Experiencias de intervención e investigación: buenas prácticas, alianzas y amenazas IV

Especialización en Patrimonio Cultural Sumergido
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Universidad Externado de Colombia

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história territórios comunidades
CENTRE FOR FUNCTIONAL ECOLOGY SCIENCE FOR PEOPLE & THE PLANET
INSTITUTO DE HISTÓRIA CONTEMPORÂNEA
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INSTITUTO DE ARQUEOLOGIA E PALEOCIÊNCIAS IAP
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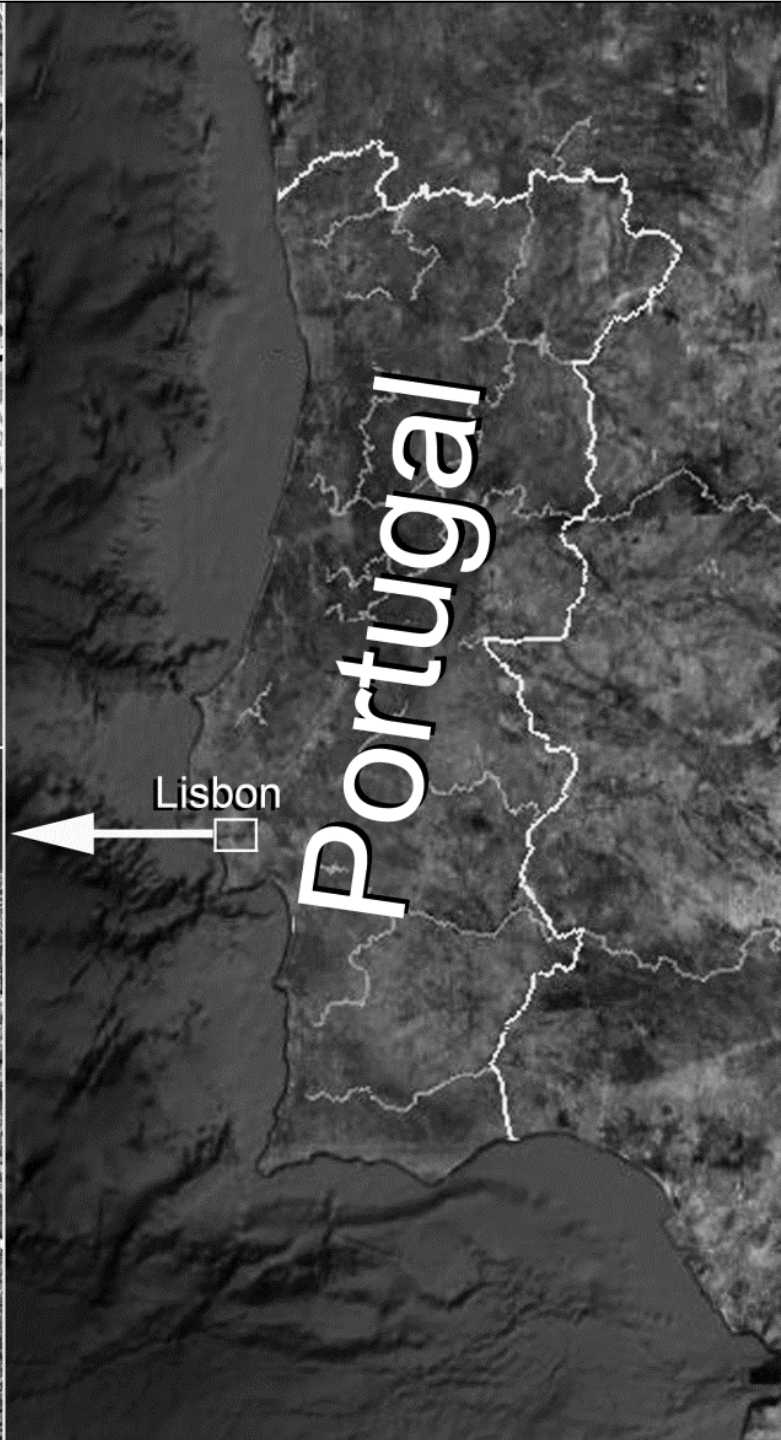
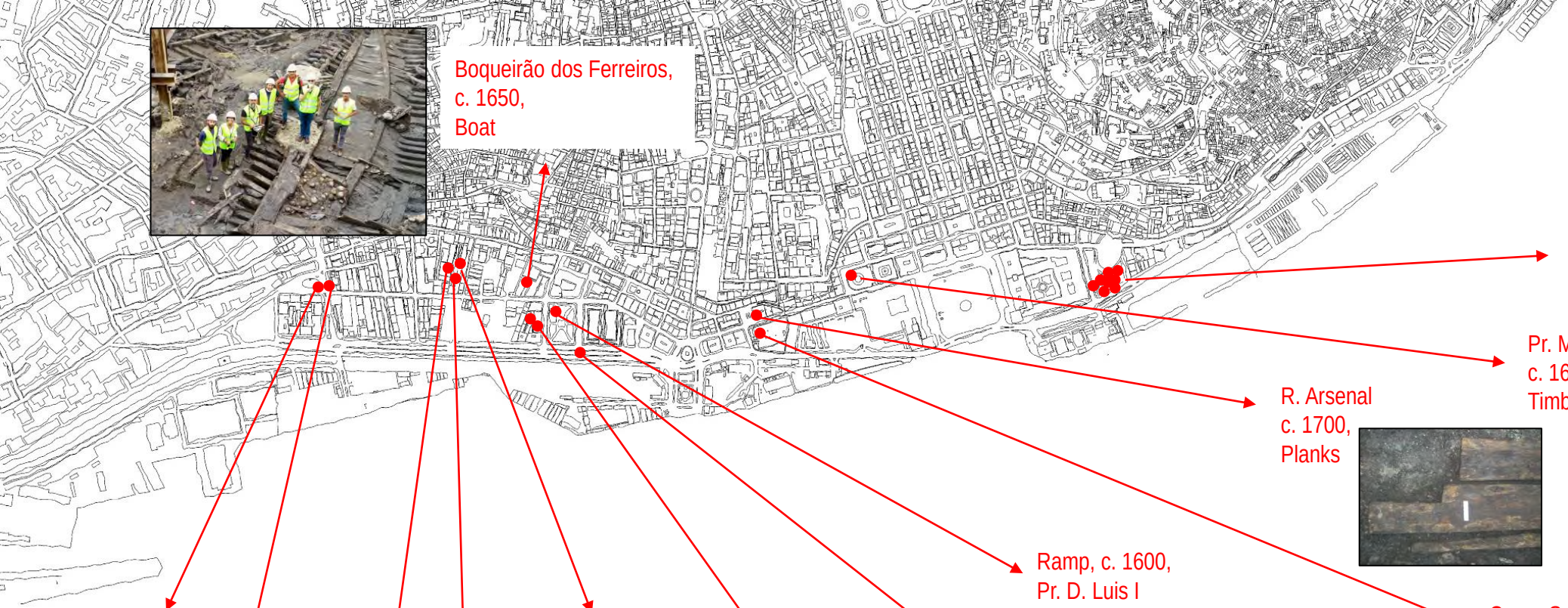


Found in 1995 during the construction of a new subway station in Lisbon, this shipwreck was carbon-dated to around 1500.

The archaeologist responsible for accompanying the excavation works was absent at the time of the finding and the machines dug through the center of the shipwreck, destroying the master frame(s) and the mast step arrangement.

Photo: Paulo Jorge Rodrigues

A significant number of reported finds attest to the archaeological importance of Lisbon's waterfront, but there is no consistent plan to preserve, study, and share the information.



Boqueirão dos Ferreiros,
c. 1650,
Boat

C. das Cebolas 1-8,
c. 1850,
Boats

Pr. Município
c. 1600,
Timbers

R. Arsenal
c. 1700,
Planks

Ramp, c. 1600,
Pr. D. Luis I

Corpo Santo,
c. 1400,
Ship

Ramp, c. 1800,
Lg. Vitorino Damásio

Embankment structure
w/ reutilized ship parts,
c. 1700,
Av. D. Carlos I

Santos 2
c. 1700,
Shipyard

Boavista 1 and 2,
c. 1700,
Boats

Cais do Sodré,
c. 1500,
Ship

Santos 1
c. 1700,
Boat

Santos 3
c. 1700,
Timbers

The ship was lying perpendicularly to the axis of the subway gallery being excavated, 6.5 m below the water level, and its bow and stern were cut by the subway walls.

The ship remains were found in April 1995 and excavated and recorded in the summer of that year, with the help of the contractor, who recorded all timbers in situ with a theodolite. The ship was dismantled and transported to a warehouse in the same summer, abandoned by the cultural agency and left to dry and warp, and handed to CNANS in 1996.

The contractor declared the find to the proper authorities and required support from the Ministry of Culture to record the site *in situ*, before its removal to a conservation facility.

No effort was made to recover the timbers ripped by the machines from the municipal garbage dump.

Photo: Paulo Jorge Rodrigues

Críticas ao Ippar por causa do barco do Cais do Sodré

Maus tratos por negligência

Isabel Braga

A Associação Arqueonáutica acusa o Instituto Português do Património Arquitectónico e Arqueológico (Ippar) de ter deixado apodrecer "irremediavelmente" os restos do barco encontrado durante as obras do Metro, no Cais do Sodré. O Ippar afirma que as madeiras já estavam deformadas quando foram descobertas e que o processo de datação está em marcha. Pensa que há alarmismo à volta da situação mas não explica tudo o que aconteceu.

Um barco em seco, ou irremediavelmente naufragado nos grandes mares da burocracia?

O barco descoberto há precisamente um ano durante as obras do Metro no Cais do Sodré e entregue desde então aos cuidados do Ippar está "irremediavelmente perdido", afirmou o vice-presidente da associação de arqueólogos subaquáticos amadores, Arqueonáutica, Filipe Vieira de Castro, que ameaça o Ippar com uma queixa à Provedoria de Justiça se não forem tomadas medidas imediatas.

"O único arqueólogo encarregado pelo Ippar da recuperação do barco [Paulo Jorge Rodrigues] foi despedido em Dezembro e não foi substituído. As madeiras ficaram sem tratamento, secaram e estão prontas para o lixo. Já não é possível recuperá-las de modo a reconstituir a embarcação", afirmou a mesma fonte.

Removidas em Agosto para as antigas Oficinas Gerais do Exército, em Belém (ver PÚBLICO de 4/1/96), as madeiras acabaram por ficar sem tratamento, acusa Vieira de Castro. Que considera ainda que o Ippar "desvalorizou a descoberta antes de saber do que se tratava". Isto porque "lá dentro se começou a dizer que o barco era do século XIX quando não se sabe nada sobre ele". O francês Eric Rieth, da Universidade de Paris, um dos grandes especialistas mundiais em arqueologia naval, veio em Dezembro a Lisboa observar o achado, e com base no tipo de construção do navio e numa das peças encontradas — um encaixe da cana do leme —, datou-o como sendo do século XVII (ver PÚBLICO de 4/1/96).

O Ippar não se pode queixar de falta de financiamentos para a operação de recuperação do achado, pois o Metropolitano ofereceu ajuda em tudo quanto fosse necessário.

Análises em marcha

A Arqueonáutica, presidida por Francisco Alves — director do Museu Nacional de Arqueologia e convidado pelo Ministério da Cultura para dirigir o novo organismo que tutelará o património cultural subaquático dentro do novo Instituto Português de Arqueologia (IPA) — quer explicações do Ippar sobre a forma como tem tratado o achado do Cais do Sodré. A incumbência foi endossada à comissão instaladora do IPA cujo presidente, Vítor Oliveira Jorge, receberá a associação na segunda-feira. "Tenho muita esperança nesta mudança de interlocutor e que o IPA resolva um problema a que o Ippar nunca deu resposta", sublinhou Filipe Vieira de Castro.

O vice-presidente do Ippar, Paulo Pereira, afirmou que as madeiras do barco encontradas no Cais do Sodré — "apenas parte da quilha e sobrequilha, algumas balizas do cavername e uma parte do forro" — "nunca dariam uma leitura completa, em termos museográficos", da embarcação. Essas madeiras tinham já sofrido "deformações 'in situ', resultante da pressão das terras". Por isso, a sua "eventual reposição na forma original" não se afigura uma prioridade e não parece justificar-se". E mais: "O grau de secagem [atingido pelas madeiras] está estabilizado, não havendo perdas significativas de informação, com excepção de algumas marcas de carpinteiro por serem muito superficiais".

O Ippar afirma que, "em Janeiro", foram encomendadas análises por carbono 14 ao Instituto de Tecnologia Nuclear. "A inexistência de uma estrutura laboratorial para peças de grande porte é o motivo que levou a que os restos da embarcação não tivessem sido tratados de outra forma", justifica o vice-presidente da instituição. Que nega que esta tenha afirmado alguma vez que o barco é do século XIX. Terá dito, isso sim, que "estava envolvido por um aterro dessa época".

Quanto ao afastamento do arqueólogo Paulo Jorge Rodrigues, Paulo Pereira diz que é "um colaborador em prestação de serviços, pelo que não foi despedido, mas dispensado temporariamente até que haja uma definição sobre o des
volvimento do assunto". mesmo responsável sublin que Francisco Alves "acom nhou parte dos trabalhos ef tuados", concretamente, execução do registo fotográ do achado. "A demora na r lução do assunto" prend "fundamentalmente" com resultado das análises por bono 14, bem como "com as rências existentes em infra truturas de apoio à arque gia subaquática" que "não tão dependentes da dispon lidade do Metropolitano Lisboa".

A resposta não esclare os restos da embarcação contrados foram adequa mente tratados, não exp porque, desde Dezembro, encontram ao abandono, diz se o grau de estabiliza das madeiras é o desejável se estas se limitaram a atin a secura máxima, nem re os motivos pelos quais o Ip esperou nove meses para p as análises necessárias à d ção do barco. ■

After the contractor delivered the timbers to the services of the Ministry of Culture, they were abandoned to dry and warp.

Arqueonáutica pediu uma auditoria técnica e um inquérito para apurar responsabilidades

Barco do Cais do Sodré encalhado

Fernanda Ribeiro

O barco encontrado nas obras do Metro no Cais do Sodré, em Abril do ano passado, deverá ser mais antigo do que inicialmente se supôs, podendo remontar ao século XVII, ou mesmo XVI. Mas apurar com rigor científico a datação do navio poderá já ser impossível. Nada foi feito pelo Ippar para preservar as madeiras do barco, cujas formas se alteraram, abrindo fendas. E a associação Arqueonáutica pediu já a realização de uma auditoria técnica e de um inquérito sobre como foi possível chegar-se a esta situação.

O abandono a que as peças do barco foram votadas poderá dificultar o seu estudo

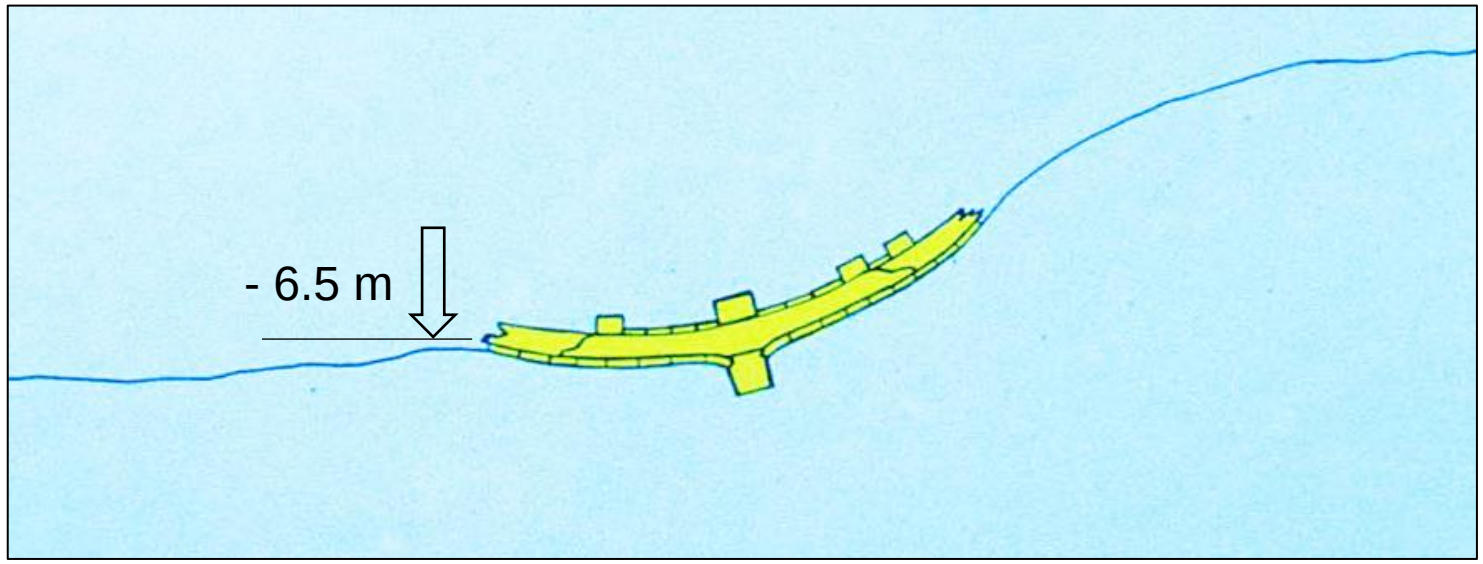
O barco que, em Abril do ano passado, foi —, Eric Reith alertou para o perigo de apodrecimento rápido ou seja a partir da segunda metade do século XVII, as estrutura do nhando que as próprias marcas capazes de fornecer indicações

Contactado pelo PÚBLICO, Paulo Jorge Rodrigues, reconhe- madeiras ficaram à mercê dos raios solares, da gordura das gasolinas existente no solo e de um processo de secagem nocivo que agora é alvo de contestação.

