provides a smooth surface for the application of outer planks (Fig. 4). The purpose of the double framing was not fully understood until the explanation of the term 'furring' was found in Sir Henry Mainwaring's *Seaman's Dictionary*, which was composed *c.* 1620–23:

> The other, which is more eminent and more properly furring, is to rip off the first planks and to put other timbers upon the first, and so to put on the planks upon these timbers. The occasion of it is to make a ship bear a better sail, for when a ship is too narrow and her bearing either not laid out enough or too low, then they must make her broader and lay her bearing higher. They commonly fur some two or three strakes under water and as much above, according as the ship requires, more or less. I think in all the world there are not so many ships furred as are in England, and it is pity that there is no order taken either for the punishing of those who build such ships or the preventing of it, for it is an infinite loss to the owners and an utter spoiling and disgrace to all ships that are so handled.[10]

The 'Gresham Ship' was furred, presumably either during the construction process or shortly thereafter. The original outer planking was removed and a second layer of framing timbers added. On the level of the orlop deck above the waterline, further chocks were inserted at intervals between original frames and furring timbers to achieve the desired moulded dimension. The original wale was left *in situ* between original frames and furring timbers and served as a stringer

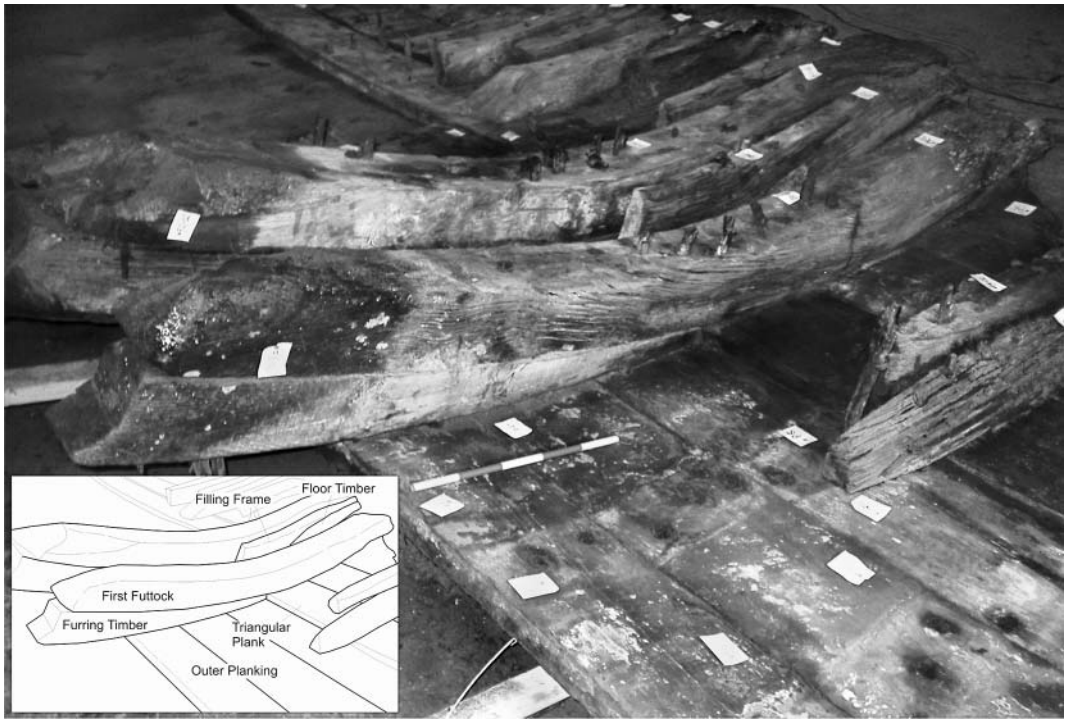

FIG. 4
The 'Gresham Ship': furring timber on first futtock, Piece 1 (photograph, Jens Auer, Wessex Archaeology).

to increase longitudinal strength. The triangular-sectioned plank closed the gap between furring timbers and frames and allowed re-planking of the hull. As a result of the furring process the vessel gained *c.* 300mm in width on each side. This increase in fullness is also reflected in the stem rabbet, where filling pieces were used to change the angle of the rabbet and accommodate the hood ends of the planks.

KEEL

Only a 1.82m-long fragment of the forward end of the keel is preserved (Fig. 5). One end is joined to the stempost with a flat vertical scarf joint; the other is broken. The keel is made of oak and is heavily eroded; moulded and sided dimensions appear to be *c.* 250–300mm. The upper 90mm of the moulded dimension is occupied by rabbets between 60 and 65mm deep. In addition to treenails and iron bolts securing the scarf joint, four vertical treenails were observed in the moulded side of the keel fragment. Their function is as yet unclear.

STEMPOST ASSEMBLY

The preserved part of the stempost has a total length of 4.86m (Fig. 6). The upper part of the post shows signs of a fresh break, while the heel is joined to the keel. The post has an average sided dimension of 200–250mm on the outside and 250–350mm on the inside. The average moulded dimension is 300mm. The stem rabbets are located between 120mm and 150mm from the outside of the post. They have an average depth of 65–70mm and an angle of *c*. 36 degrees. In the lower part of the post, the hood ends of a series of outer planks are fastened in the rabbet with a combination of treenails and iron nails. Toolmarks and cut treenails show that the rabbet angle was modified to reflect the ship's increase in fullness caused by furring. The stemson is fastened to the inside of the stempost with treenails and iron bolts. The visible length is 3.08m; the sided dimension on the inside is 550mm. The moulded dimension is *c.* 250mm. Filling pieces were used to close the gap between post and stemson and provide a smooth surface for planking. All elements of the bow are made of oak. As this section was left assembled, the apron and

