

# *Angra B*: the Lead-sheathed Wreck at Porto Novo (Angra do Heroísmo, Terceira island, Azores-Portugal)

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**A B S T R A C T**

The Institute of Nautical Archaeology (INA) was able to dive and tentatively examine a wooden wreck in the Porto Novo area of Angra bay, during a 1996 underwater campaign. The site designated as *Angra B* – or Lead-Sheathed wreck – was comprised of a major ballast pile of stone roughly 15 m x 15 m and substantial wood remains, fastened by iron fasteners in conjunction with treenails. The Lead-Sheathed wreck proves to have some interesting features not readily seen in the archaeological record such as a primary ballast, a type of concrete that looks to have flowed between the frames, an interesting feature up to now dated to the seventeenth century and that may hint at a ship built in the Biscay region of Spain.

The major timber dimensions of *Angra B* also fit within the spectrum of known data from Spanish and Portuguese wrecks in the New World from both the sixteenth and seventeenth centuries. Fastening patterns observed on the *Angra B* wreck lend support to this range of dates.

**R E S U M O**

Durante uma primeira campanha de arqueologia subaquática, em 1996, arqueólogos do Institute of Nautical Archaeology (INA) tiveram a oportunidade de mergulhar e examinar uns destroços de madeira na área de Porto Novo, na baía de Angra do Heroísmo. O local então designado por *Angra B* – ou o navio forrado de chumbo – compunha-se de um monte de pedras de lastro de cerca de 15 x 15 m, cobrindo estruturas de madeira do navio, fixadas

simultaneamente por cavilhas de ferro e por cavilhas de madeira. Os destroços estão forrados a chumbo e têm interessantes características que não são detectáveis à primeira vista, como um lastro primário, de um tipo específico, que parece ter escorrido por entre o cavername, o que constitui um traço interessante até agora datado do século XVII e que parece indicar um navio construído na região espanhola da Biscaia.

As dimensões das maiores madeiras de *Angra B* também se encaixam no leque de dados conhecidos sobre destroços espanhóis e portugueses dos séculos XVI e XVII no novo mundo. Os padrões de cavilhamento observados nos destroços de *Angra B* sustentam esta datação.

## Overview

*Angra B* or the "Lead-sheathed Wreck" is one of the three known wrecks in the Porto Novo area of Angra Bay (fig. 1). The site lies beneath 5 meters of water and is comprised of a stone ballast pile measuring roughly 15 m in length by 11 m in width. A substantial portion of a wooden hull, of approximately the same dimensions as the ballast mound, lies beneath the stones. A second, smaller ballast pile to the north-west of the primary ballast mound suggests that the ship struck the large boulder adjacent to the wreck site and broke in two.

The wreck remains beneath the principal ballast mound consist of the keel and one side of the hull. The bow and stern of the wreck have not yet been determined due to the lack of endposts or characteristic features. Identifiable timbers protruding from beneath the ballast at the southern end of the site include the keel, frame floors and futtocks, interior (or 'ceiling') planking, stringers, and outer hull planking. The name of the site was suggested by the numerous crumpled pieces of sheet lead seen around the site, as well as lead oxidation found on the keel.

Preliminary examinations of the wreck by the MAH\*/INA\*\* team were made in 1996 on September 16, and further limited measurements were taken on September 18 and 21. Our hull inspection was limited to the southern end of the primary ballast mound due to the accessibility of the timbers in this location.

## Hull Timbers

The extant remains of the keel measure approximately 15 m in length and are oriented along a north-south axis (Fig. 2). The portion of keel exposed by hand-fanning at the southern end of the wreck was 17 cm moulded by 27 cm sided. The timber surfaces were extremely eroded, but indications of a rabbet were apparent about 7 cm below the top of the keel. Bolts or other types of large fasteners for attaching the frames and keelson to the keel were not observed at this time. The exposed section of keel was covered by a soft blue-grey coating that was almost certainly lead oxide produced by the deterioration of lead sheathing. Small nail holes with bits of lead around them could also be seen on the side of the keel.