A associação Arqueonáutica, presidida por Francisco Alves — que é director do Museu Nacional de Arqueologia — está mesmo indignada com o abandono a que o barco do Cais do Sodré foi votado. E, após uma visita às instalações de Belém, em meados de Dezembro, decidiu escrever ao novo presidente do Ippar, Luís Calado, pedindo a abertura de um inquérito, para apurar responsabilidades, e a instauração de uma auditoria técnica, "para que os trabalhos sejam conduzidos doravante por quem tem competência na área da conservação".

Francisco Alves disse ao PÚBLICO ter sugerido que a condução do processo fosse agora entregue a Adília Alarcão, directora do Museu de Conimbriga, que deverá proximamente deslocar-se a Belém, para fazer uma avaliação do estado do barco.

No entender de Francisco Alves, que, como responsável da



Radiocarbon analysis placed this structure around the 16th century:

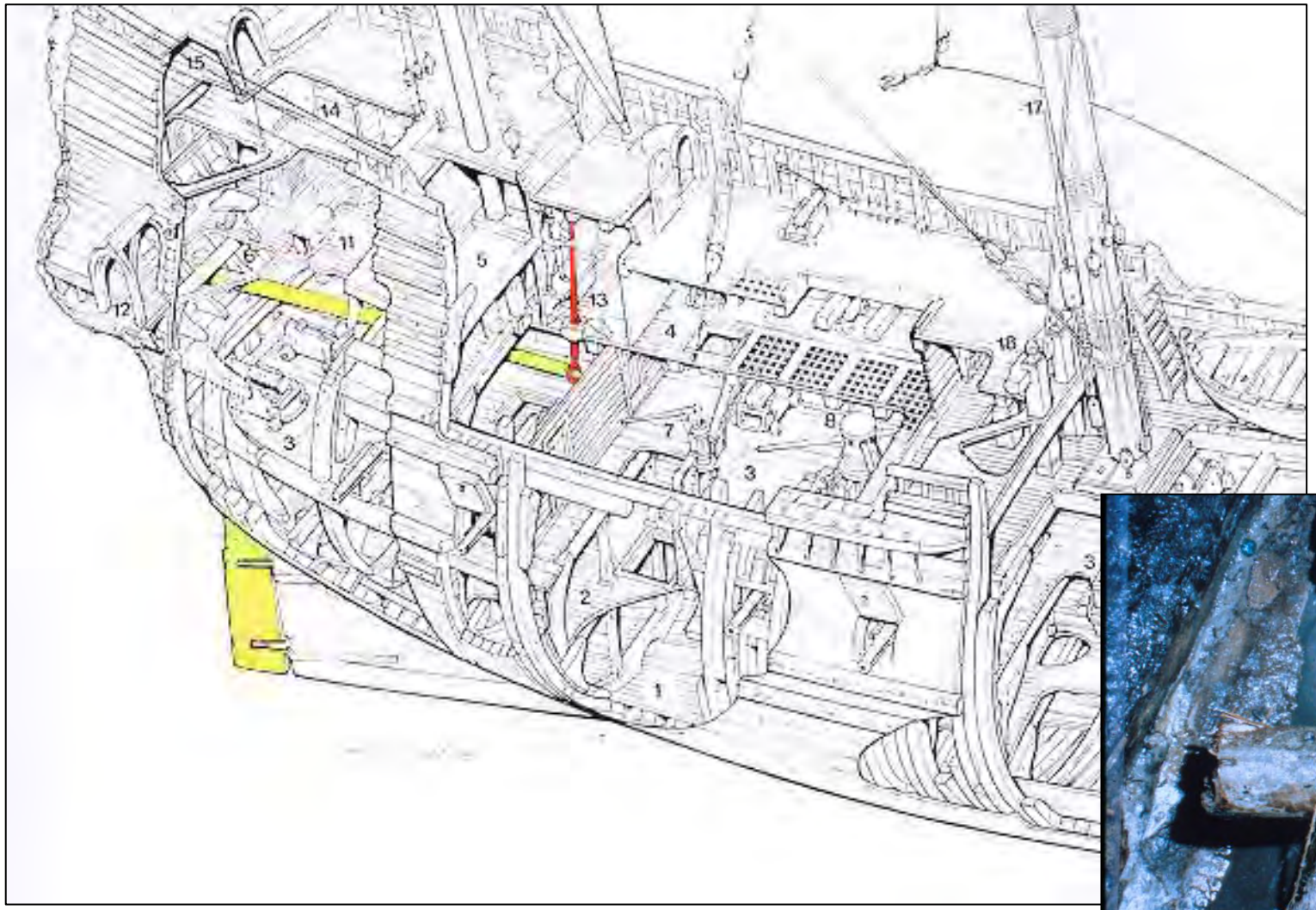
Hull plank: 400 ± 40 BP

Floor timber: 430 ± 45 BP

Which calibrated gave the date 1449 in the Stuiver & Pearson curve:

1σ - 1438-1478 AD;

2σ - 1424-1516 AD / 1590-1622 AD

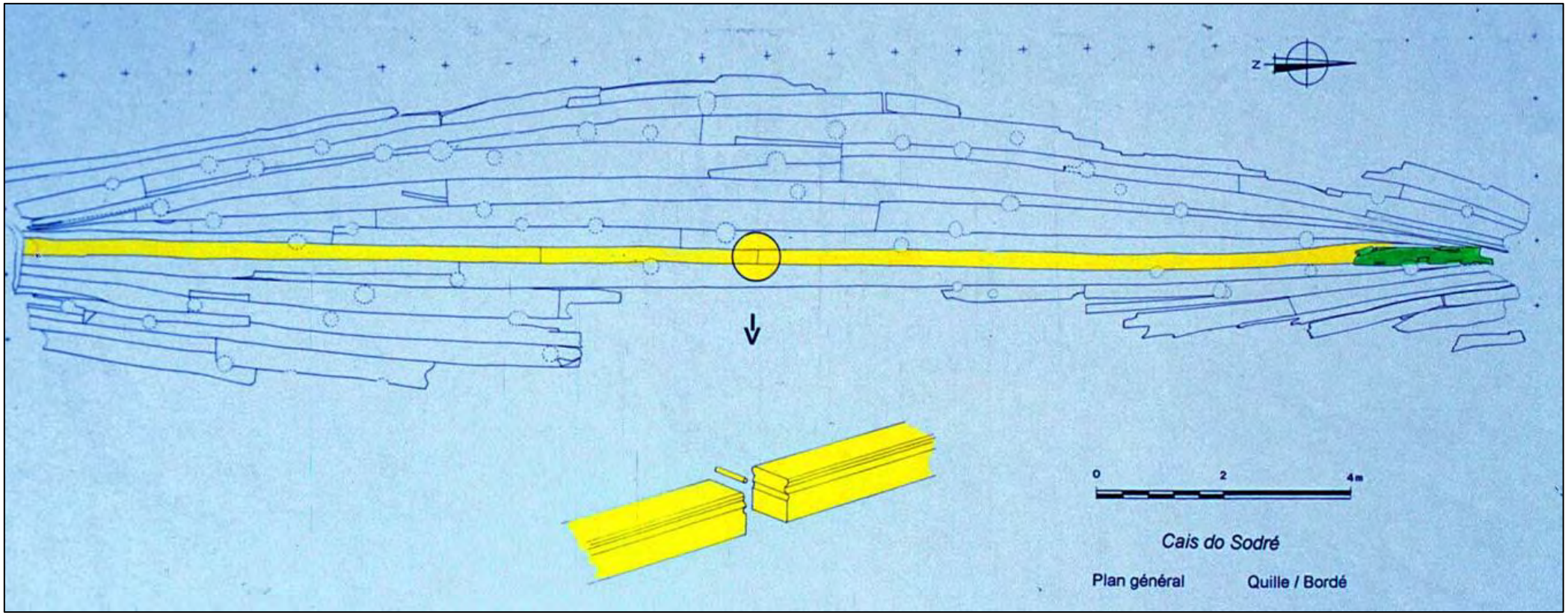


A whipstaff was found in the proximity of this shipwreck.

Three anchors, and a small iron gun were also found in the proximity of this shipwreck.

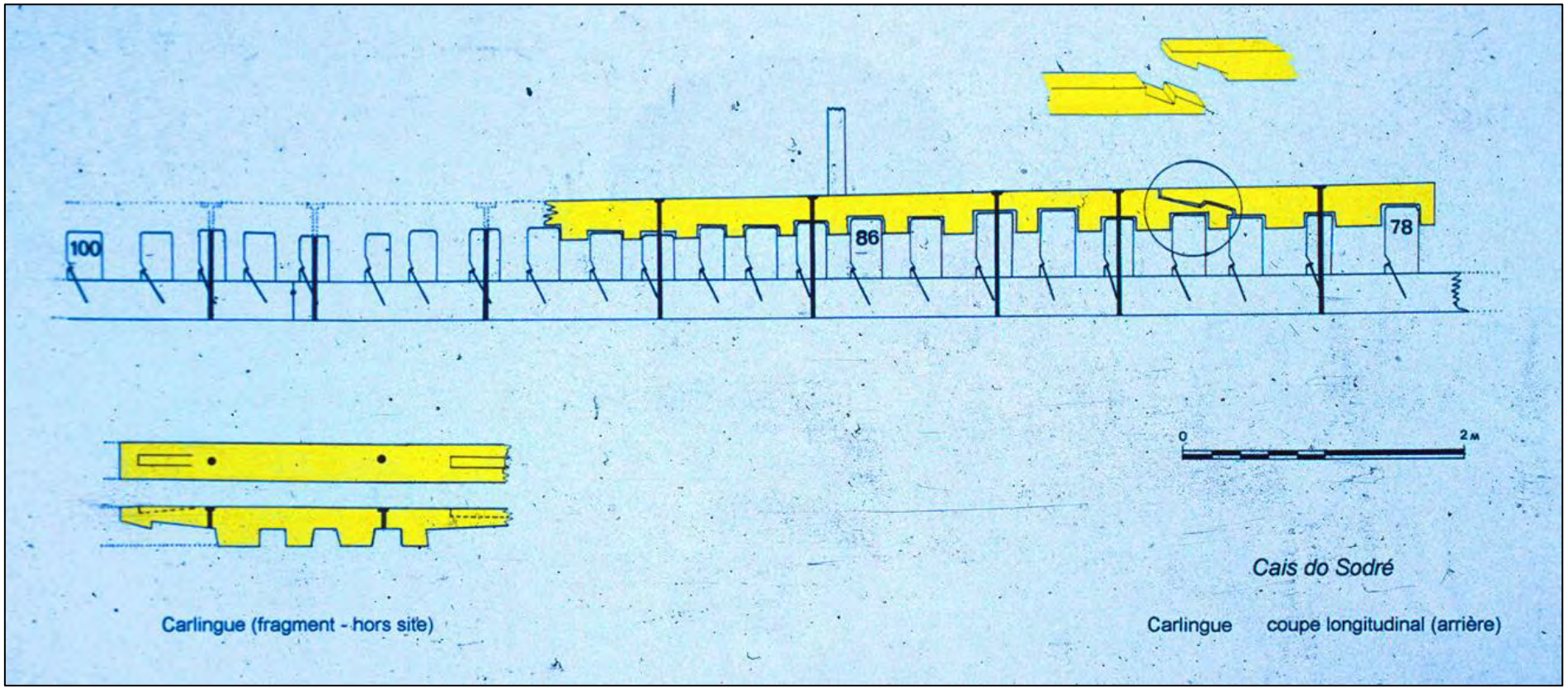
Construction features immediately apparent were:

1. The keel sections were not connected with scarves;



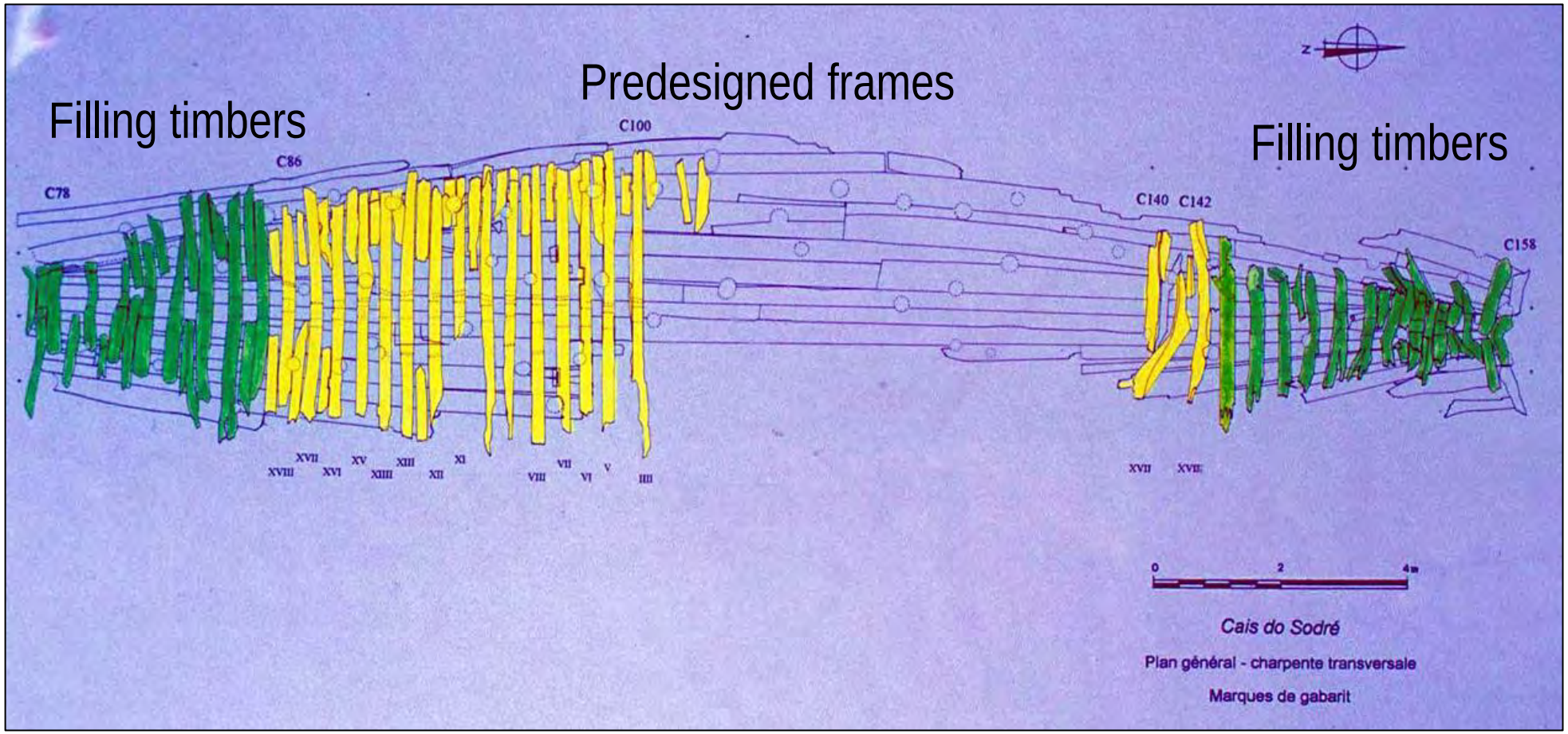
Construction features immediately apparent were:

2. The keelson was notched and scarved with hook scarves;



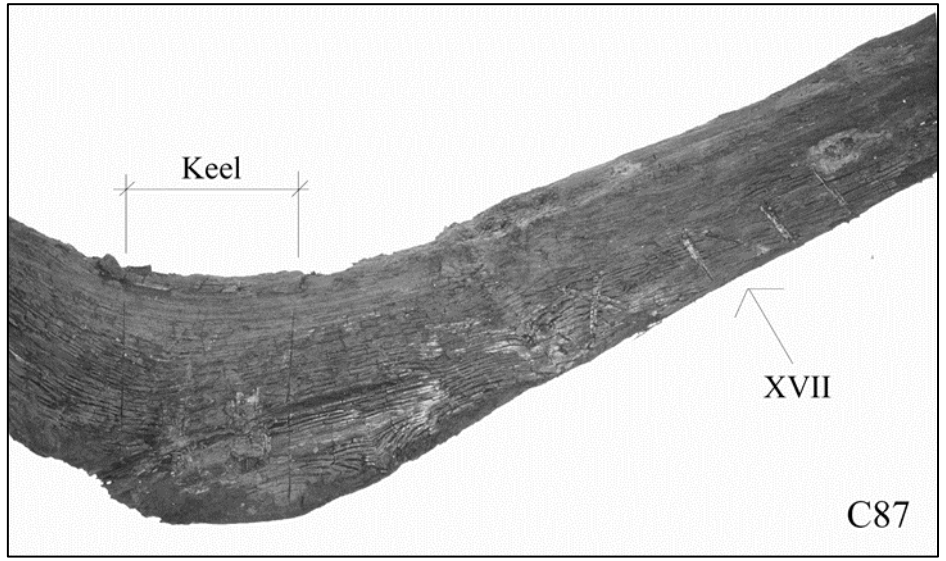
Construction features immediately apparent were:

3. Frames divided into two groups;



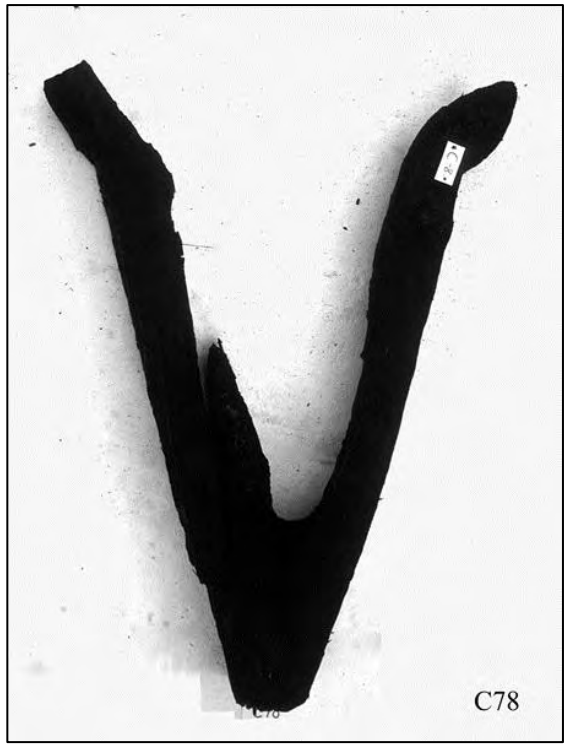
a. Predesigned frames;

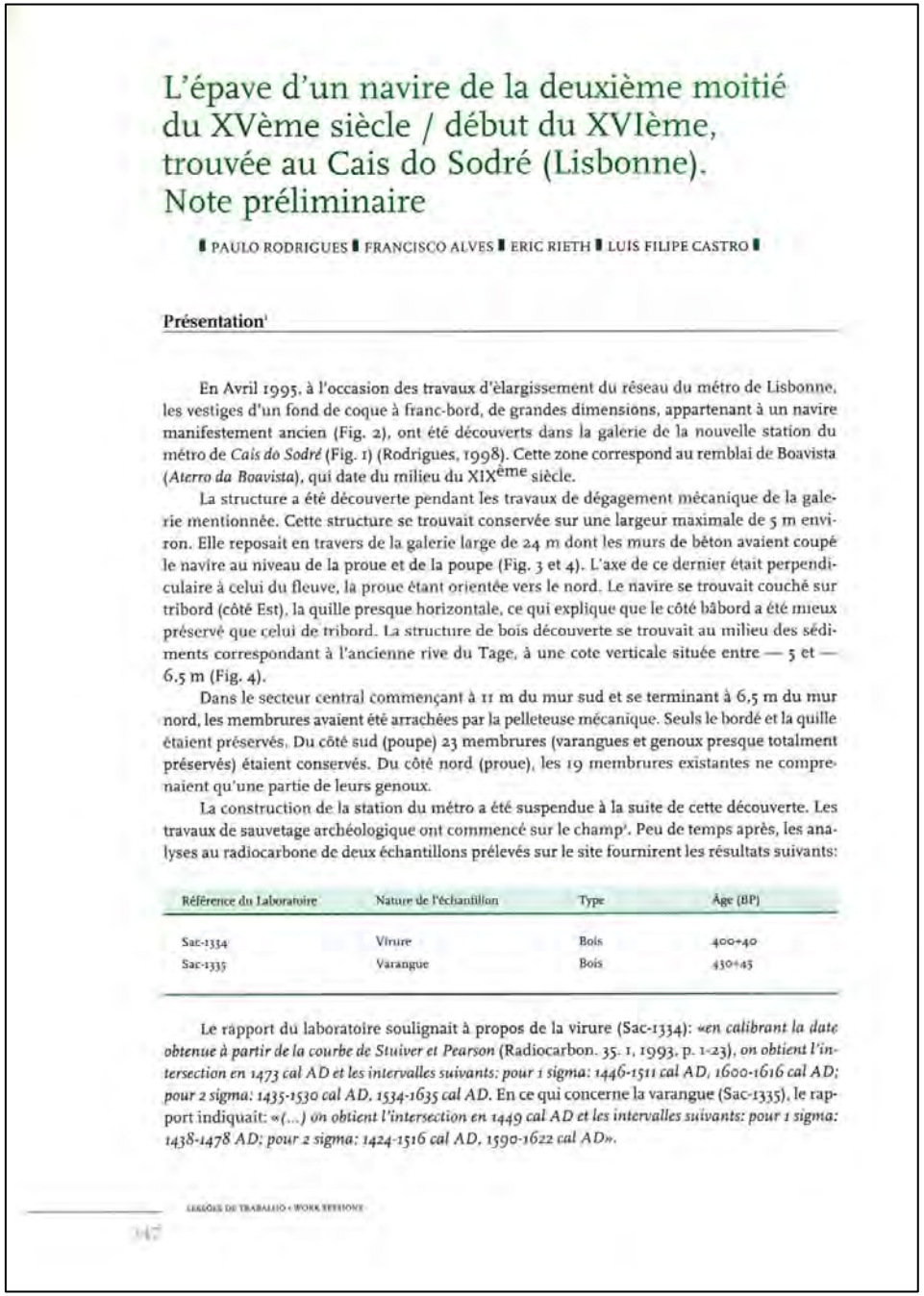
1. Numbered with Roman numerals, from I to XVII;
2. Fastened to the keel with a vertical spike;
3. Connected to the futtocks with dovetail scarves;
4. Bearing keel marks;
5. Possibly turn of the bilge marks.



b. Filling timbers;

1. Not numbered;
2. Fastened to the keel with a diagonal spike inserted from the forward of after face;
3. No dovetail scarves;
4. No keel marks;
5. No turn of the bilge marks;
6. At the stern extremity tilted outside with a clear kink;
7. The extreme ones tabbed, sitting on deadwood.





L'épave d'un navire de la deuxième moitié du XVème siècle / début du XVIème, trouvée au Cais do Sodré (Lisbonne). Note préliminaire

PAULO RODRIGUES ▮ FRANCISCO ALVES ▮ ERIC RIETH ▮ LUIS FILIPE CASTRO ▮

Présentation[1]

En Avril 1995, à l'occasion des travaux d'élargissement du réseau du métro de Lisbonne, les vestiges d'un fond de coque à franc-bord, de grandes dimensions, appartenant à un navire manifestement ancien (Fig. 2), ont été découverts dans la galerie de la nouvelle station du métro de *Cais do Sodré* (Fig. 1) (Rodrigues, 1998). Cette zone correspond au remblai de Boavista (*Aterro da Boavista*), qui date du milieu du XIX^{ème} siècle.

La structure a été découverte pendant les travaux de dégagement mécanique de la galerie mentionnée. Cette structure se trouvait conservée sur une largeur maximale de 5 m environ. Elle reposait en travers de la galerie large de 24 m dont les murs de béton avaient coupé le navire au niveau de la proue et de la poupe (Fig. 3 et 4). L'axe de ce dernier était perpendiculaire à celui du fleuve, la proue étant orientée vers le nord. Le navire se trouvait couché sur tribord (côté Est), la quille presque horizontale, ce qui explique que le côté bâbord a été mieux préservé que celui de tribord. La structure de bois découverte se trouvait au milieu des sédiments correspondant à l'ancienne rive du Tage, à une cote verticale située entre — 5 et — 6,5 m (Fig. 4).

Dans le secteur central commençant à 11 m du mur sud et se terminant à 6,5 m du mur nord, les membrures avaient été arrachées par la pelleteuse mécanique. Seuls le bordé et la quille étaient préservés. Du côté sud (poupe) 23 membrures (varangues et genoux presque totalment préservés) étaient conservés. Du côté nord (proue), les 19 membrures existantes ne comprenaient qu'une partie de leurs genoux.

La construction de la station du métro a été suspendue à la suite de cette découverte. Les travaux de sauvetage archéologique ont commencé sur le champ[2]. Peu de temps après, les analyses au radiocarbone de deux échantillons prélevés sur le site fournirent les résultats suivants:

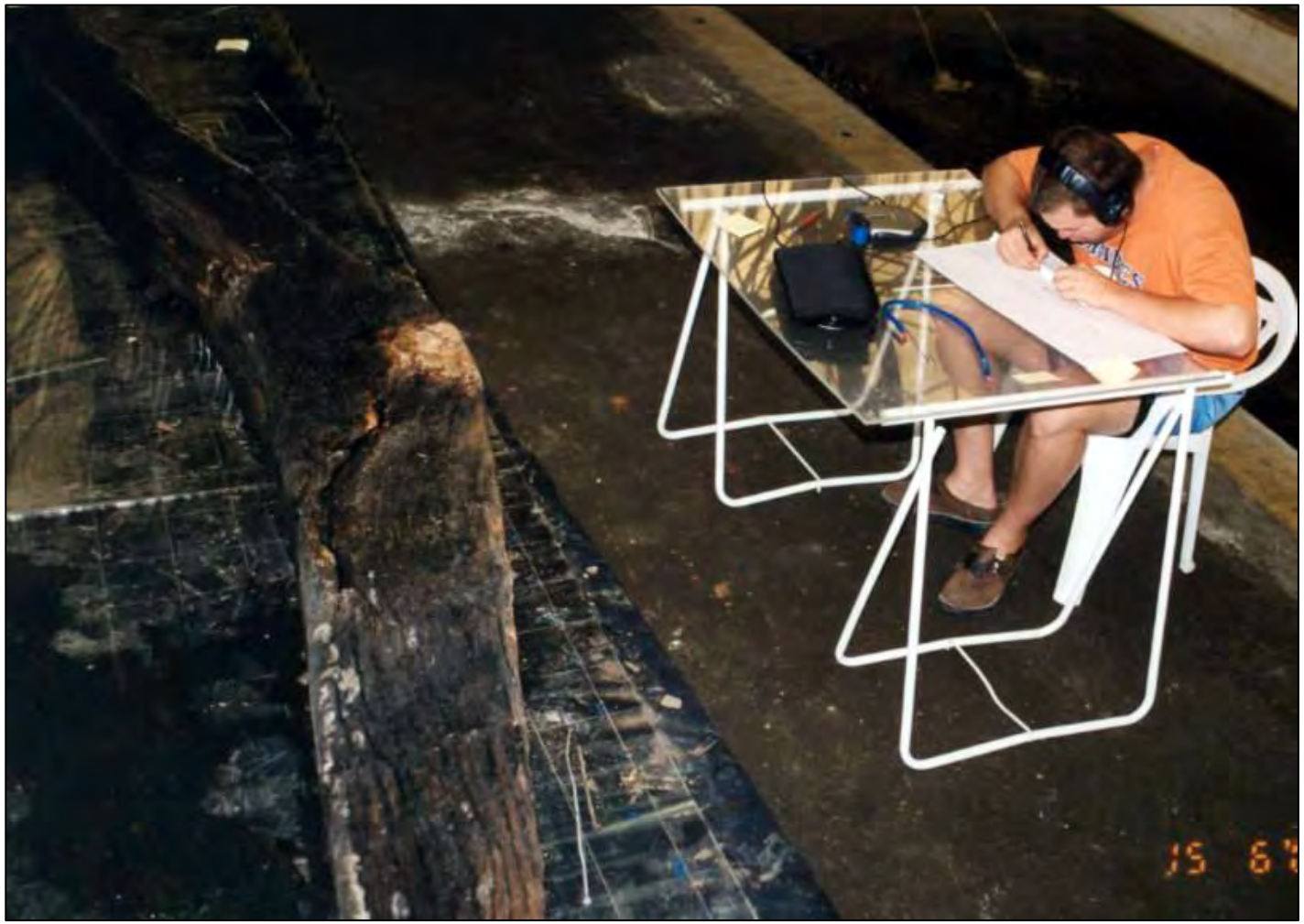
Référence du Laboratoire	Nature de l'échantillon	Type	Âge (BP)
Sac-1334	Virure	Bois	400±40
Sac-1335	Varangue	Bois	430±45

Le rapport du laboratoire soulignait à propos de la virure (Sac-1334): «*en calibrant la date obtenue à partir de la courbe de Stuiver et Pearson* (Radiocarbon. 35. 1, 1993, p. 1-23), *on obtient l'intersection en 1473 cal AD et les intervalles suivants: pour 1 sigma: 1446-1511 cal AD, 1600-1616 cal AD; pour 2 sigma: 1435-1530 cal AD, 1534-1635 cal AD.* En ce qui concerne la varangue (Sac-1335), le rapport indiquait: «*(...) on obtient l'intersection en 1449 cal AD et les intervalles suivants: pour 1 sigma: 1438-1478 AD; pour 2 sigma: 1424-1516 cal AD, 1590-1622 cal AD*».

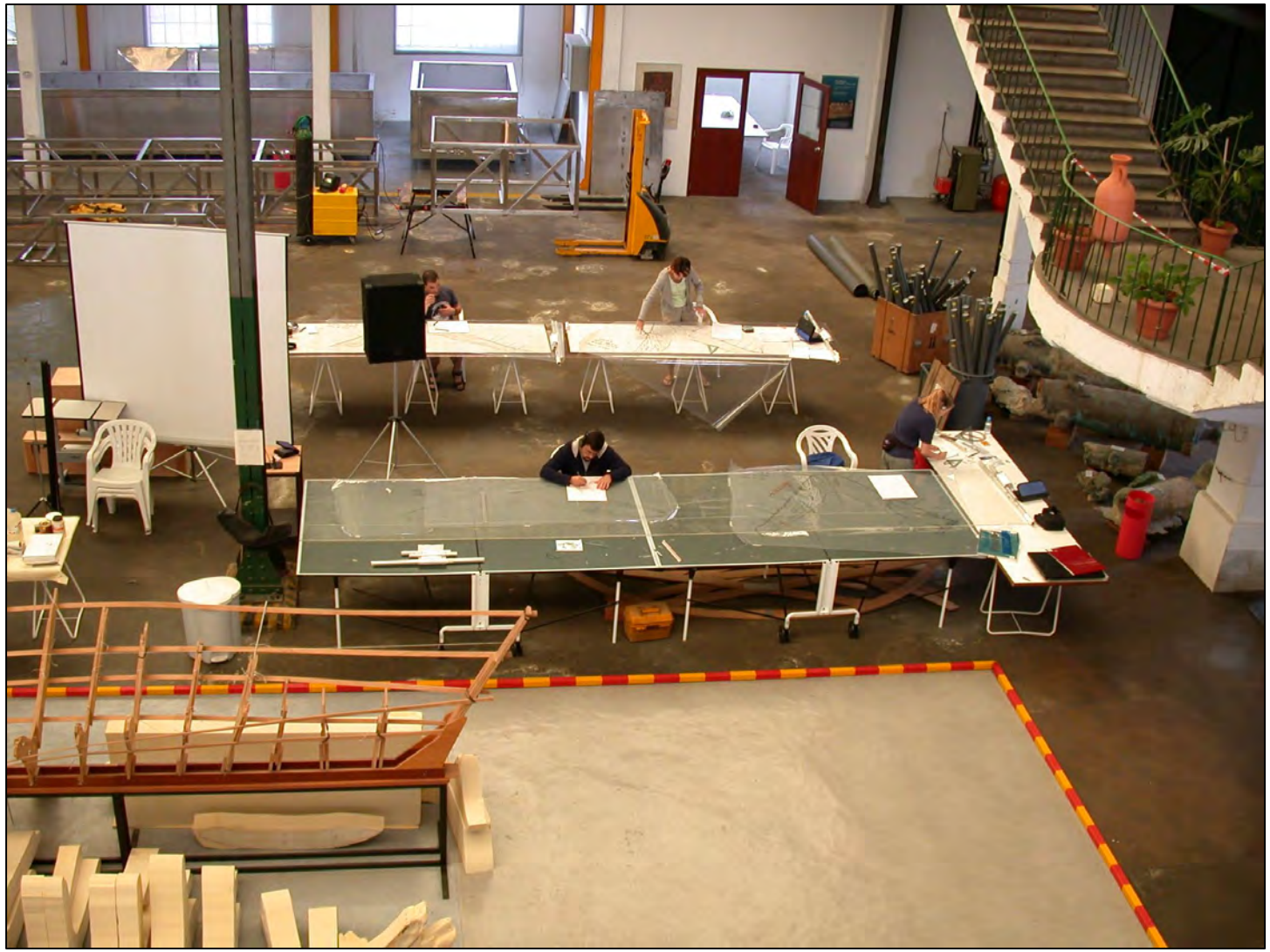
The ship timbers were later studied by archaeologist Paulo Rodrigues, who wrote a MA thesis on this shipwreck at the Sorbonne University, under the orientation of Dr. Eric Rieth, and published the ship in the proceedings of a1998 meeting held in Lisbon, dedicated to the archaeology of Iberian Atlantic ships.