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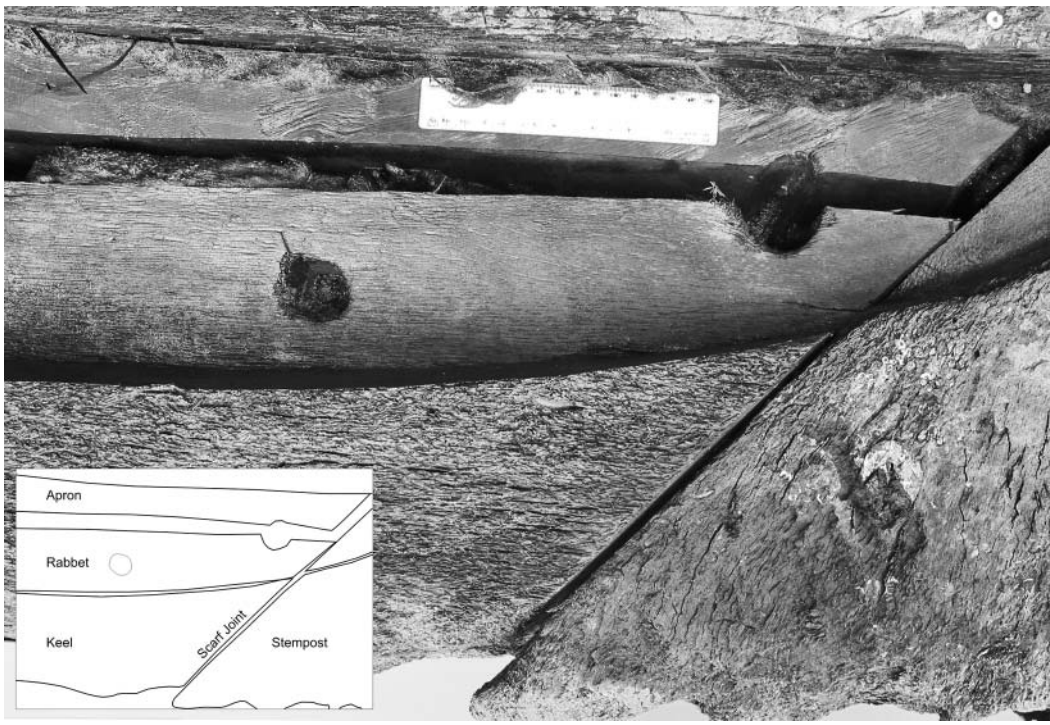

FIG. 5
The 'Gresham Ship': scarf joint between keel and stempost (photograph, Jens Auer, Wessex Archaeology).

the joint between apron and stemson cannot yet be described in detail; the section will be the subject of detailed recording in the post-excavation process.

FRAMING

All frames are of oak; they were either sawn or converted with an axe and then dubbed with an adze. Floor timbers, first futtocks and second futtocks, as well as filling frames, are preserved. While the size of the main framing components is fairly consistent, with average moulded and sided dimensions between 150 and 250mm, the filling frames at the turn of the bilge have sided dimensions of only 100–150mm. Floor timbers and first futtocks are joined with double or single non-trapezoidal dovetail joints (Fig. 7), secured with a single treenail through the centre of the joint. First and second futtocks and filling frames are not connected to other framing components.

PLANKING

The planks are of sawn oak; their lengths vary between 2m and 6m. The average plank width is 300–460mm; thickness varies between 50 and 70mm. All outer planks are joined with flat vertical scarf joints which are secured with treenails and up to four square-shanked iron nails (Fig. 8). The plank seams are waterproofed using a type of setwork rather than caulking. The lower edges of outer planks have been furnished with V-shaped or U-shaped hollow grooves which are filled with three strands of tarred animal hair. All knots in outer planks have been carefully removed and replaced with small wooden patches fastened with miniature treenails, or in some cases iron nails. On well-preserved planks, a white or cream-coloured surface covering could be observed, possibly so-called 'white stuff'.[11]

FASTENINGS

The outer planks are fastened with cleft and shaved oak treenails, 30mm in diameter. In most cases the outboard faces of the nails have been split in a V-shaped or cross-shaped pattern to receive caulking. The inboard faces are generally split and wedged. The joints between the planks and hood ends are fastened with iron nails or bolts. The iron nails used to secure plank joints are in most cases