Ten frames were exposed at the southern end of the ballast mound; all of them were eroded near the keel and on most of their upper surfaces. Frames 8, 9 and 10, the northernmost exposed frames, exhibited evidence of having a flat upper surface near the keel and then sloped downward to where they disappear under the ceiling planking. The extent of ballast and sand

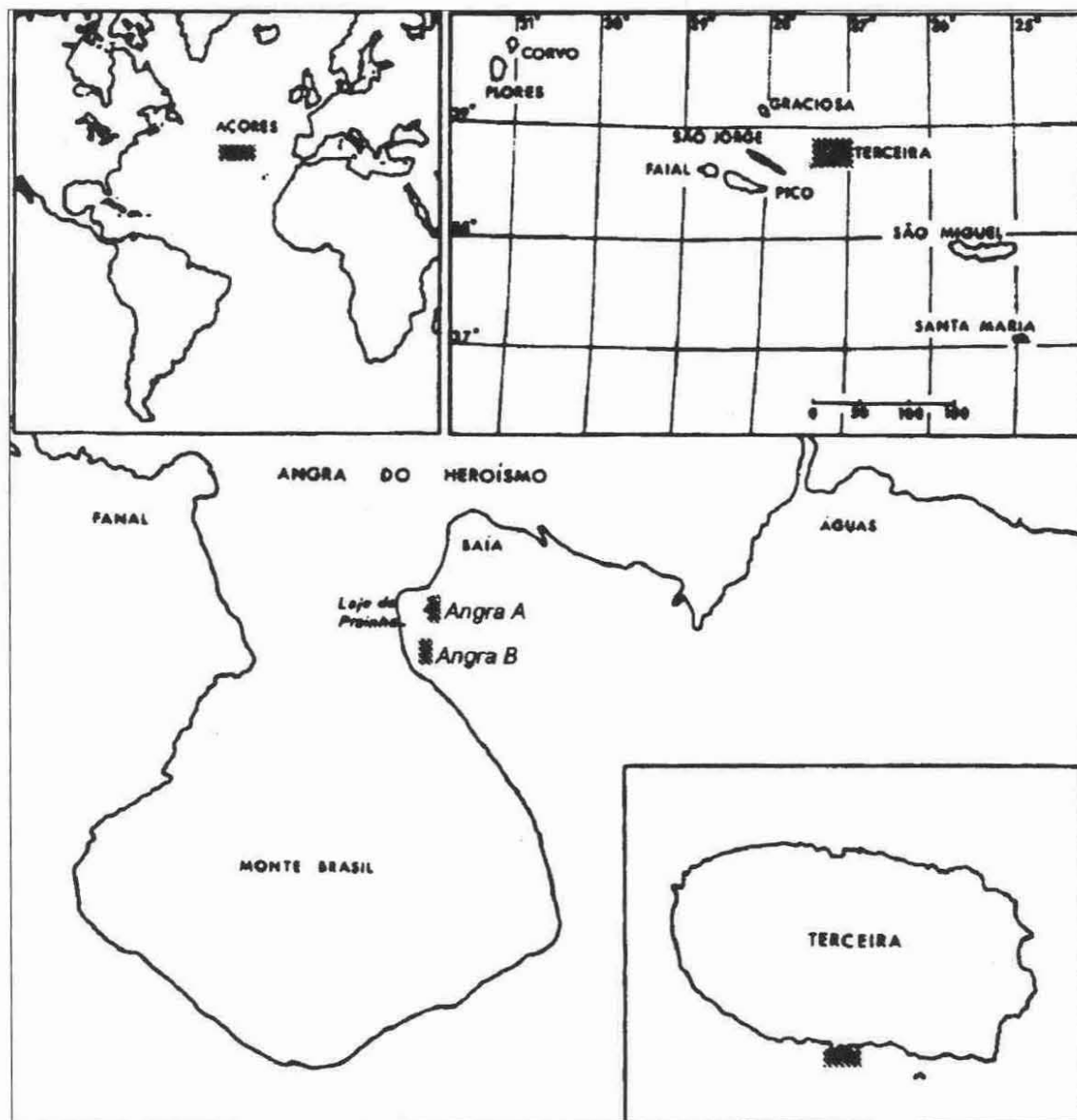


Fig. 1

THE LEAD-SHEATHED WRECK

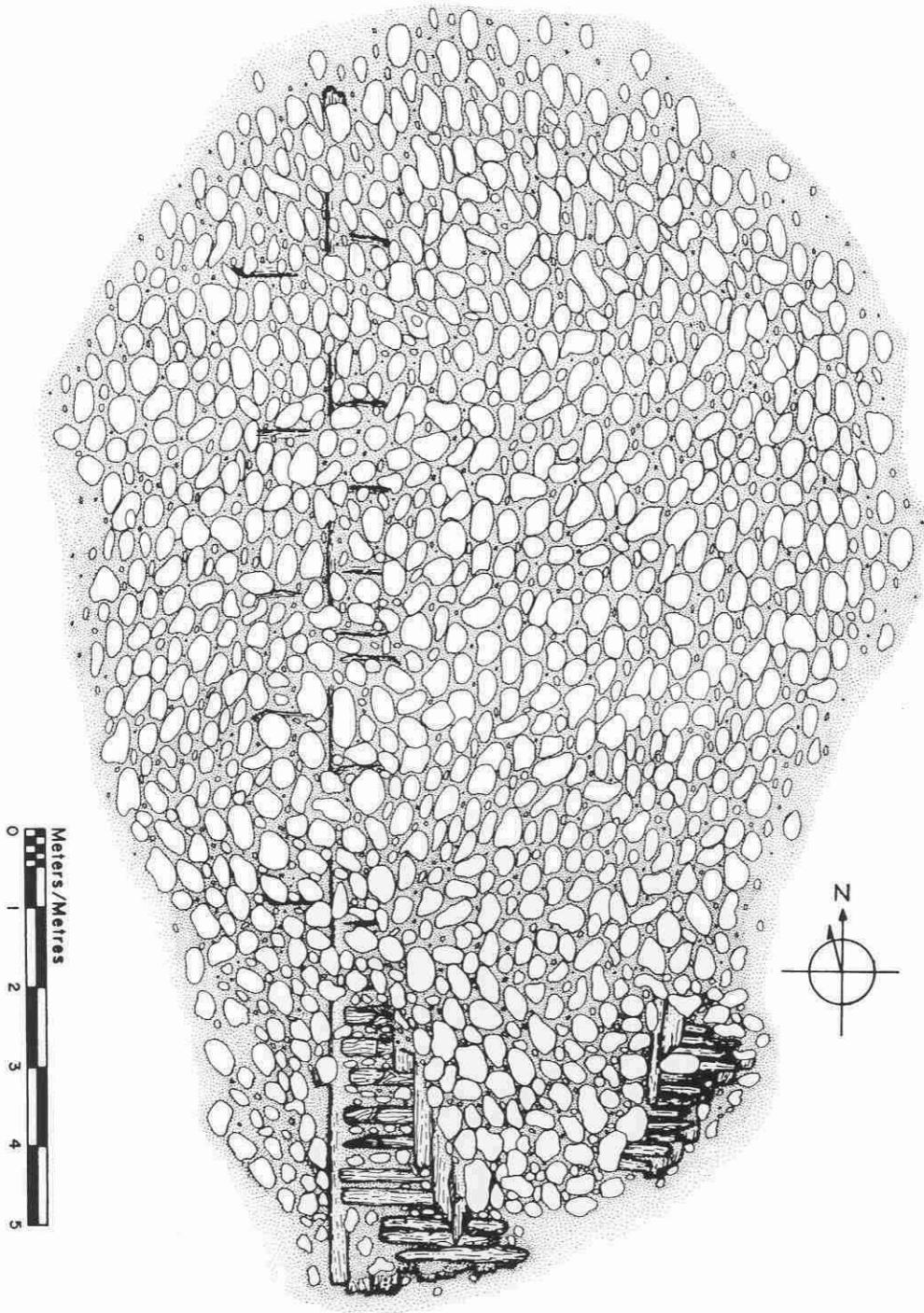


Fig. 2

on the site made it possible to accurately record only the sided dimension of these timbers. The frames ranged from 13 cm to 25 cm sided; a moulded dimension of 20 cm was recorded at frame 1, the southern-most exposed frame, but due to the deteriorated nature of this frame this dimension can be regarded as only approximate. Frame spacing, measured from center-to-center, averages 37 cm. Evidence of both treenails and iron fasteners was preserved on some of the timbers. The futtocks seen in the south-east side of the plan were measured only in relation to the other elements of the wreck and no specific dimensions were recorded. The overlap of the frames and futtocks was not readily observed and descriptions of the fasteners were not recorded.