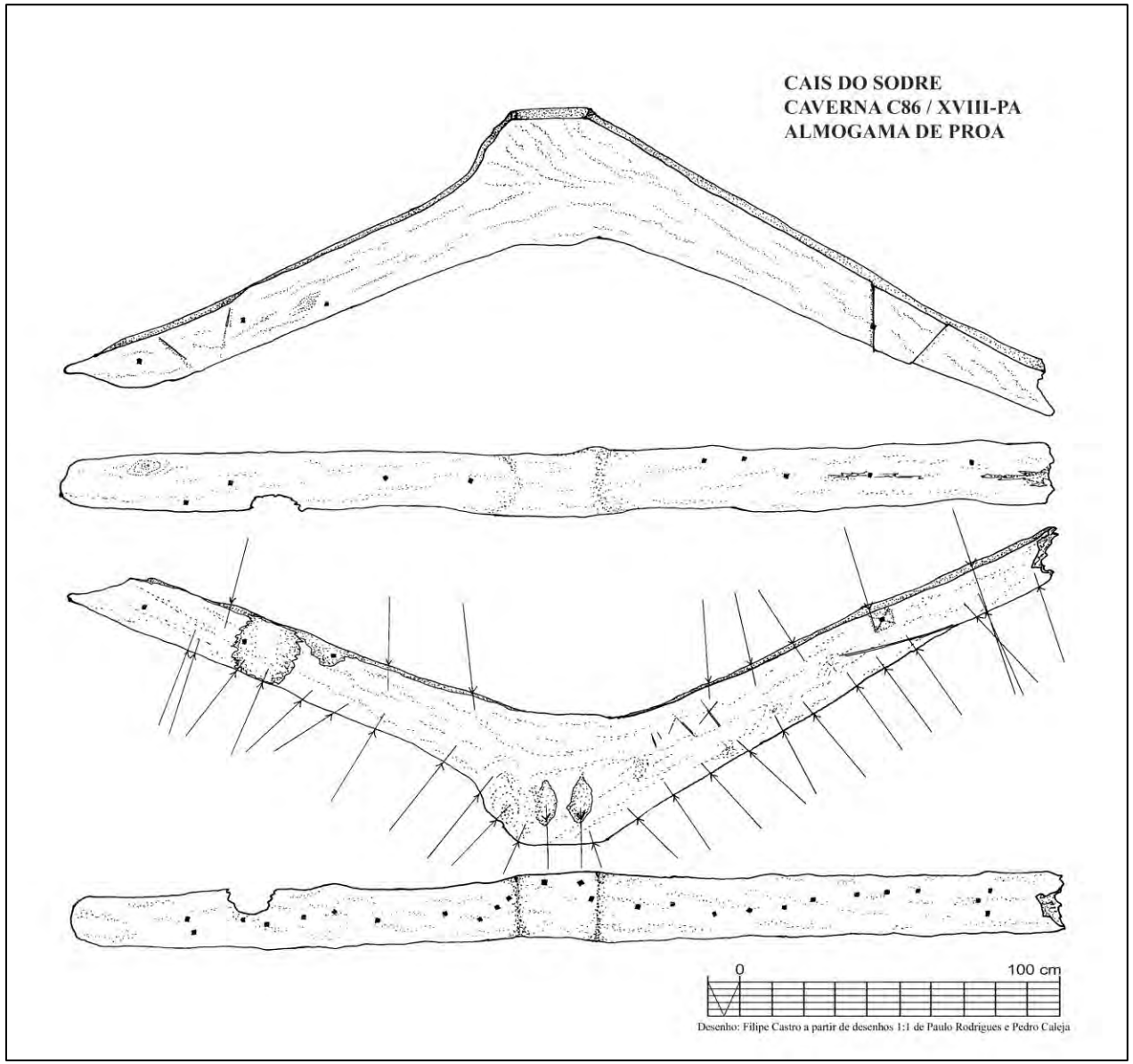
Rodrigues, P., Alves, F., Rieth, E. and Castro, F., 2001, L'épave d'un navire de la moitié du XV.ème siècle/début du XVI.ème, trouvée au Cais do Sodré (Lisbonne). Note Preliminary, in F. Alves (ed.), *Proceedings of the International Symposium, Archaeology of Medieval and Modern Ships of Iberian-Atlantic Tradition, 347–80. Lisbon.*

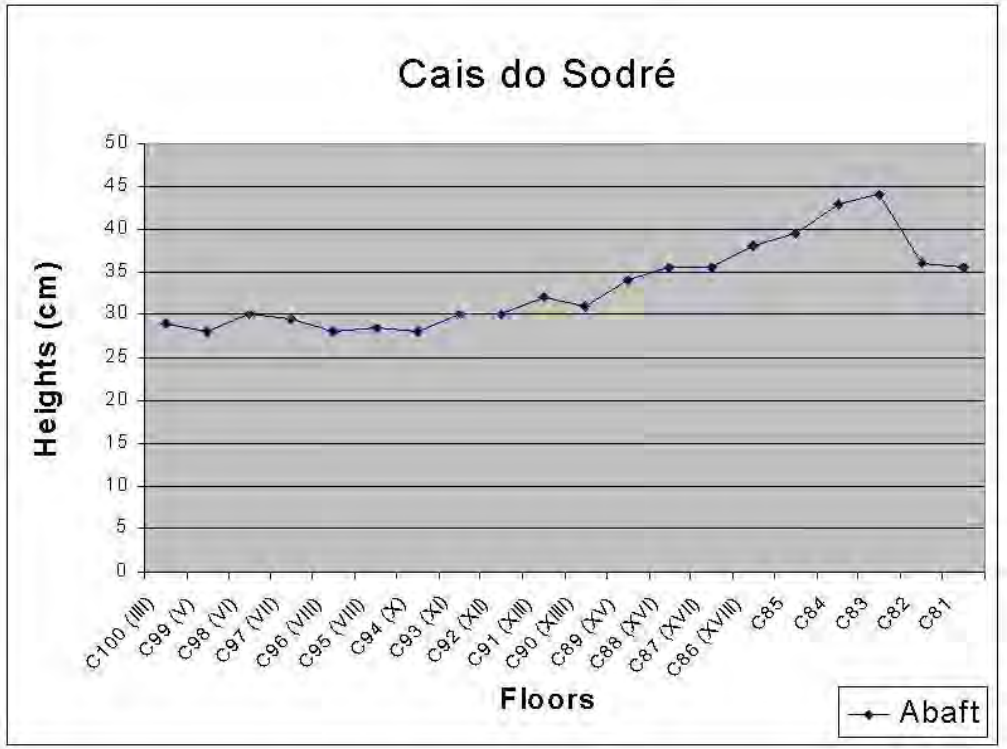
In 2001 and 2002 a team from Texas A&M was allowed to help with the recording. We recorded all the floor timbers of this shipwreck.



Two Texas A&M University 2001 and 2002 summer schools and record all floor timbers at 1/1 and 1/10 scales.



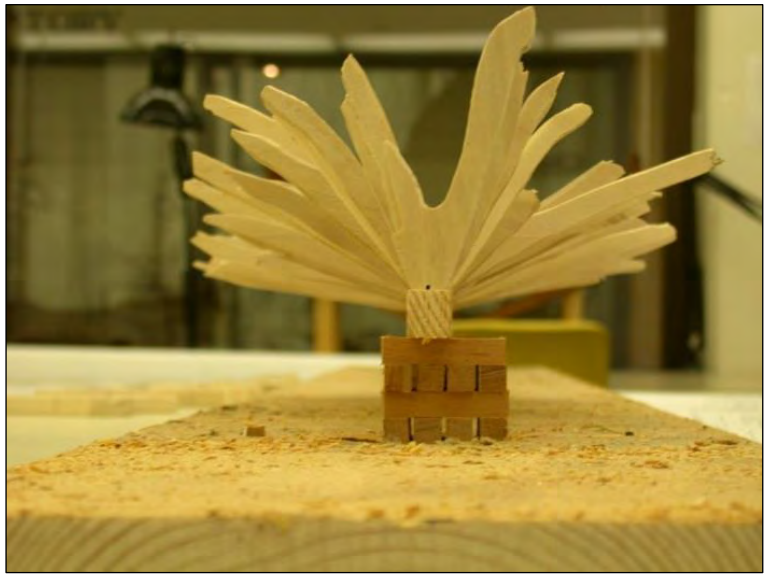




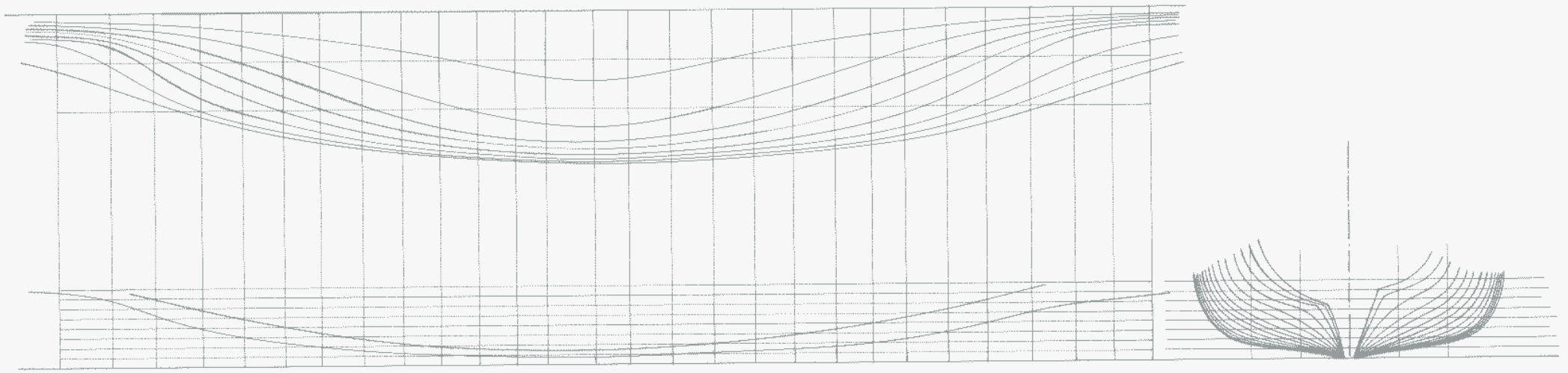
All floor timbers were recorded in 2001/02 and reduced to 1/10 and 1/20 scales, for publication.

The work continued throughout the year 2002 at Texas A&M University, until the catalogue of the floor timbers was ready to be integrated in Paulo Rodrigues' thesis.

A 1/20 model was developed to assess the warping of the timbers.

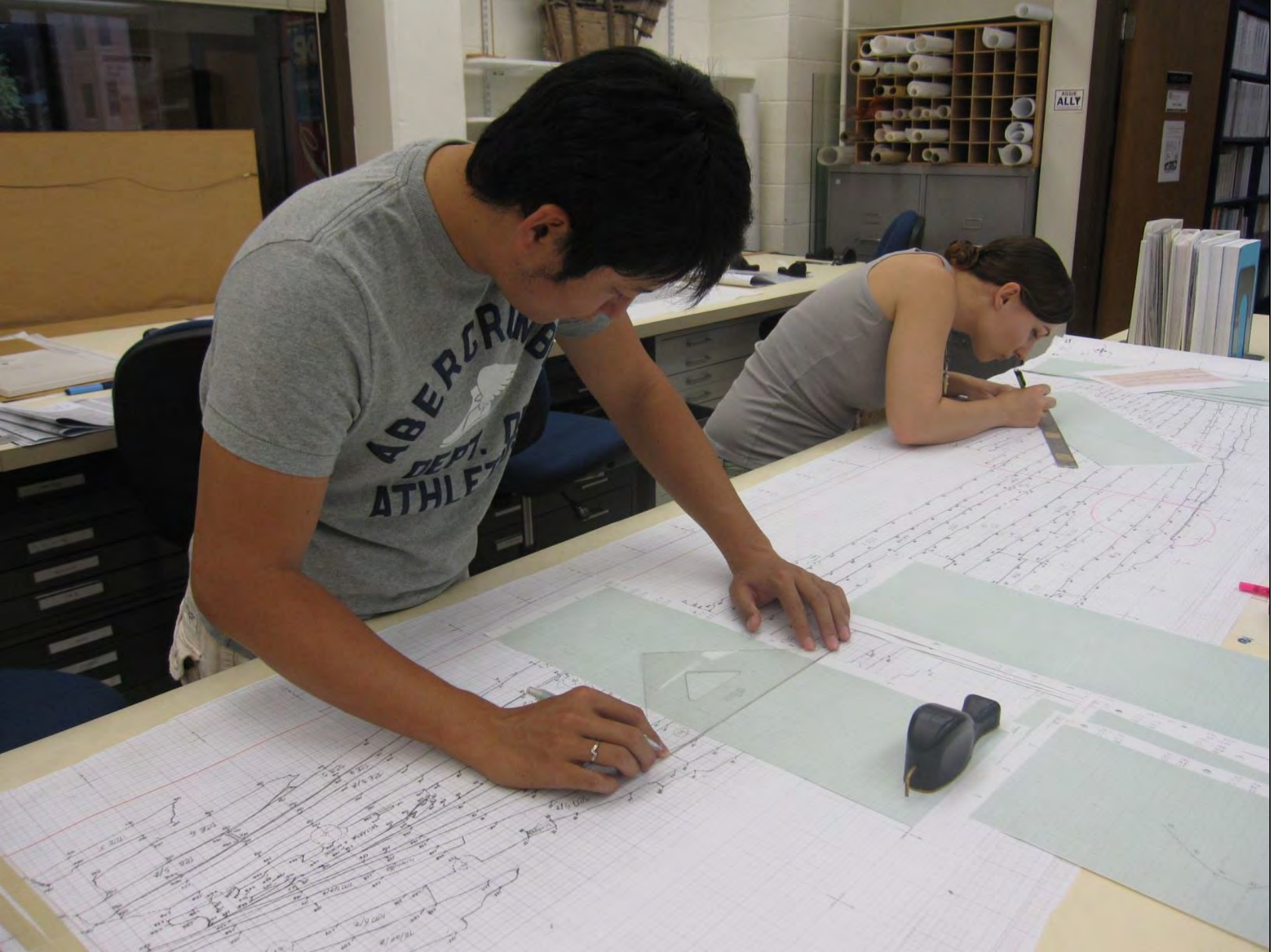


A first attempt at getting a lines drawing was also produced:



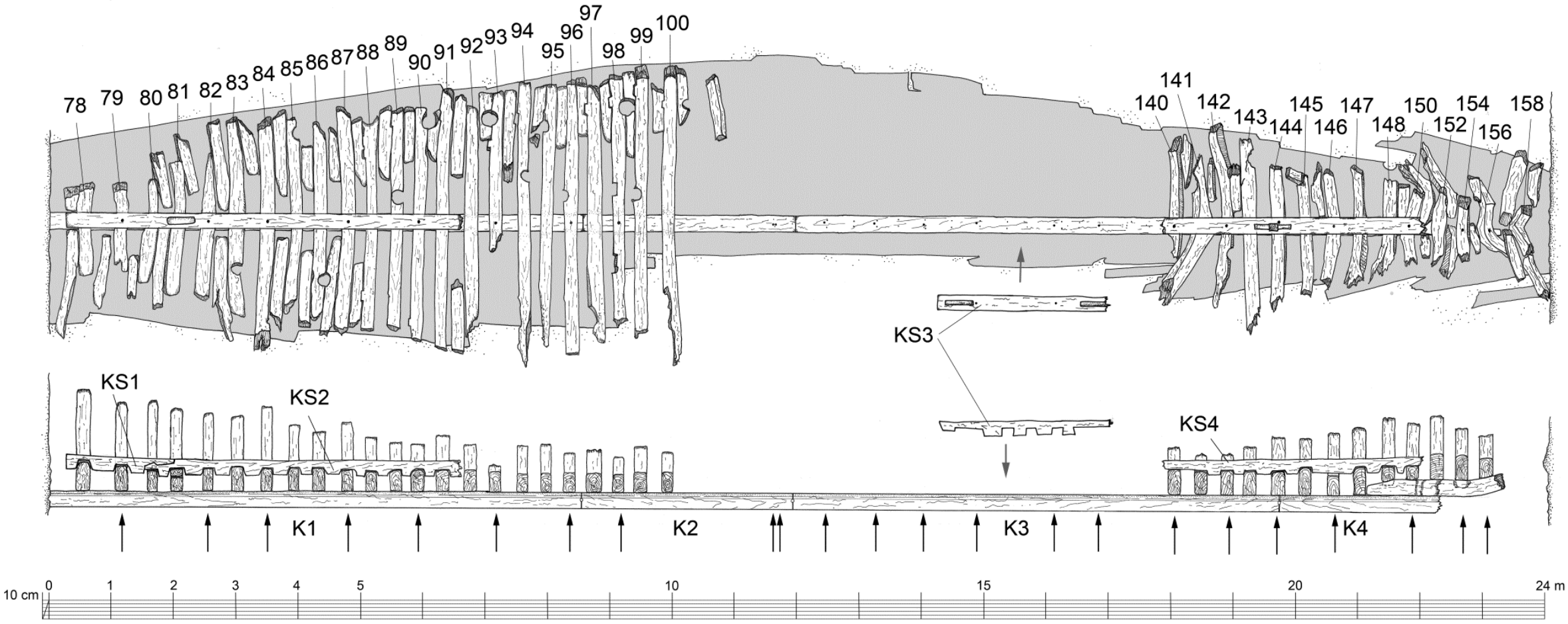
Drawing: Kotaro Yamafune

After the tragic death of Paulo Rodrigues, Filipe Castro was granted permission, in 2010, to finish the recording, organize the original drawings, and reconstruct the data pertaining to the recording of this shipwreck.