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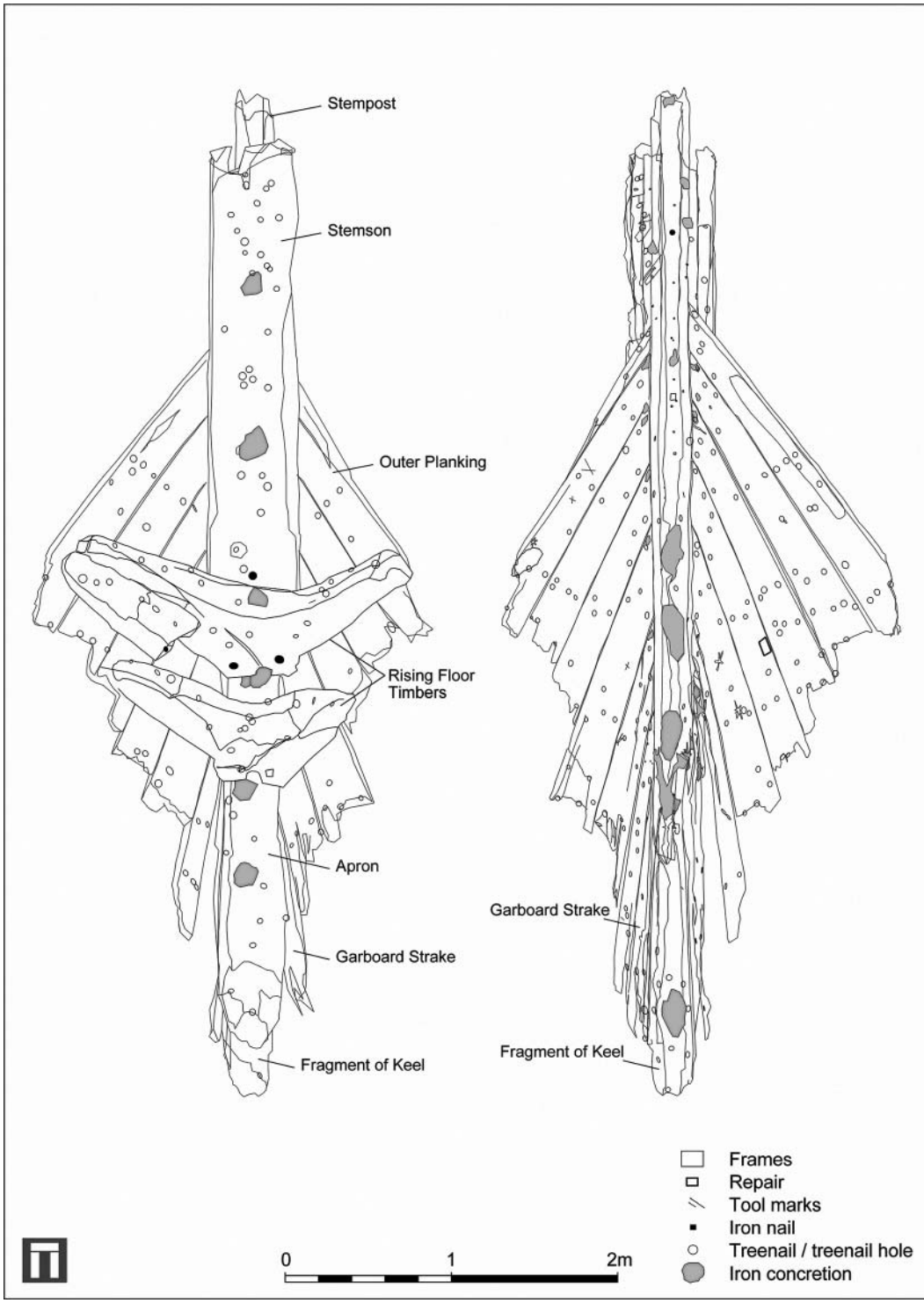

FIG. 6

The 'Gresham Ship': inside view and front view of the bow section (drawn by Kitty Brandon, Wessex Archaeology).

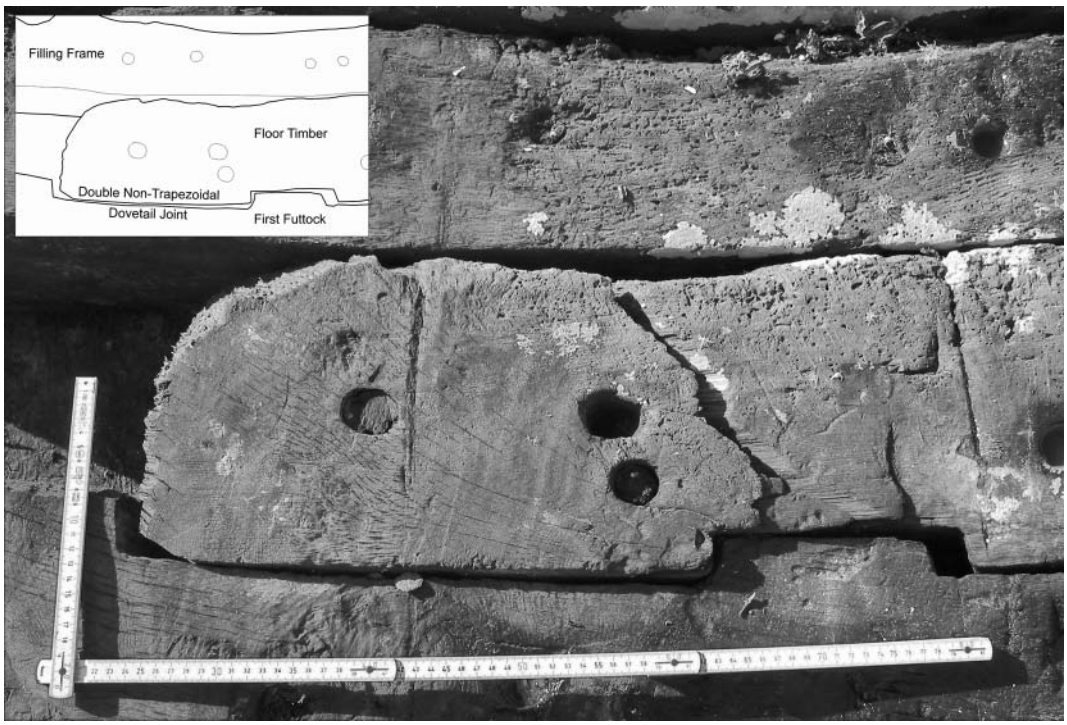

FIG. 7

The 'Gresham Ship': non-trapezoidal dovetail joint between floor timber and first futtock on Piece 3a (photograph, Jens Auer, Wessex Archaeology).

countersunk, and the holes plugged with tar and caulking material.

DECK CONSTRUCTION

The construction of the orlop deck is visible on Piece 3b (Fig. 9). Recesses show where two deck beams measuring 0.20 × 0.20m rested on the shelf clamp. A 2.34m-long half beam clamp or carling is set between the beams. Mortises of varying size, spaced 0.36m apart, indicate the positions of half-beams or ledges. The edge of the waterway is preserved above the carling. No evidence for hanging knees could be found and it is currently assumed that the deck construction was reinforced with the help of lodging knees.

GUNPORTS

Two gunports situated above the orlop deck show that the 'Gresham Ship' was armed. The ports are spaced 2.5m apart and are located 0.70m above the orlop deck. The fully preserved forward gunport is 0.40mm wide. Owing to erosion, the gunport height cannot be established.