Four ceiling planks and two stringers were also exposed *in situ* at the south end of the wreck. The ceiling had an average width of 26 cm with a thickness of 5 cm. Stringer 1, nearest the keel, was 19 cm sided and 11,5 cm moulded while stringer 2, outboard of stringer 1, was only 14 cm sided. Evidence of iron nails and treenails were observed on ceiling plank 1, the innermost ceiling, over frame 9. The use of both iron nails and treenails to fasten ceiling planking to frames appears to be infrequent, although the fragmentary remains of the early 16th century Molasses Reef Wreck did have one ceiling plank fastened with a treenail.<sup>1</sup>

Eight outer hull strakes were observed and recorded including the garboard. The garboard did not appear any thicker than the other strakes measured, so has not been dealt with separately. The average width of the strakes was 27 cm and they possessed an average thickness of 5 cm. Iron fasteners in conjunction with treenails were observed on the second and third strakes outboard of the keel. The fastening pattern of 2 or 3 iron nails and one treenail suggest that these were the butt ends of the planks. The practice of using both iron nails and treenails to fasten exterior planking seems to have been fairly common in the 16th and 17th centuries; examples of wrecks with this combination of fasteners include the early 16th century Molasses Reef and Highborn Key wrecks, the Basque whaler *San Juan* (sunk in 1565), and the *San Martin* (sunk in 1618).<sup>2</sup> According to one contemporary source shipwrights in France and other northern European countries preferred to use only treenails for fastening outer planking, while Portuguese shipwrights favoured fastening planking entirely with iron nails.<sup>3</sup>

### Fasteners

The iron fasteners recorded were square in cross-section and measured about 1 cm on each side. The treenails were of an undetermined wood type and averaged 2.5 cm in diameter. Several examples of small copper nails or tacks, presumably used to fasten the lead sheathing to the outer planking, were found around the south end of the wreck. Two of them were measured, and were found to be 4 mm square in section and 3 cm in length.

### Ballast

The ballast received only cursory study during the 1996 survey, but an interesting feature discovered on the wreck may hint at the use of a *primary* ballast. A type of concrete was discovered between frames 2 and 3, on the east side of stringer 1 at frame 3 and on the end of strake 3. The concrete appears to have flowed between the frames in a liquid form and then hardened. We know from the building contract of *Nuestra Señora de Atocha* (built 1620), translated by

Eugene Lyon, that ballast of a similar type was used in the early 17th century. The contract states:

The lower hull and crutches from stem to stem must be filled with lime and sand and gravel of small pebbles between frame and frame, and above it they must place the planking of the ceiling, from stem to stem up to the extreme end floor timbers.<sup>4</sup>

A fine ballast of this type was observed during the excavation of the *Nuestra Señora de Santa Margarita* (sunk 1622) and the *San Martin*.<sup>5</sup> A further similarity was that these ships were all built in the Biscay region of Spain. *Atocha*, *Santa Margarita*, and *San Martin* all demonstrate that the use of concrete ballast between frames was a common practice in the early seventeenth century, but we do not yet know when this practice began and when it terminated.

### Lead Sheathing

As previously noted, many crumpled pieces of sheet lead were found around the exposed timbers at the southern end of the 'primary ballast mound, and the keel exhibited a layer of what appeared to be lead oxide as well as tack holes with bits of lead around them. The discovery of sheet lead is not very surprising, since lead in various forms was commonly used for many centuries in the construction and maintenance of wooden ships. The *San Esteban* (sunk 1554), for example, had strips of lead tacked into its plank seams to secure caulking of oakum and resinsoaked cloth; the wreck of the *Santa Maria de Yciar* (also sunk in 1554) yielded small lead patches that were probably used to cover leaks in the outer planking.<sup>6</sup>

The practice of entirely sheathing a hull in lead first appeared in the Mediterranean in the 4th century BC (if not earlier), and continued until the 1st century AD. The primary purpose of the lead sheathing used at this time was to render hulls watertight by covering (and thereby preserving) an inner coating of resin-impregnated fibers; the sheathing did, of course, have the secondary effect of protecting timbers from marine borers and fouling. Changes in shipbuilding technology and in the economics of ship construction and ownership resulted in the abandonment of lead sheathing after the 1st century A.D., although sheet lead remained in use throughout the Roman and Medieval eras for patching or minor repairs.<sup>7</sup>