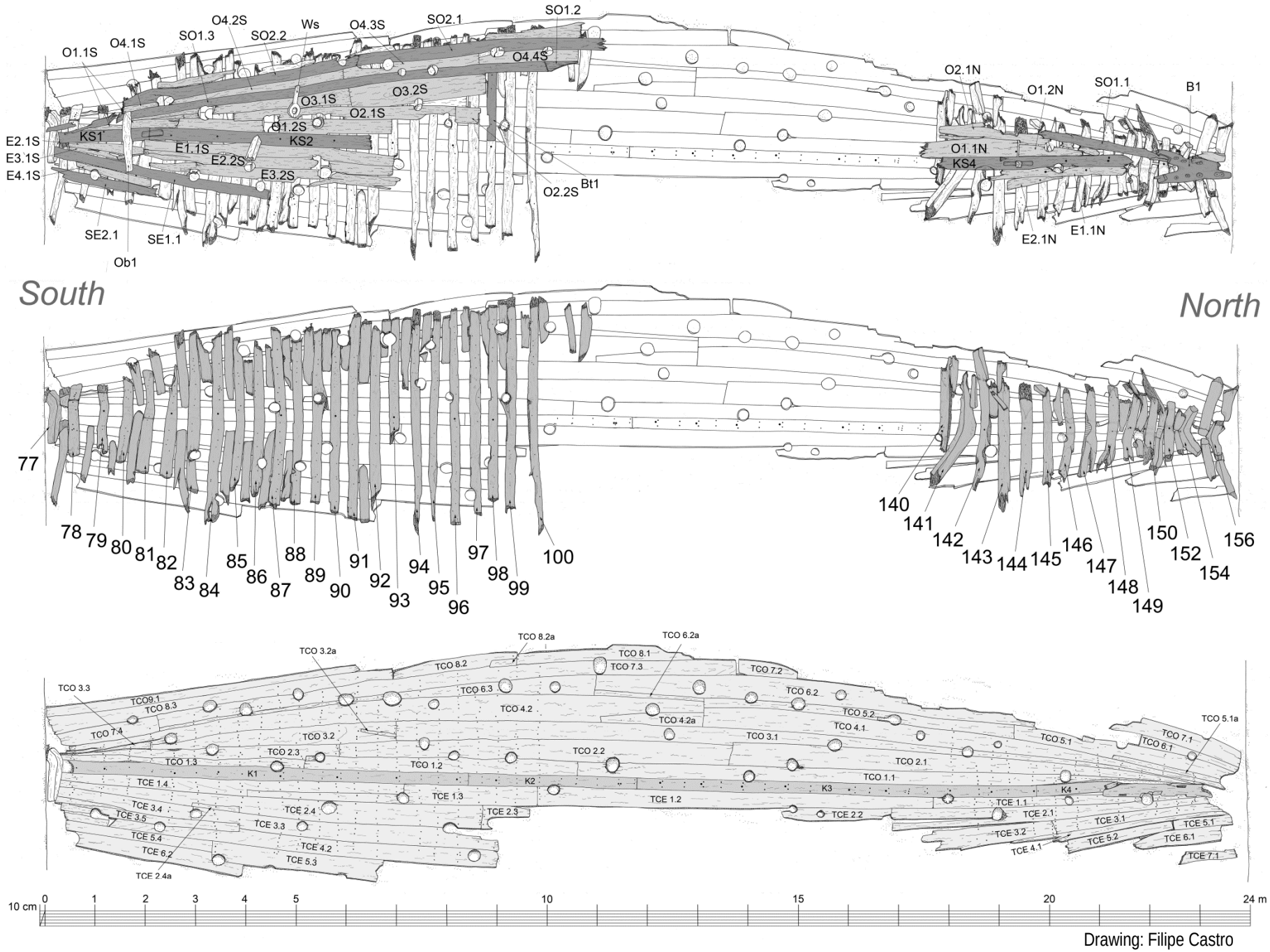


New site plans were produced at Texas A&M University.

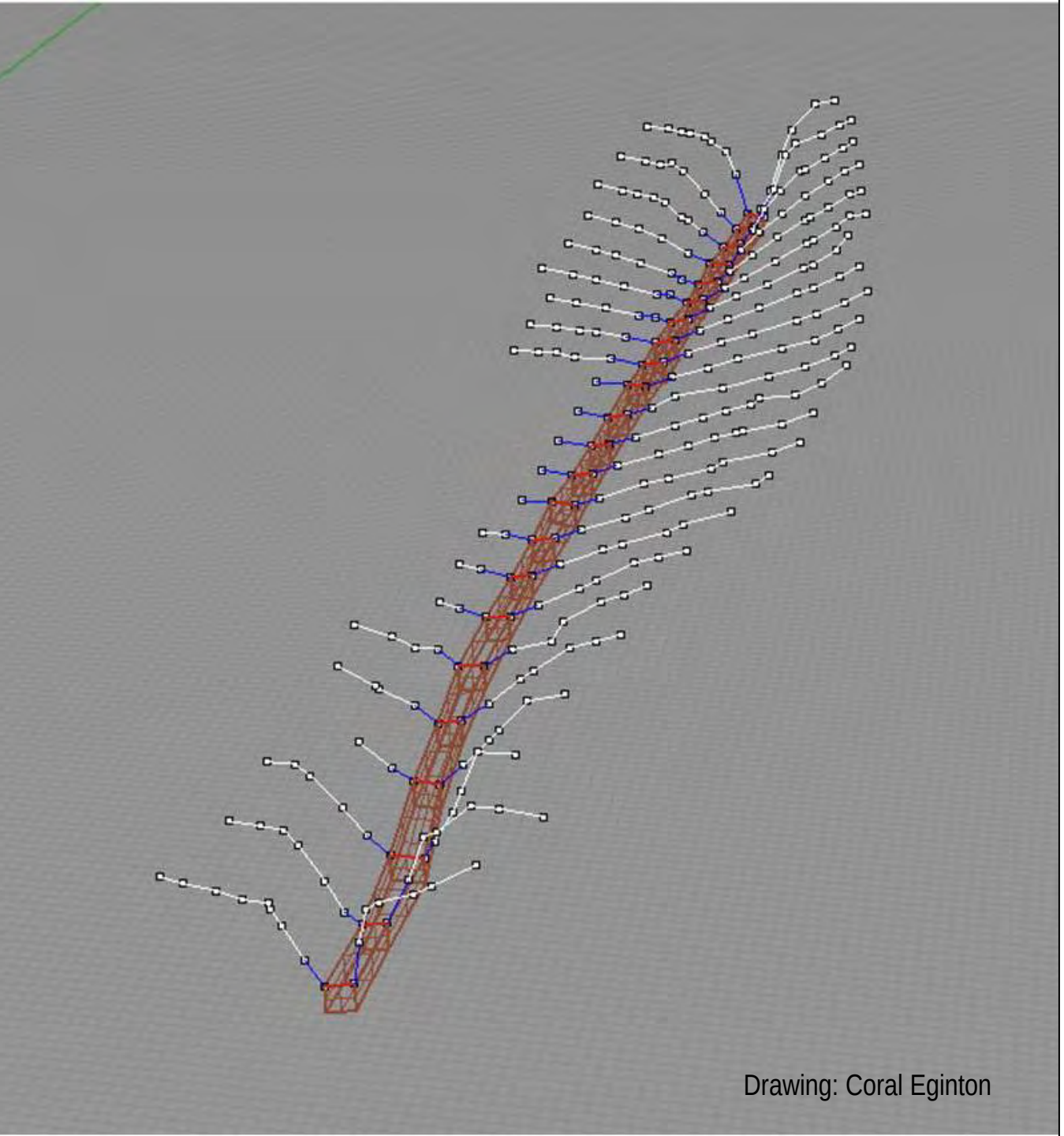
All timbers were numbered, the spike and bolt wholes referenced, and the position of the keelson reconstructed:



Drawing: Filipe Castro



Drawing: Filipe Castro



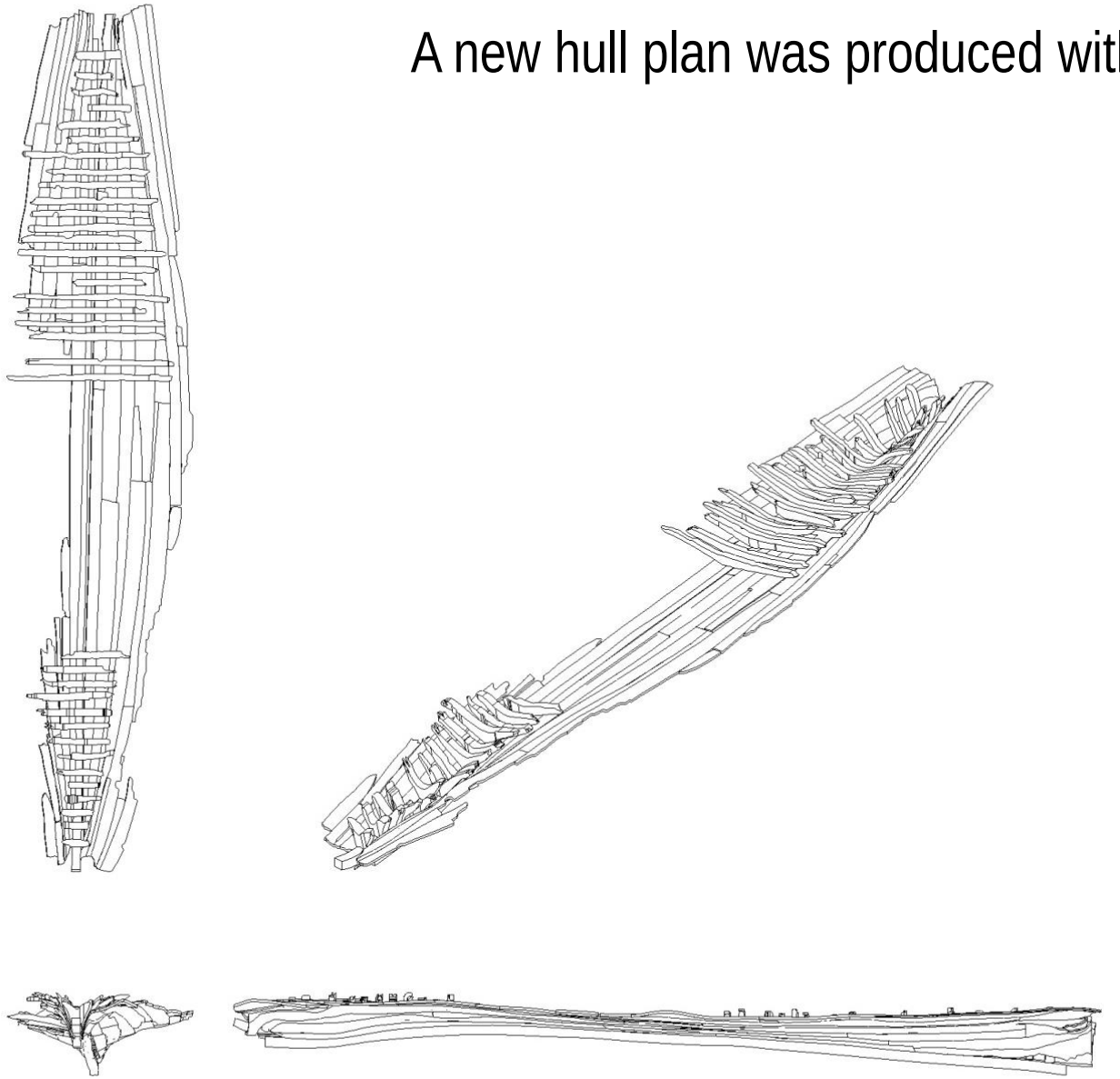
Drawing: Coral Eginton

The total station data were converted into tri-dimensional drawings:

Model: Coral Eginton

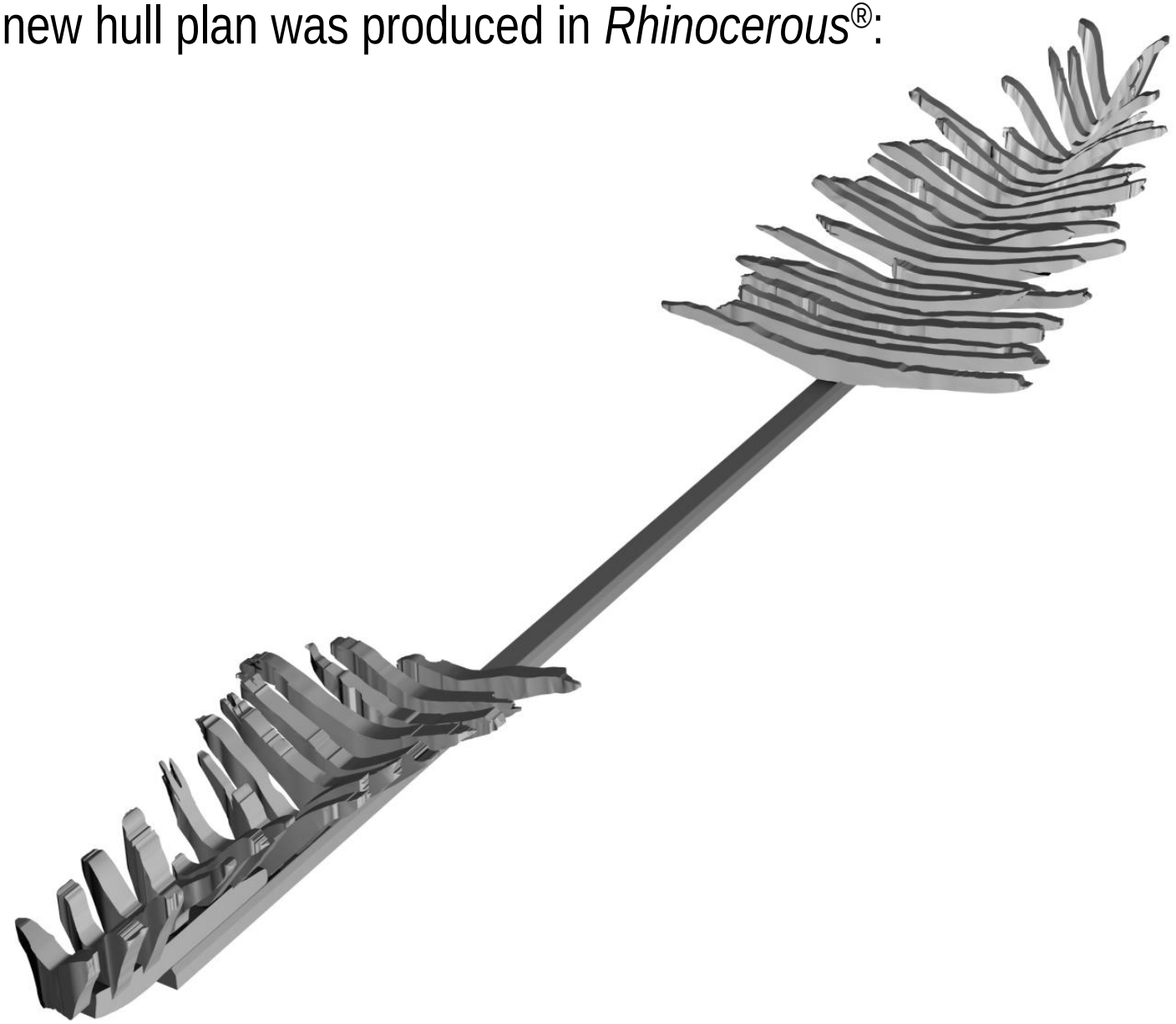
A 3D planking plan was produced in *Rhinocerous*®:

A new hull plan was produced with *Rhinocerous*® software:



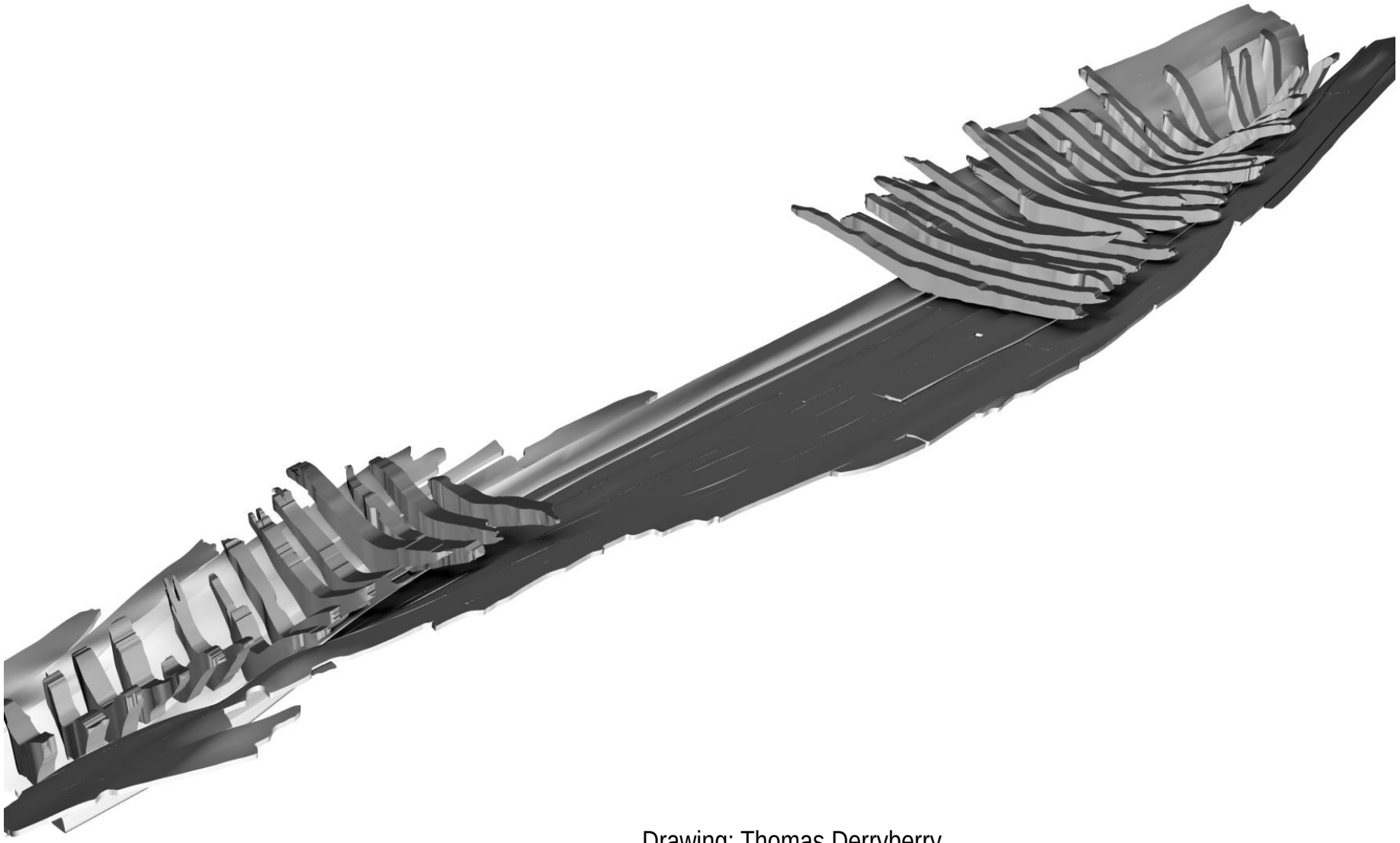
Drawing: Thomas Derryberry

The keel was then straightened, and new hull plan was produced in *Rhinocerous*®:

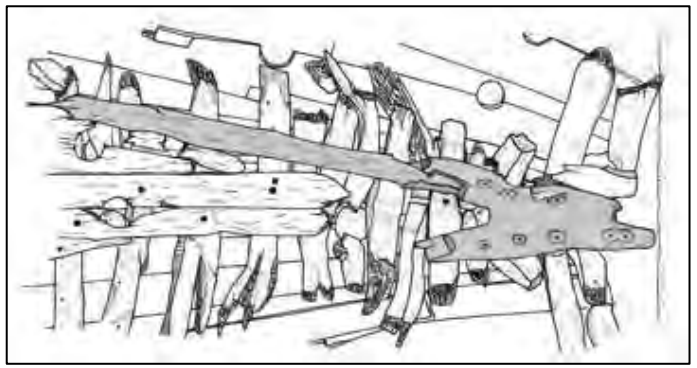


Drawing: Thomas Derryberry

A new hull plan was produced in *Rhinocerous*®:

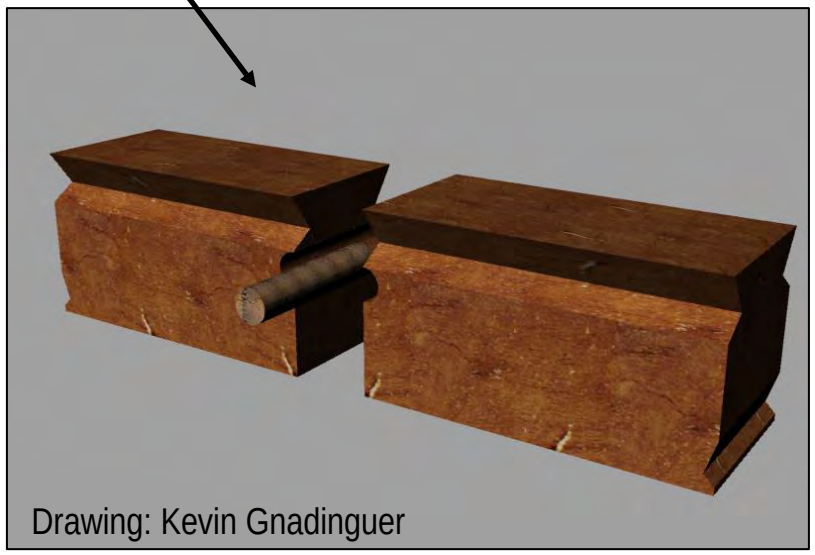


Drawing: Thomas Derryberry



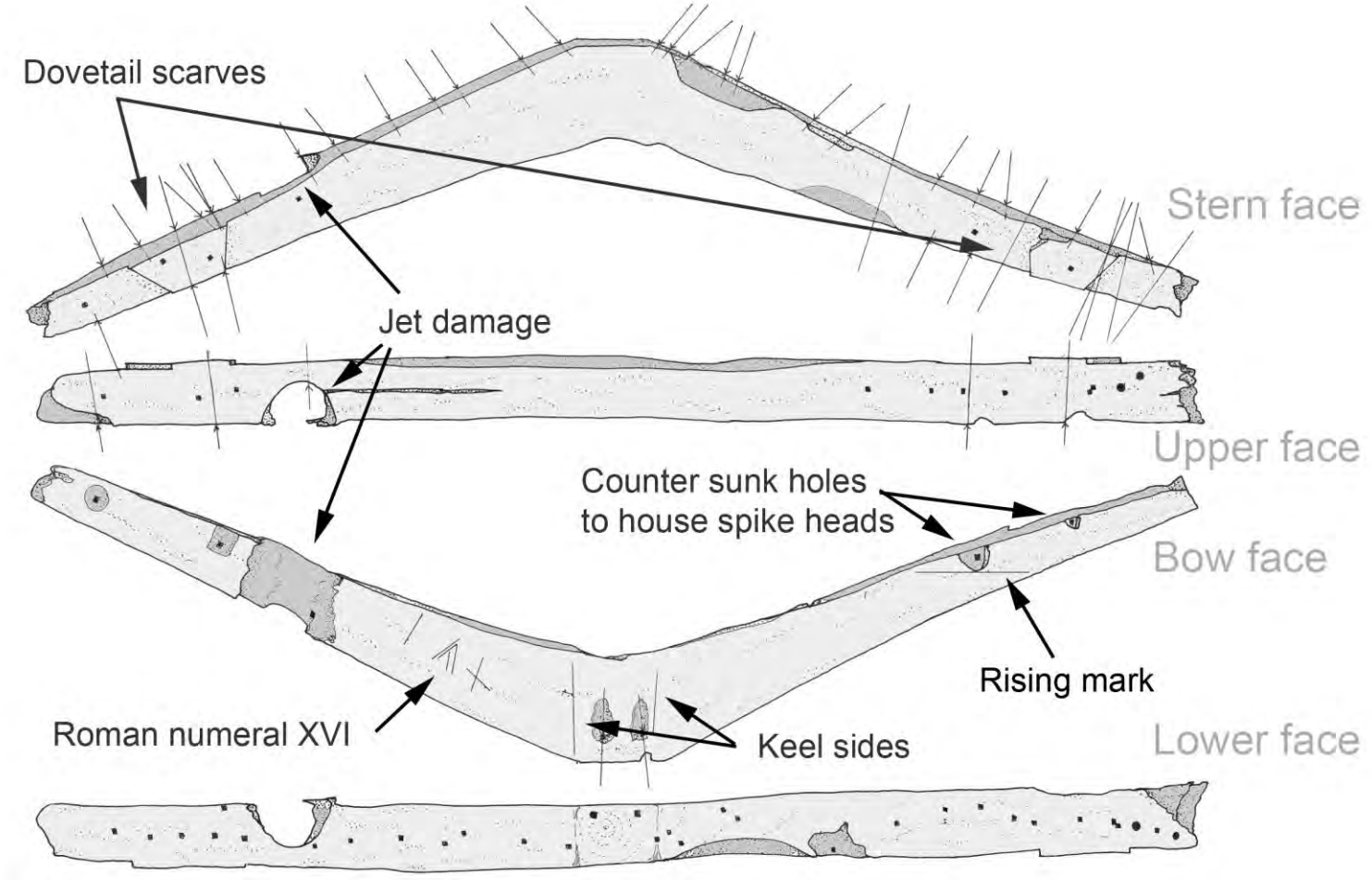
A new model of the shipwreck was developed and used to analyze its structure.

Drawing: Thomas Derryberry



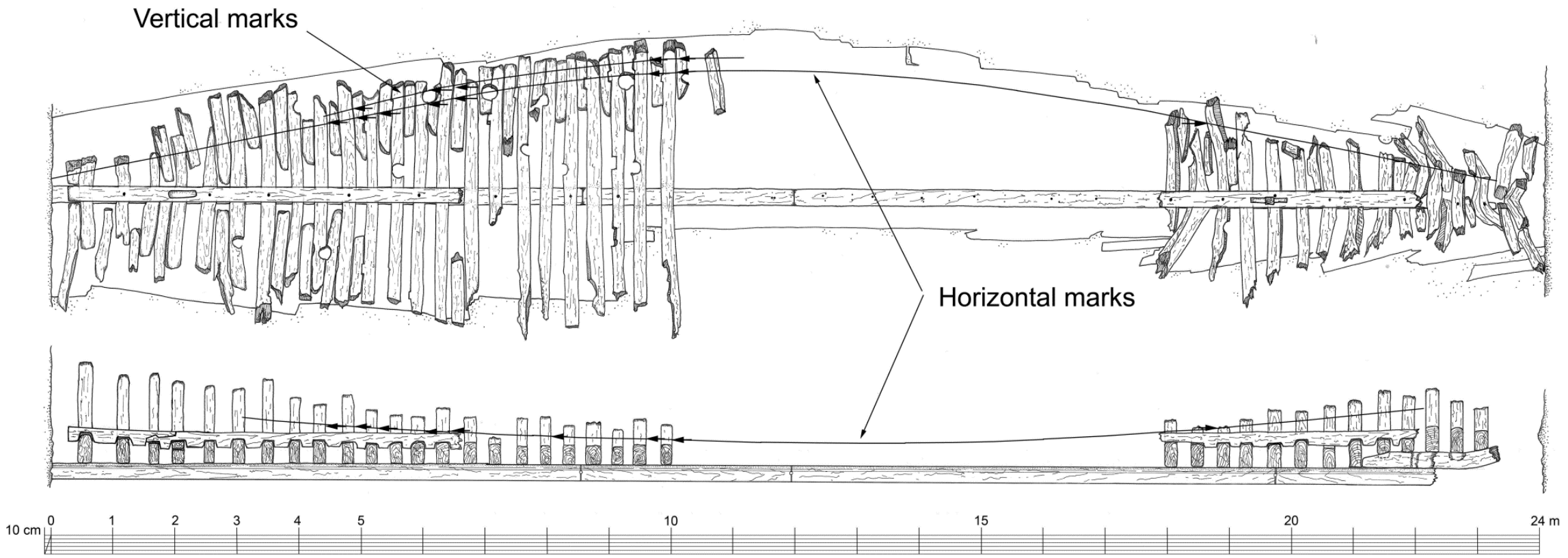
Drawing: Kevin Gnadinguer

The most important characteristic of this shipwreck were the construction marks inscribed on the floor timbers:

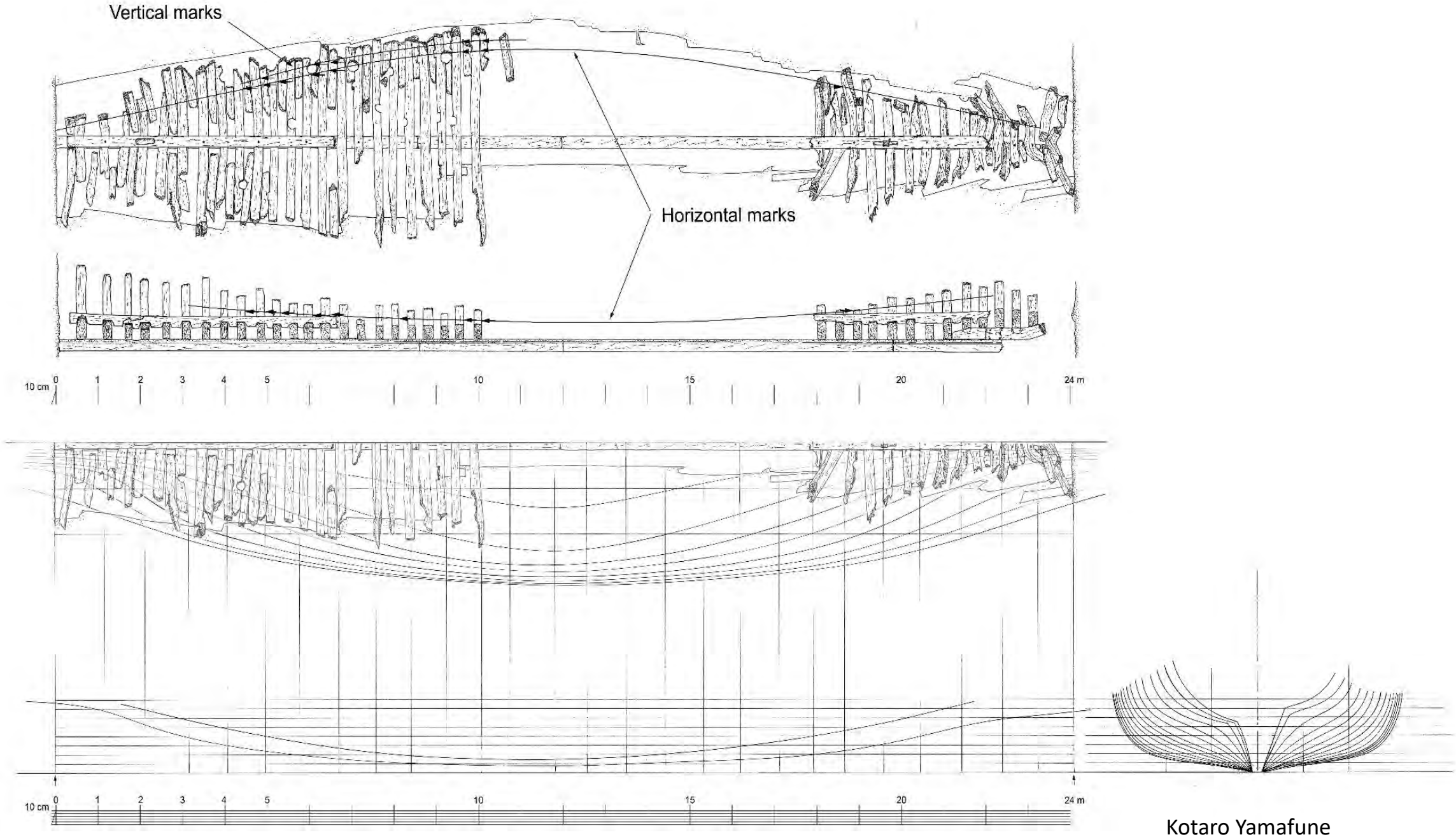


Drawing: Filipe Castro

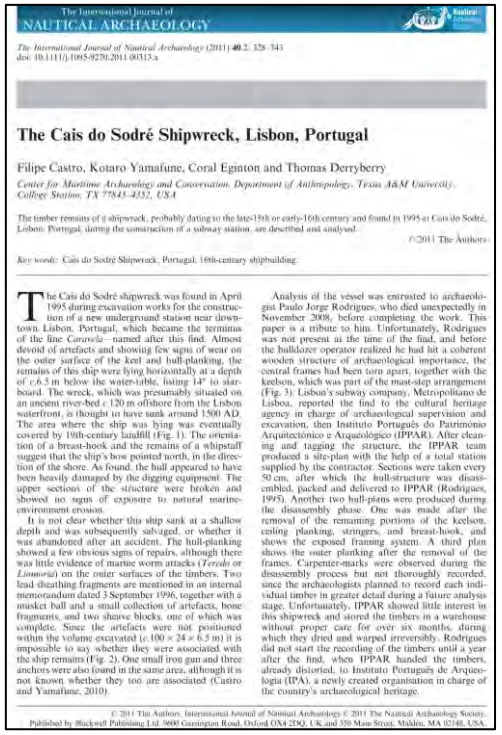
A first attempt to understand the rising and narrowing patterns failed to yield a clear method:



Drawing: Filipe Castro



Kotaro Yamafune



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The Cais do Sodré Shipwreck, Lisbon, Portugal

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The timber remains of a shipwreck, probably dating to the late-15th or early-16th century and found in 1995 at Cais do Sodré, Lisbon, Portugal, during the construction of a subway station, are described and analysed.