THE ARMAMENT

Altogether, four guns were recovered from the site. A wrought-iron breech loader (Fig. 10) was found among the grabbed material. It was well preserved in a heavy concretion, which was partly removed. Two lifting rings are positioned centrally on the barrel of the gun, one of which preserves remains of cordage, and another piece of cordage was wrapped around the muzzle end. Near the breech end, and in front of the lifting rings, are pairs of straps for riveting the barrel to the wooden carriage. Fragments of the carriage are preserved in the concretion. The gun is 1.24m long and has a 0.13mm bore. The wrought iron breech chamber is 0.37m long and had an apparent calibre of 75mm. The touch-hole is trapezoidal and was fashioned from two iron sheets.

A cast-iron muzzle loader also formed part of the grabbed material. This gun is 2.32m long and has a 80mm bore. No markings are visible and the button end of the cascabel is missing.

Two further cast-iron guns were recovered during the Phase III excavation. One of them

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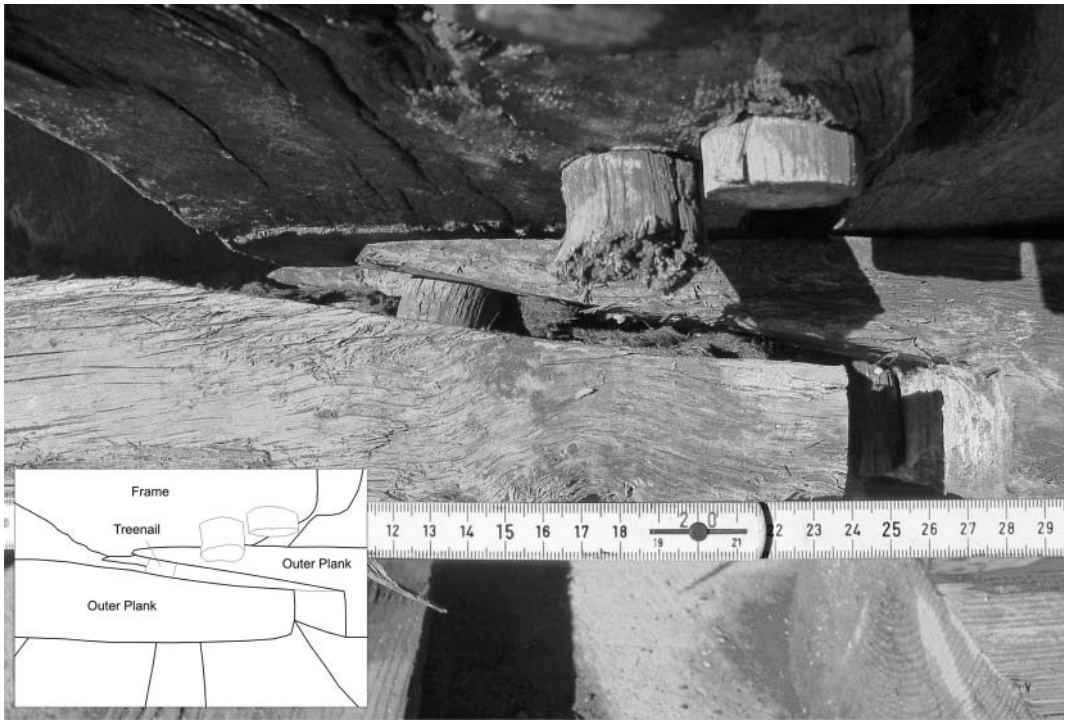

FIG. 8
The 'Gresham Ship': a vertical scarf joint between two outer planks (photograph, Jens Auer, Wessex Archaeology).

remains heavily concreted; it is *c.* 2.3m long and has a 80mm bore. The second, 2.2m long and with a bore of 76mm, has been recorded in more detail. Its first reinforce is marked with the moulded initials 'TG', the incised numbers '8-0-0' and the moulded emblem of a grasshopper (Fig. 11). The initials and emblem allow the identification of the founder, the Elizabethan financier and merchant Sir Thomas Gresham, who owned a gun foundry in Mayfield in the Weald from 1567 to his death in 1579. He was involved in arms export and is known to have founded guns for the King of Denmark and others.[12] The number '8-0-0' specifies the weight as 8cwt [406kg]; the gun is a rare example of an early English small saker.[13] Adjacent to one of the guns, parts of an elm gun carriage were found.

FITTINGS AND ARTEFACTS

Apart from an anchor, which was recovered by grab in 2003, very little of the ship's fittings or equipment survives. The anchor is made from cast iron, is 3.13m long and originally had a beam of 1.72m. The ring is missing; one arm is broken off 180mm from the shank, which is slightly bent. When raised, the anchor was still fitted with its 3.11m long, slightly double-tapered, wooden stock. This is made from two symmetrical halves treenailed together around the anchor shank.

Most of the small finds recovered from the wreck site are still concreted and awaiting treatment. Notable among them are a pewter candleholder (Fig. 12), leather shoes and parts of leather garments (Fig. 13), a wooden pike shaft with iron head and a fragment of a Spanish olive jar.

CARGO

The ship's cargo consisted of iron bars and ingots of lead and tin. While other cargo might have been present, no archaeological evidence for this has yet been found. Two types of iron bar were found (Fig. 14). The first is narrow with a square section of 30 × 30mm, folded four times to lengths between 1.9m and 2m, with an unfolded length of 6m. The