The Portuguese and Spanish voyages of discovery during the 15th and early 16th centuries AD exposed European ships to warm tropical seas where they were consumed at an alarming rate by the wood-boring marine worm known as *teredo navalis*. During his fourth voyage of discovery from 1502 to 1504, Christopher Columbus had to abandon three of his four caravels when "...all of the people with pumps, kettles, and other vessels were insufficient to bail out the water that entered by the worm holes."<sup>8</sup> If ships were to last more than one or two tropical voyages, shipwrights were forced to devise new means of repelling teredos, or at least slowing the rate at which they infested a ship's bottom. One solution to the problem was to sheath a hull below the waterline with lead. The earliest reference to covering a hull with sheet lead dates to 1513, when a Spanish expedition to the New World under the command of Pedrarias Dávila was ordered to sheath its caravels before departure. Although caravels were typically rather small vessels, each required between one and two tons of lead.<sup>9</sup>

The historical and archaeological record suggests that during the 16th century lead sheathing was commonly, but not universally, applied to Portuguese and Spanish ships voyaging to the East and West Indies. There were drawbacks to lead that made it less than ideal for ships' bottoms. The English sailor Sir Richard Hawkins, writing around 1600, observed that lead sheathing

was limited to Iberian ships: "...besides the cost and waight, although they use the thinnest sheet-lead that I haue seene in any place, yet it is nothing durable, but subject to many casualties." He advocated other methods for discouraging teredos, including charring the outer planking and then covering it with pitch, or nailing half inch-thick (1,27 cm) elm sheathing over a thick coating of tar and hair. Hawkins thought the latter approach to worm repelling the cheapest and most effective available.<sup>10</sup>

Archaeological examples of lead-sheathed Spanish ships include the *San Martin* (1618) and *Santa Margarita* (1622), both of which left many crumpled pieces of sheet lead scattered around their wreck sites (the lead was obviously stripped away as the ships grounded).<sup>11</sup> The one example of a non-Iberian lead-sheathed ship that we have encountered was the Dutch East Indiaman *Mauritius*, which was lost off the coast of Gabon in 1609. The builders of *Mauritius* protected the vulnerable lead sheathing by nailing a sacrificial layer of 3 cm-thick pine planks over the lead.<sup>12</sup> The practice sheathing ships with lead appears to have continued into the 17th century, and possibly in a very limited manner into the 18th century as well. More research on this subject is clearly necessary.

## Discussion

Our limited exploration of the Lead-sheathed Wreck in 1996 revealed interesting features not commonly seen in the archaeological record. Evidence of both primary ballast and lead sheathing has only been recorded on two seventeenth century wrecks, the *Santa Margarita* and the *San Martin*, and unfortunately neither of these wrecks have been studied systematically. The limited knowledge we have at this time suggests that the Lead-sheathed Wreck at Porto Novo is very likely Iberian in origin, and probably dates to the 16th or 17th centuries. The dimensions of the principal timbers fit within the range of dimensions from Spanish and Portuguese wrecks in the New World dating to both the 16th and 17th centuries. Fastening patterns observed on the Lead-sheathed Wreck lend support to this range of dates. Planking thickness, on the other hand, is thinner than for all of the seventeenth century wrecks and suggests we may be looking at a vessel similar in size to those excavated from the sixteenth century. A more detailed study in the future would undoubtedly provide more data for evaluation and dating of the site.

\*MAH - Museu de Angra do Heroísmo

\*\* INA - Institute of Nautical Archaeology

## NOTES

<sup>1</sup> OERTLING, 1989, p. 5-235; KEITH, 1988, p. 60.

<sup>2</sup> OERTLING, 1989, p. 235; GRENIER, R.; LOEWEN, B.; PROULX, J.-P., 1994, p. 139; MOORE & MUIR, p. 192.

<sup>3</sup> GRENIER, R.; LOEWEN, B.; PROULX, J.-P., 1994, p. 139.

<sup>4</sup> MOORE, 1988, p. 14.

<sup>5</sup> MOORE & MUIR, p. 192-193.

<sup>6</sup> ROSLOFF, J.; ARNOLD III, J. B., 1984, p. 293; Personal Communication, Dr. D.L. Hamilton, Nautical Archaeology

Program, Texas A&M University, 1996.

<sup>7</sup> HOCKER, F. M., 1989, p. 197-206.

<sup>8</sup> SMITH, 1988, p. 40.

<sup>9</sup> HARING, 1964, p. 277-278.

<sup>10</sup> HAWKINS, 1933, p. 80-82.

<sup>11</sup> MOORE & MUIR, p. 193-194.

<sup>12</sup> L'HOUE, M.; LONG, L.; REITH, E., p. 65.

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