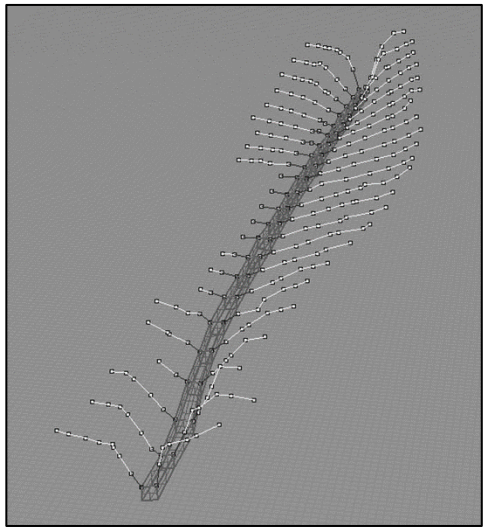
Key words: Cais do Sodré Shipwreck, Portugal, 16th-century shipbuilding.

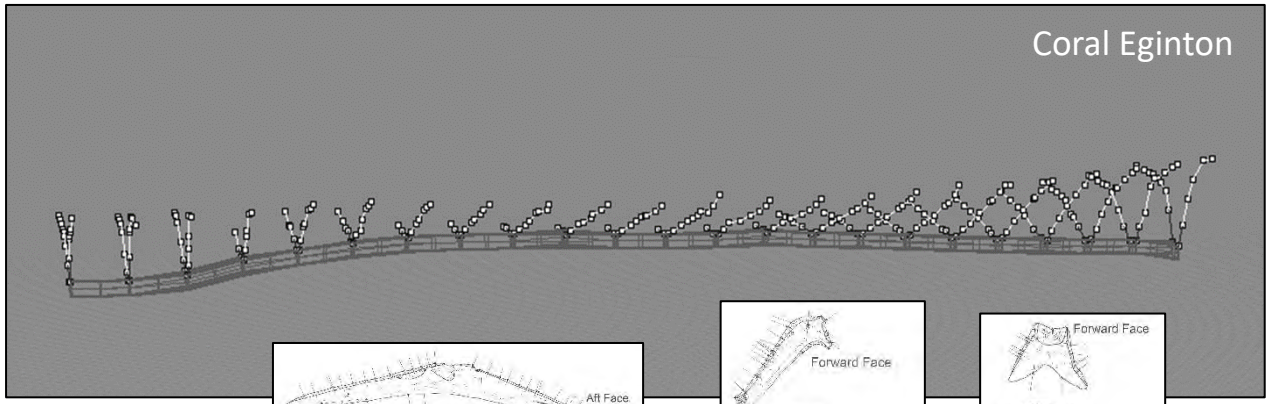
The Cais do Sodré shipwreck was found in April 1995 during excavation works for the construction of a new underground station near downtown Lisbon, Portugal, which became the terminus of the line *Caravela*– named after this find. Almost devoid of artefacts and showing few signs of wear on the outer surface of the keel and hull-planking, the remains of this ship were lying horizontally at a depth of *c.*6.5 m below the water-table, listing 14° to starboard. The wreck, which was presumably situated on an ancient river-bed *c.*120 m offshore from the Lisbon waterfront, is thought to have sunk around 1500 AD. The area where the ship was lying was eventually covered by 19th-century landfill (Fig. 1). The orientation of a breast-hook and the remains of a whipstaff suggest that the ship's bow pointed north, in the direction of the shore. As found, the hull appeared to have been heavily damaged by the digging equipment. The upper sections of the structure were broken and showed no signs of exposure to natural marine-environment erosion.

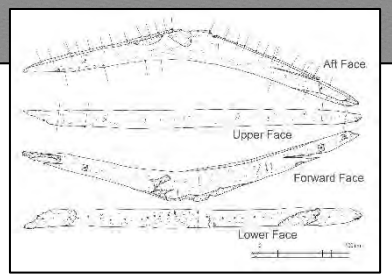
It is not clear whether this ship sank at a shallow depth and was subsequently salvaged, or whether it was abandoned after an accident. The hull-planking showed a few obvious signs of repairs, although there was little evidence of marine worm attacks (*Teredo* or *Limnoria*) on the outer surfaces of the timbers. Two lead sheathing fragments are mentioned in an internal memorandum dated 3 September 1996, together with a musket ball and a small collection of artefacts, bone fragments, and two sheave blocks, one of which was complete. Since the artefacts were not positioned within the volume excavated (*c.*100 × 24 × 6.5 m) it is impossible to say whether they were associated with the ship remains (Fig. 2). One small iron gun and three anchors were also found in the same area, although it is not known whether they too are associated (Castro and Yamafune, 2010).

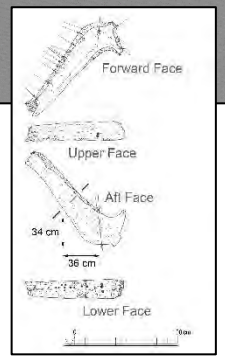
Analysis of the vessel was entrusted to archaeologist Paulo Jorge Rodrigues, who died unexpectedly in November 2008, before completing the work. This paper is a tribute to him. Unfortunately, Rodrigues was not present at the time of the find, and before the bulldozer operator realized he had hit a coherent wooden structure of archaeological importance, the central frames had been torn apart, together with the keelson, which was part of the mast-step arrangement (Fig. 3). Lisbon's subway company, Metropolitano de Lisboa, reported the find to the cultural heritage agency in charge of archaeological supervision and excavation, then Instituto Português do Património Arquitectónico e Arqueológico (IPPAR). After cleaning and tagging the structure, the IPPAR team produced a site-plan with the help of a total station supplied by the contractor. Sections were taken every 50 cm, after which the hull-structure was disassembled, packed and delivered to IPPAR (Rodrigues, 1995). Another two hull-plans were produced during the disassembly phase. One was made after the removal of the remaining portions of the keelson, ceiling planking, stringers, and breast-hook, and shows the exposed framing system. A third plan shows the outer planking after the removal of the frames. Carpenter-marks were observed during the disassembly process but not thoroughly recorded, since the archaeologists planned to record each individual timber in greater detail during a future analysis stage. Unfortunately, IPPAR showed little interest in this shipwreck and stored the timbers in a warehouse without proper care for over six months, during which they dried and warped irreversibly. Rodrigues did not start the recording of the timbers until a year after the find, when IPPAR handed the timbers, already distorted, to Instituto Português de Arqueologia (IPA), a newly created organisation in charge of the country's archaeological heritage.

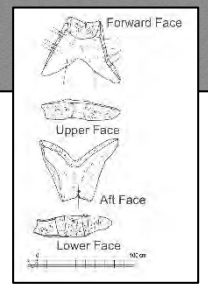
In 2011 the results of this work were published in IJNA

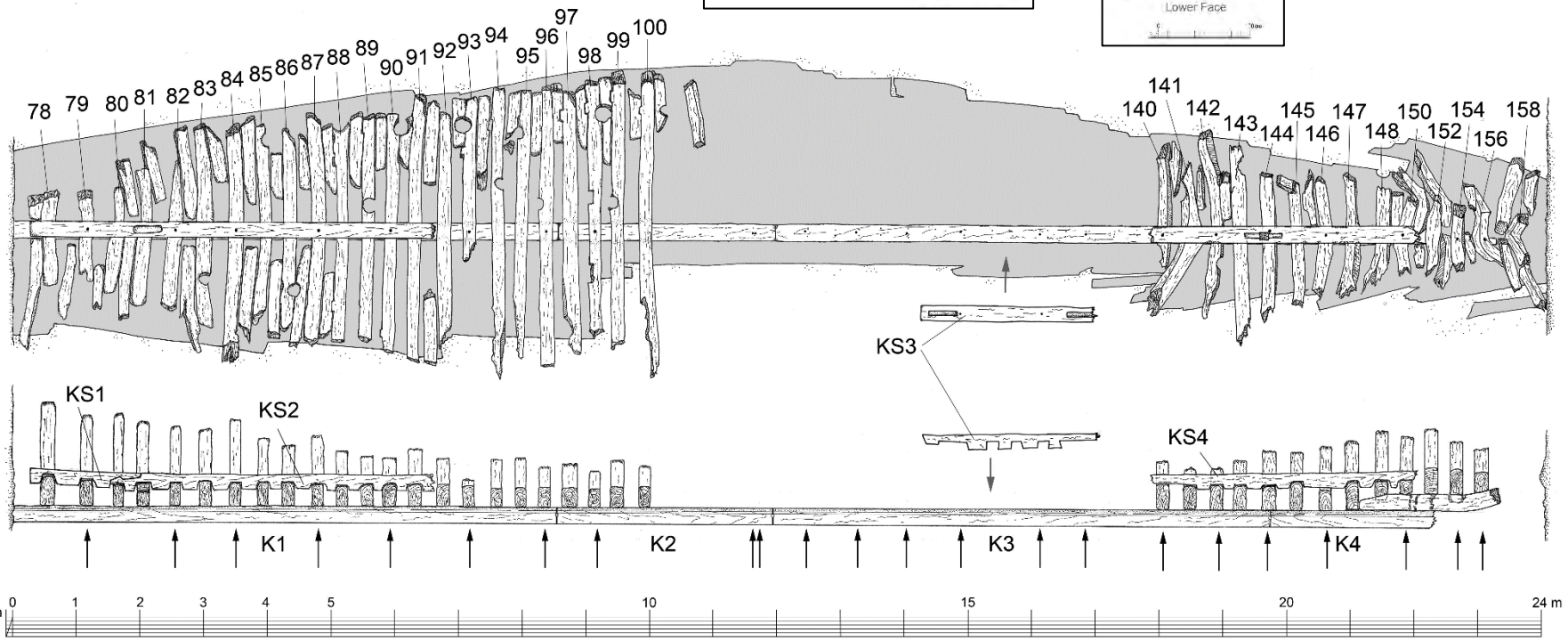




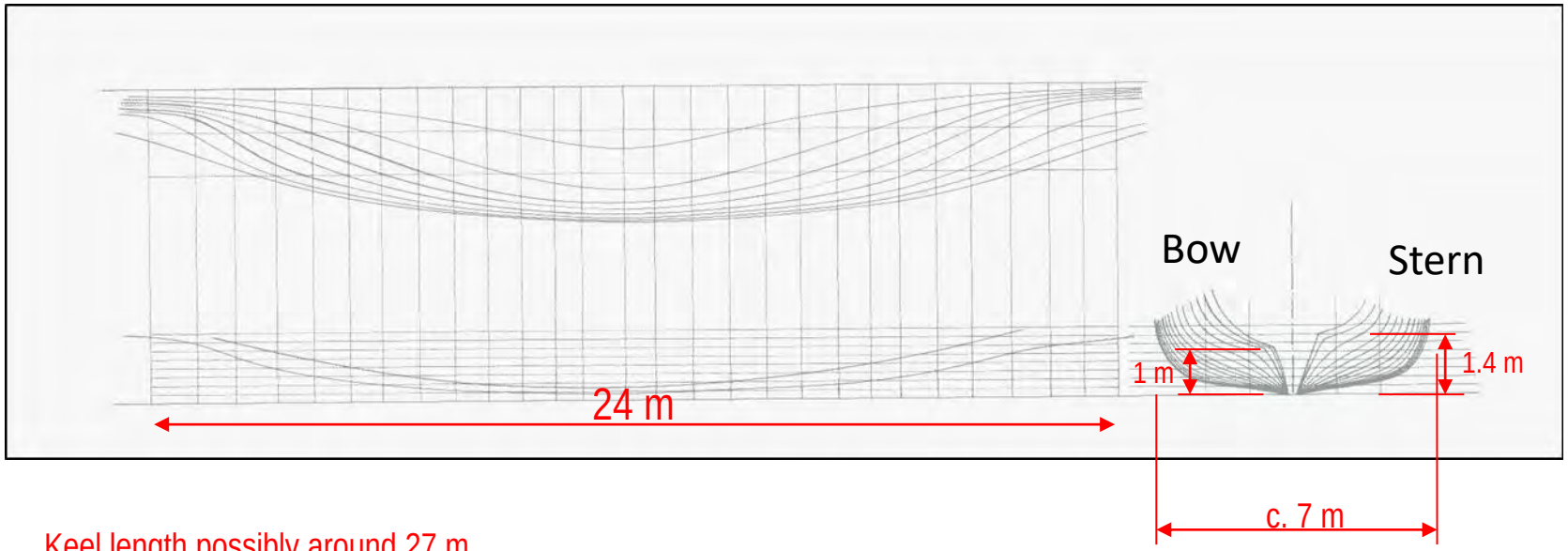








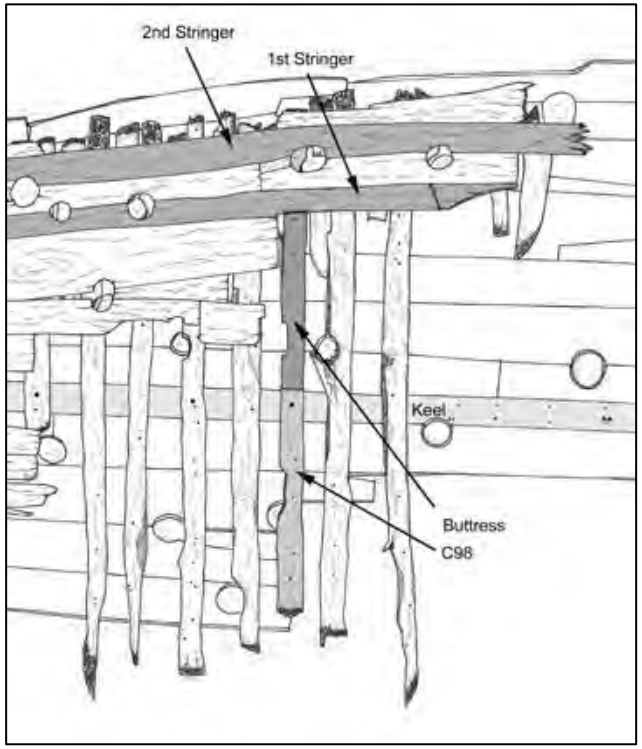
Given the shapes of the entries and runs and taking into account the relatively light scantlings for the size of this ship, we believe that this may be a type of river craft.

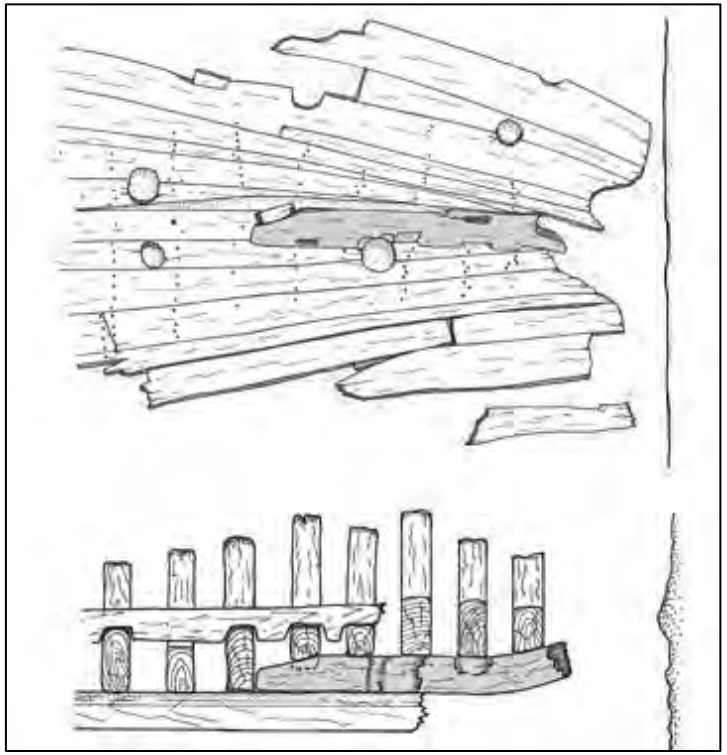


Keel length possibly around 27 m
Max. beam possibly around 8-10 m
Height of the runs possibly not more than 3 m
Height of the entries possibly around 2 m

The presence of a fragment of a whipstaff in the ship bilge – assuming that it belonged to this vessel – argues otherwise. Only further research may shed some light on this study, which is just starting.