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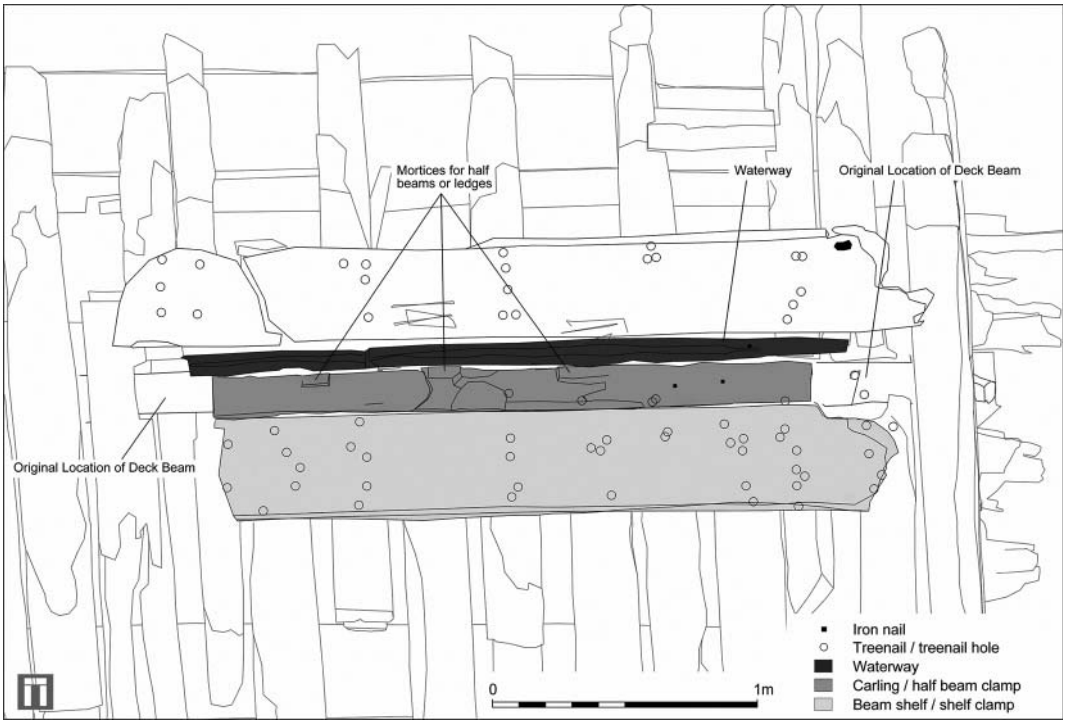

FIG. 9

The 'Gresham Ship': elements of the orlop deck construction on Piece 3b (drawn by Kitty Brandon, Wessex Archaeology).

second type has a rectangular section of 30 × 80mm and is folded once at the centre. The origin of the iron bars has not been identified.

The lead ingots are boat-shaped (Fig. 15). They measure *c.* 600 × 220 × 120mm and have an average weight of 56kg. The upper surface of each ingot has been stamped up to seven times, presumably with a maker's mark. Their provenance is unknown.

The tin ingots (Fig. 16) measure 520 × 16–18mm and have a trapezoidal cross-section. Their provenance is also unknown.

PRELIMINARY INTERPRETATION

As noted above, dendrochronological dating indicates that the 'Gresham Ship' was built soon after 1574 from English oak. The origin of the timbers used for the construction is likely to be East Anglia — perhaps Essex. The vessel was carvel-built. The joints between floor timbers and first futtocks suggest a construction in the so-called 'frame-first' method. The vessel was subject to 'furring', possibly during the initial construction process. This resulted in an increase in fullness of *c.* 300mm on either side of the ship. Archaeological evidence suggests that the vessel was a small- to medium-sized ocean-going armed merchantman. The lowest deck in the ship, the orlop deck, also served as a gun deck. While a full hull analysis and reconstruction of the ship are still outstanding, the preserved hull sections allow a preliminary estimate of its original size. Currently a keel length of 15–20m and a tonnage of *c.* 150–250 tons are assumed. More specific statements will only be possible after a detailed study of the hull remains. The depiction of the small merchantman *Emanuell* of 200 tons with a beam of 26ft [7.92m], in Matthew Baker's 'Fragments of Ancient English Shipwrightry'[14] can serve as a model for the original appearance of the 'Gresham Ship' (Fig. 17).

Although no historical sources regarding the loss of a vessel in the Thames at the end of the 16th century have yet been found, reports of salvage by divers in 1846 might be associated with

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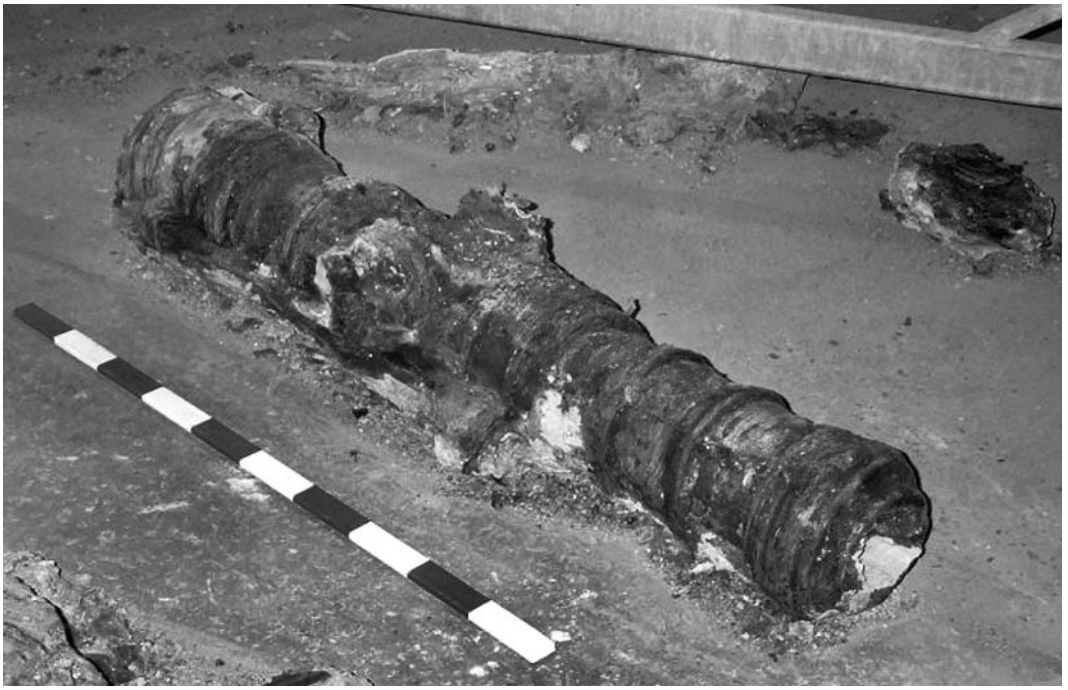

FIG. 10
The 'Gresham Ship': wrought-iron gun (photograph, Mikkel Thomsen, Wessex Archaeology).

the 'Gresham Ship'. The *Whitstable Shipping and Mercantile Gazette* of 2 May 1846 mentions Whitstable divers salvaging six guns, tin, iron and lead from a wreck on the Girdler Sand,[15] which is immediately adjacent to Princes Channel. The *Journal of the British Archaeological Association*[16] also reported Elizabethan artefacts found in the wreck including a knife, a leather shoe and a silk doublet. The iron guns were described as of 'very ancient date'; a total of 2,700 tin ingots were lifted. Iron bars, lead pigs and red lead in casks are also mentioned. The location of the wreck is not specified, but the depth is given as four fathoms [7.4m] at low water, which is consistent with the depth of the wreck site in Princes Channel. Although there is no proof that the salvage of 1846 took place on the 'Gresham Ship', the description of the location and the material lifted makes this likely. Previous salvage would explain the relatively small amount of cargo found on the site and the rope around the lifting rings of the wrought iron gun. The six guns lifted in 1846 would also bring the total armament of the ship up to ten guns, a number consistent with the estimated size of the vessel.

It also seems likely that the wreck was known to fishermen. One of the items recovered during clearance work in 2003 was the iron skid from one side of a beam trawl that presumably had snagged on an obstruction. The wreck may also have been known to the PLA in earlier decades; there is a tantalizing reference in 1967 to diving inspection of a previously uncharted wreck that is 'fairly large . . . and rises about 15ft [4.6m] above the seabed' in Princes Channel, where 'the changeable nature of the Girdler Sand presents special problems'.[17]

CONCLUSIONS

The 'Gresham Ship' is a significant wreck on several levels, bearing comparison with — and possibly warranting re-evaluation of — other wrecks around the UK and abroad. Since it is a rare example of the relatively well-preserved structure of a small English-built merchant ship of the Elizabethan period, and the only known archaeological example of the practice of 'furring', the wreck can provide insights into many aspects of shipbuilding, from the sourcing and working

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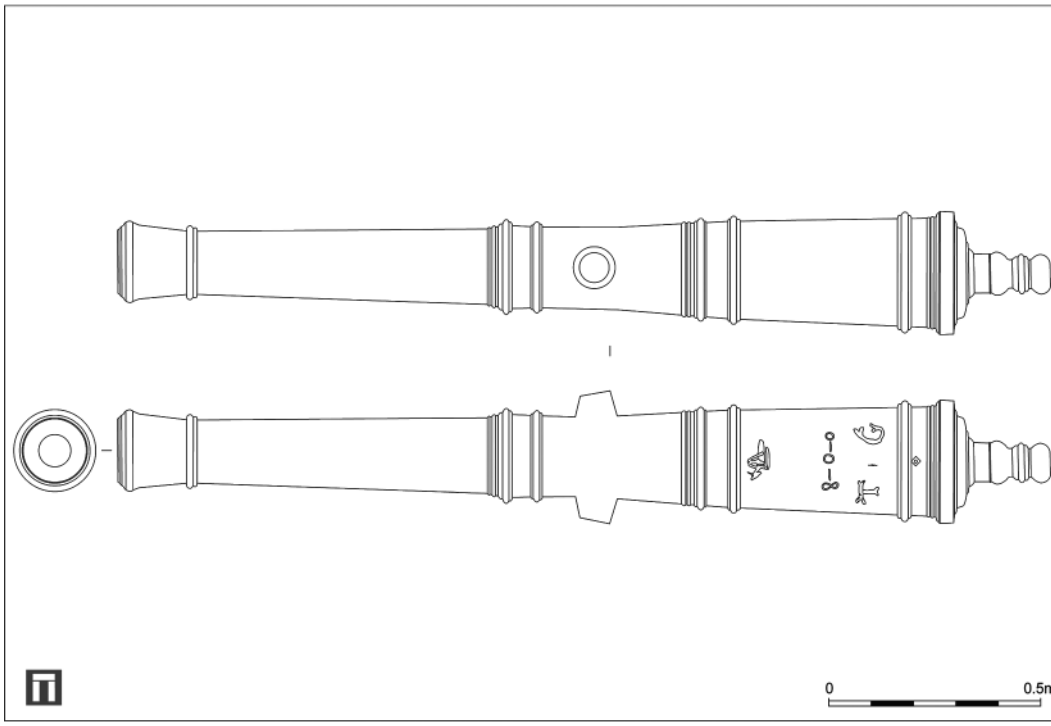

FIG. 11
The 'Gresham Ship': the small saker founded by Thomas Gresham (drawing, Frank Mallon, Jens Auer and Kitty Brandon, Wessex Archaeology).

of timber, to shipyard practices, and to broader questions of the influence of different building traditions in Atlantic Europe at a time of change. The arming of the vessel has a bearing not only on an understanding of the design, construction and fitting-out of the ship, but also on the industries and technologies being developed to furnish iron guns, both wrought and cast. The recovery of the Gresham gun not far from its origin in the Weald is a reminder that in the 16th century ships such as this linked activity in Kent, Essex and London to an expanding world. Further analysis of the Gresham link, the range of cargo, and the small finds assemblage that is still largely hidden in concretion, may evince some of the political, economic and social factors in the ship's use. We do not yet know what caused the sinking of the ship. The commonplace nature of both the ship and its last journey may add to the importance of the find. Although their relation to this wreck are not certain, the records of 1846 and 1967, and the recovery of old fishing gear, may provide insight into the processes that both allow the survival of such wrecks, and cause their deterioration, especially in dynamic environments like the sandbanks and channels of the Thames.

Finally, the experience gained through these investigations is important as an example of marine development-led archaeology in a demanding offshore environment. Some difficulties in conducting such investigations and providing properly for their consequences are still unresolved; they go well beyond the specific instance of the 'Gresham Ship' and the scope of this paper. Nonetheless, valuable practical lessons were learned — for example, in developing a staged approach to investigation, in integrating geophysical, diver-based and shore-based recording, and in using an explicit research framework to inform fieldwork priorities. Furthermore, the PLA was quick to understand the implications of this discovery for its own activities. By carrying out strategic work on the archaeological potential of wrecks within the Thames, providing archaeological awareness training to staff, and engaging English Heritage and the Receiver of Wreck in discussions, the PLA

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FIG. 12

The 'Gresham Ship': pewter candle-holder (photograph, Jens Auer, Wessex Archaeology).

now provides a lead in the port industry in the integration of archaeological considerations within its day-to-day operations.

Much remains to be discovered. The 'Gresham Ship' is subject to a five-year post-excavation programme that started in October 2007, co-ordinated by University College London.

APPENDIX 1: CARVEL CONSTRUCTION AND TERMINOLOGY

The 'Gresham Ship' was constructed using the carvel process, characterized by the fixing of planks to a pre-formed skeleton of frames. The planks are laid edge-to-edge to provide a smooth outer surface to the hull, in contrast to the clinker process, in which planks overlap and are fixed to each other to form the hull, into which frames are then fixed.

The first element of a carvel ship's skeleton is the keel, which runs horizontally along the intended length of the ship to form a 'backbone'. Vertical elements are fixed to the keel at the front (the stempost) and the rear (sternpost). The 'ribs' of the ship consist of a series of frames. Each frame is U-shaped and is composed of numerous individual timbers. The bottom of the U is a floor timber which crosses from one side of the ship to the other. Generally speaking, the floor timbers of a vessel like the 'Gresham Ship' are centred on and fixed to the keel.

FIG. 13

The 'Gresham Ship': parts of leather garment (photograph, Jens Auer, Wessex Archaeology).

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FIG. 14

The 'Gresham Ship': examples of iron bars (photograph, Jens Auer, Wessex Archaeology).

The bottom of the ship is the bilge; the point at which the bottom starts to turn up to form the side is the 'turn of the bilge'.

The frame elements that are fixed to either end of each floor, to extend the frame up the sides of the U, are known as futtocks. Those fastened to each end of the floor are the first futtocks; second futtocks are fastened to the first to take the sides higher, and so on. In many vessels, frames are 'paired': each U is formed from two parallel Us fastened to each other; the timbers of each frame are shaped in such a way that the joints in one frame are overlapped by the timbers of the other, like Flemish bond in a brick wall. Framing timbers are often characterized by the dimensions of their cross-section; looking along the hull, parallel with the keel, the thickness of each rib is the 'moulded' dimension, which gives the shape of the hull. Looking out of the hull, perpendicular to the keel, the distance of each frame from side to side is the 'sided' dimension.

The framing timbers at the bottom of the U are covered by planks running along the length of the ship called ceiling planks. These planks form the floor of the hold.

At the bow and stern, where the hull of the vessel is drawn in and becomes more vertical, the U shape gives way to floor timbers that are V- or even Y-shaped, known as rising floors. Framing elements at the bow that are centred on and fixed to the stem are called breasthooks. The joint between the keel and stempost is strengthened by a timber known as an apron. Further strengthening along the length of the ship is provided by a run of timbers that make up the keelson, which lies on the line of the keel, over the floors. Similarly, the stemson is a timber that lies behind the timbers of the stem.

The planking forms continuous lines from stem to stern; each line is called a strake and is built from several planks fixed end to end. The first strake on each side of the keel is called the garboard strake. The keel is rebated

FIG. 15
The 'Gresham Ship': example of lead ingot, with marks (photograph, Jens Auer, Wessex Archaeology).

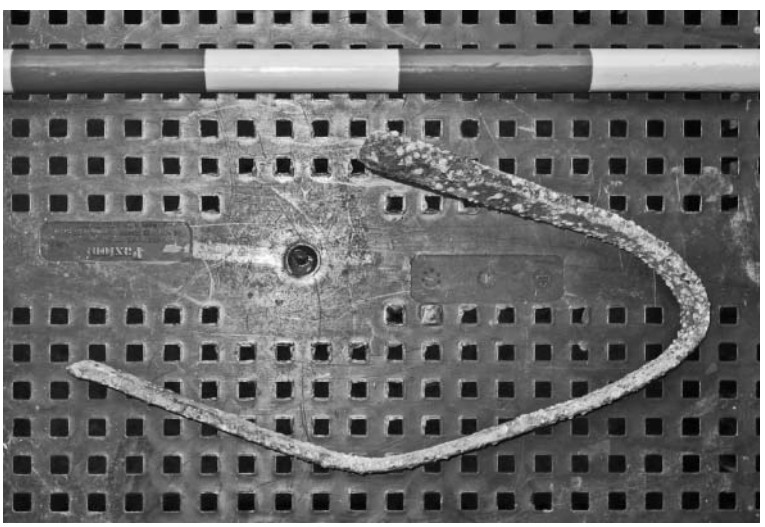

FIG. 16
The 'Gresham Ship': example of tin ingot (photograph, Jens Auer, Wessex Archaeology).

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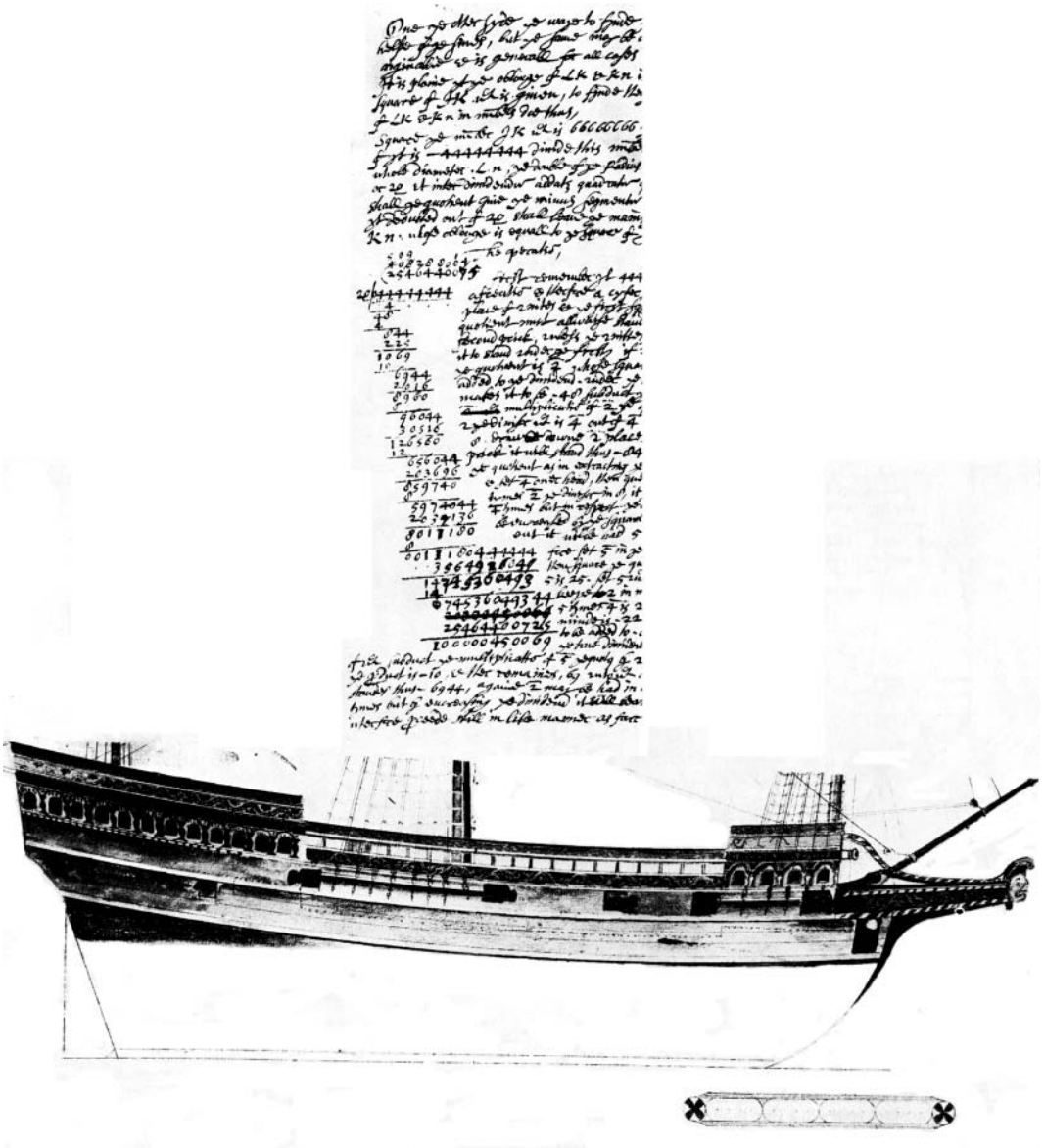

FIG. 17

The ‘Gresham Ship’: drawing of the ship *Emanuell* from ‘Fragments of Ancient English Shipwrightry’ (© Pepys Library, Magdalene College, Cambridge).

on each side to take the garboard strakes; the rebate is known as a rabbet. There are also rabbets in each side of the stempost to take the ends (‘hood ends’) of the strakes of planking.

While most strakes of planking are of uniform thickness, some of the ones above the waterline are thicker, to increase the strength of the hull and to provide protection when alongside a quay or another vessel. These thicker strakes are known collectively as a wale, which may consist of several strakes; there may be more than one wale.

Internally, the vessel is divided by decks. The lowest, forming a roof to the hold and acting as a gundeck on the ‘Gresham Ship’, is the orlop deck. There are several ways of supporting decks; this ship has a beam-shelf — a timber that runs along the length of the

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vessel and is fastened to the inside of the frames. The beam-shelf is cut to take the principal deck beams, which run across the ship. A timber known as a beam clamp or carling is fixed on top of the beam-shelf between the beams, and is cut to take secondary half-beams (ledges) which also run across the ship and, together with the principal deck beams, support the deck planking. This planking is faired into the side of the vessel by a timber, roughly triangular in section, called a waterway.

Strengthening within the hull and to the decks is often provided by right-angled timbers called knees. Where these are fixed vertically (to help carry a deck beam where it meets the side of the vessel, for example), they are known as hanging knees. Where they are fixed horizontally (so the right angle will be visible in plan view) they are known as lodging knees. Further strengthening to the hull is provided by timbers known as stringers that are fastened inside of the frames and run along the length of the ship. Various chocks and filling pieces are often used to make up gaps and add to the overall structure.

Although it relates to a vessel of 1605, about 30 years later than the 'Gresham Ship', Lavery's reconstruction of the *Susan Constant*[18] provides an accessible introduction to the construction and fitting of a broadly comparable vessel.

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NOTES

[1] Firth 2006.
[2] Admiralty Chart no. 1607, Thames Estuary Southern Part.
[3] Wessex Archaeology 2003.
[4] Wessex Archaeology 2004a.
[5] Wessex Archaeology 2004b.
[6] Nayling 2004.
[7] Watson & Gale 1990.
[8] Wessex Archaeology 2004c.
[9] Wessex Archaeology 2005.
[10] Mainwaring & Perrin 1922.
[11] Lavery 1987, 57.
[12] Teesdale 1991, 128.
[13] Nicholas Hall, Royal Armouries, pers. comm. 2004.
[14] Magdalene College Library, Cambridge, Pepys 2820.
[15] We are grateful to John Bevan for this reference.
[16] Anon. 1846.
[17] Anon. 1967.
[18] Lavery 1988.

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