Even before the 2011 publication, the data were shared with several scholars and inspired several reconstructions.





In 2013 by Mauro Bondioli and Mariangela Nicolardi (published 2017):

35. Moulds and architectural signs in the skeleton first construction. A methodology to reconstruct the original hull shape of the Cais do Sodré shipwreck (Lisbon, Portugal)

Mariangela Nicolardi & Filipe Castro

The Cais do Sodré shipwreck, Lisbon, Portugal

The Cais do Sodré shipwreck was uncovered in 1995, during the excavation of an underground train station near downtown Lisbon, Portugal. The ship remains were lying horizontally at a depth of around 6.5 m below the water table, listing 14° to starboard. Presumably lying on the ancient riverbed approximately 120 m offshore from the Lisbon waterfront, the ship's timber was ^{14}C dated to around 1500. The area was eventually covered by a 19th-century landfill. The orientation of a breast hook and the remains of a whipstaff suggest that the ship's bow pointed north, in the direction of the shore. Found at night, the excavation machines dug through the centre of the shipwreck, and destroyed the section that contained the master frame(s) and the mast step arrangement. The contractor declared the find to the proper authorities and requested support from the Ministry of Culture to record the site *in situ*, before its removal to a conservation facility. No effort was made to recover the timbers removed by the machines from the Municipal garbage dump. The contractor delivered the timbers to the services of the Ministry of Culture, which unfortunately showed little interest in the shipwreck and let the timber dry and warp (Castro *et al.*, 2011).

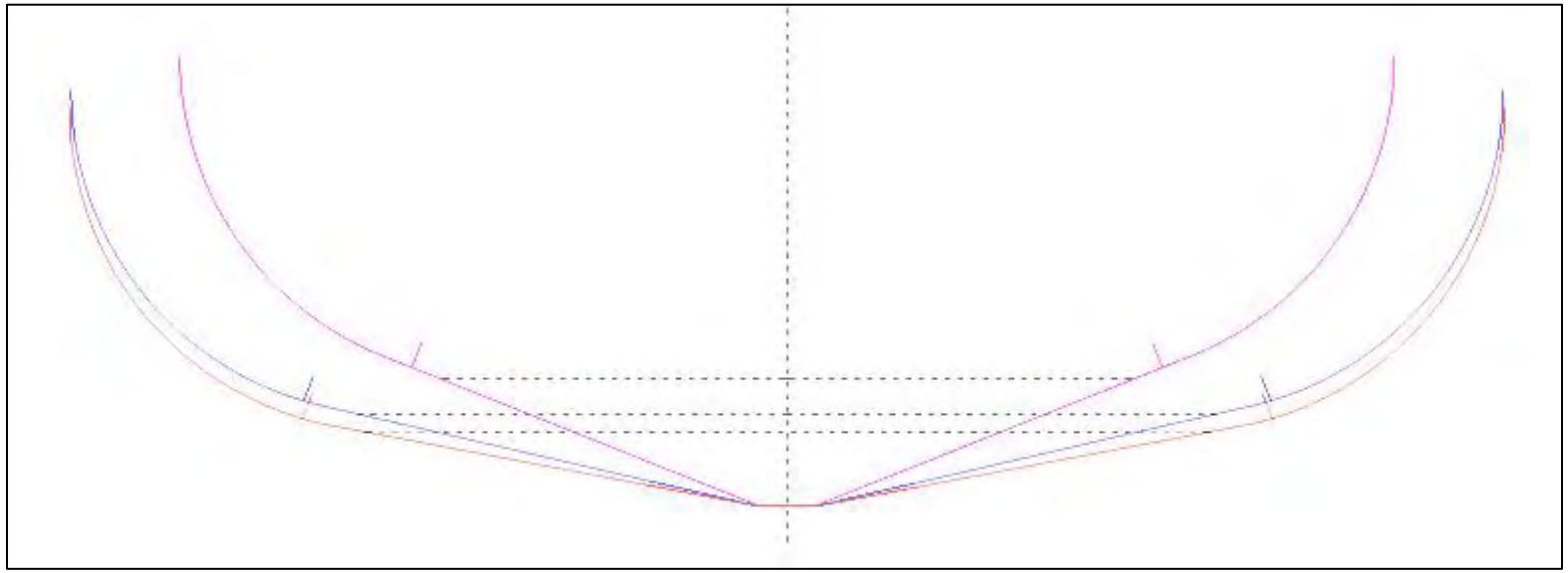
With the help of a theodolite a site plan was produced *in situ*, after which the ship structure was tagged, disassembled, packed and sent to the Portuguese cultural heritage services (Rodrigues, 1995). Carpenter marks were observed during the disassembly process but not thoroughly recorded. Drawings of the warped floor timbers in scale 1:10 and 1:20 were produced in 2001 and 2002 (Castro, 2001, 2002). The ship timbers were studied by archaeologist Paulo Rodrigues, who wrote a thesis on this shipwreck at the Sorbonne University under the supervision of Dr. Eric Rieth. A paper was published in the proceedings of a 1998 meeting held in Lisbon, dedicated to the archaeology of Iberian Atlantic ships (Rodrigues *et al.*, 2001). After the tragic death of Paulo Rodrigues, Filipe Castro was granted permission in 2010 to finish the recording, organize the original drawings, and reconstruct the total station data.

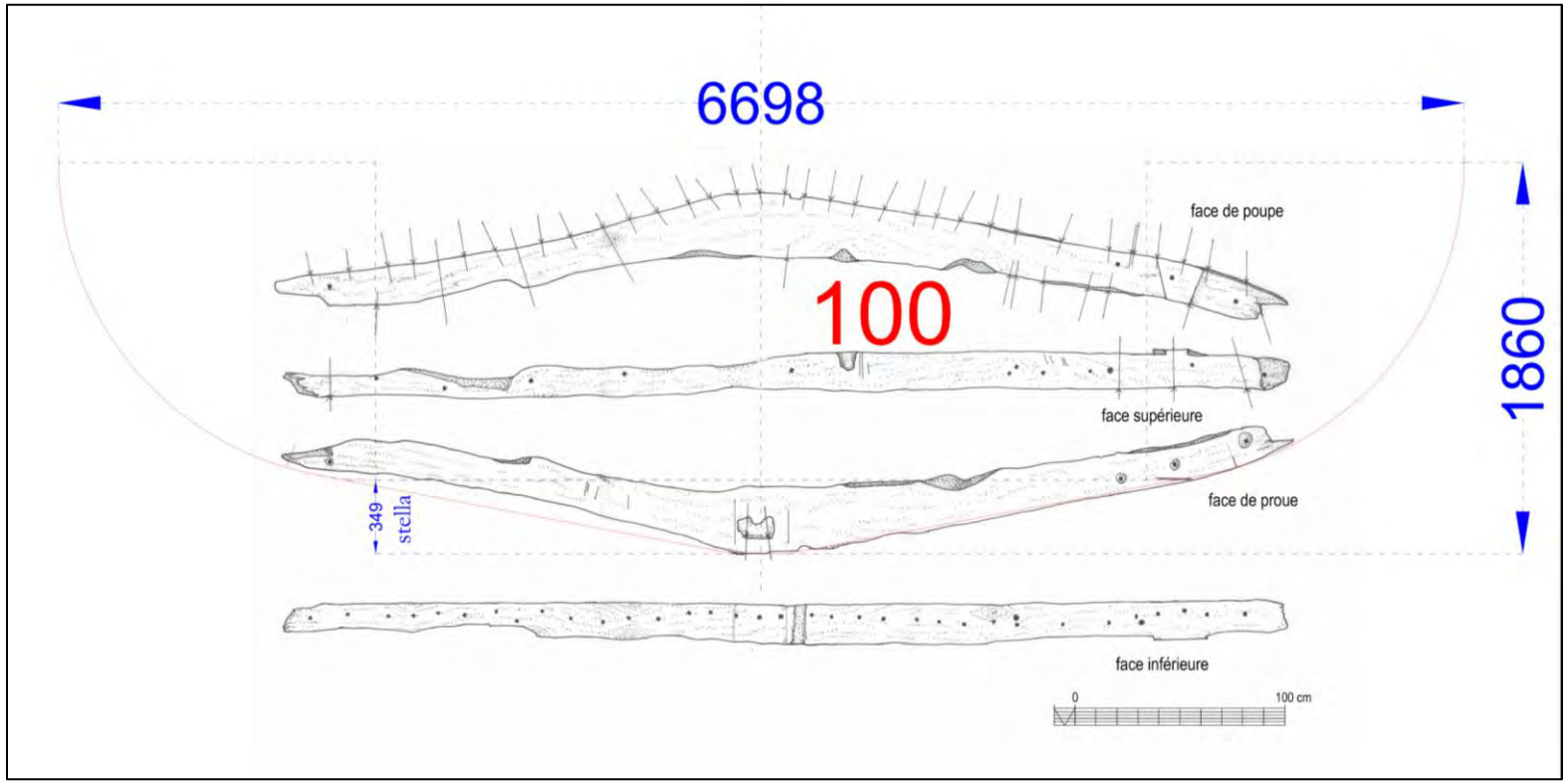
The presence of carpenter marks and Roman numerals on some frames of the Cais do Sodré shipwreck has parallels both in archaeological evidence, observed in other wrecks, and in historical references, such as in the treaties of shipbuilding written from the 15th century onwards. These sources have been the subject of several studies aimed at understanding the cultural history of technical knowledge which is at the basis of the principles and methods of design and construction of the structural elements of the hull's shape (e.g. Palou *et al.*, 1998: 137-189). Following these studies, it was decided to develop a further line of research, parallel to the results obtained in the study of the wreck of the Cais do Sodré (Castro *et al.*, 2011), in order to formulate a complementary reconstructive hypothesis of the original shape of the ship's hull. This paper compares the archaeological data of the wreck with the technical information obtained from contemporary written sources in order to formulate a tentative hypothesis on the original design of the shipwright. Here, the development of the aft section of the wreck, which is best preserved, will be illustrated.

The role of written sources in the original hull shape reconstruction process

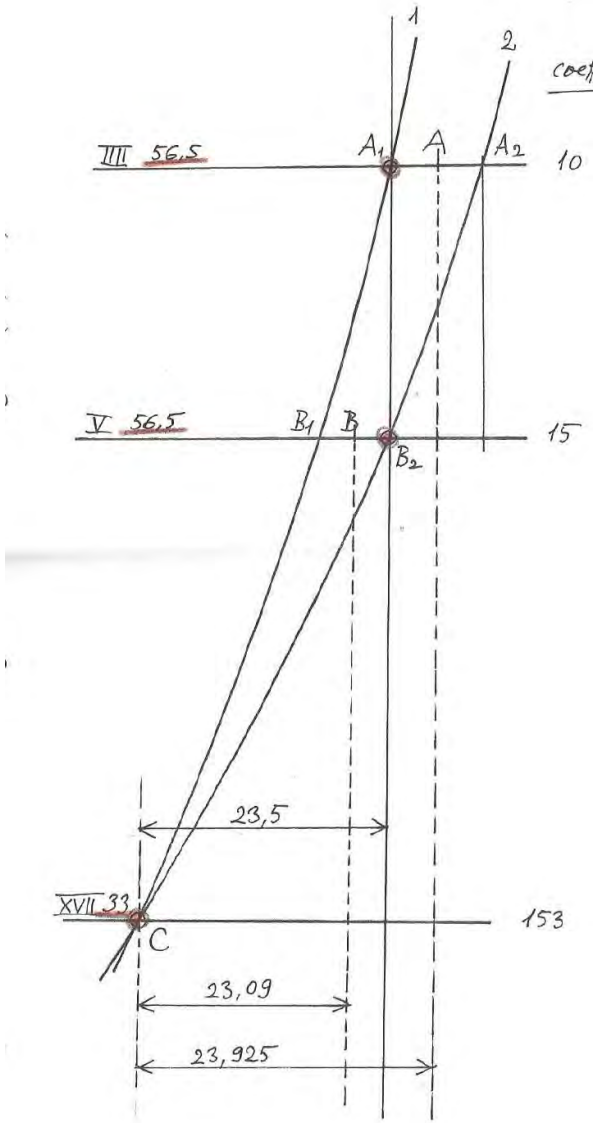
The reconstitution of the original shape of the hull of a ship is undoubtedly a crucial and delicate phase in the methodology of archaeological research. This step, starting from the documentation of the structural remains of the hull, includes:

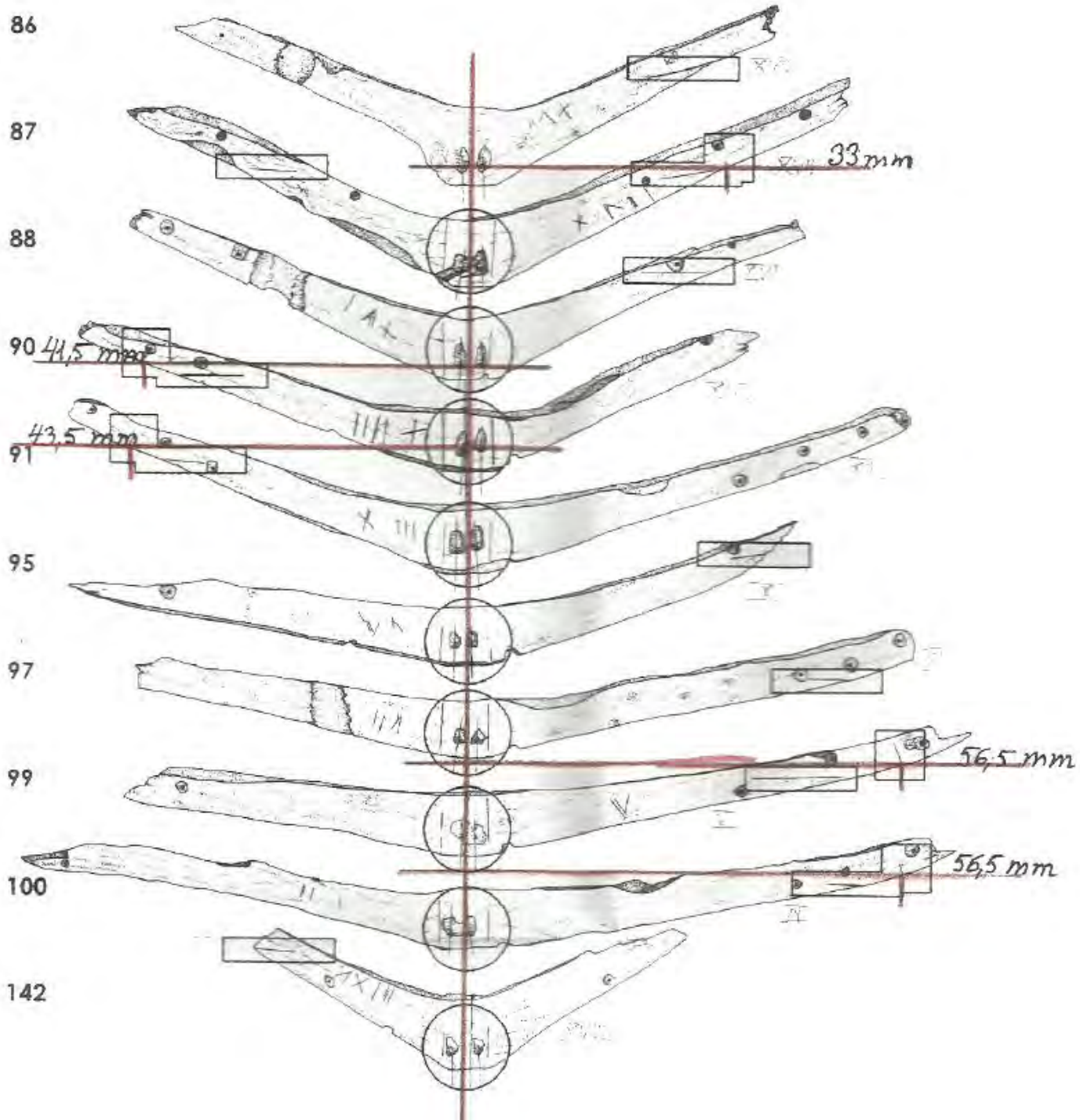
1 remodeling of the structural components of the warped wreck;
2 reassembly and reconstruction of the fragmented remains;
3 relocation of the elements that have undergone spatial dislocation into their original position;



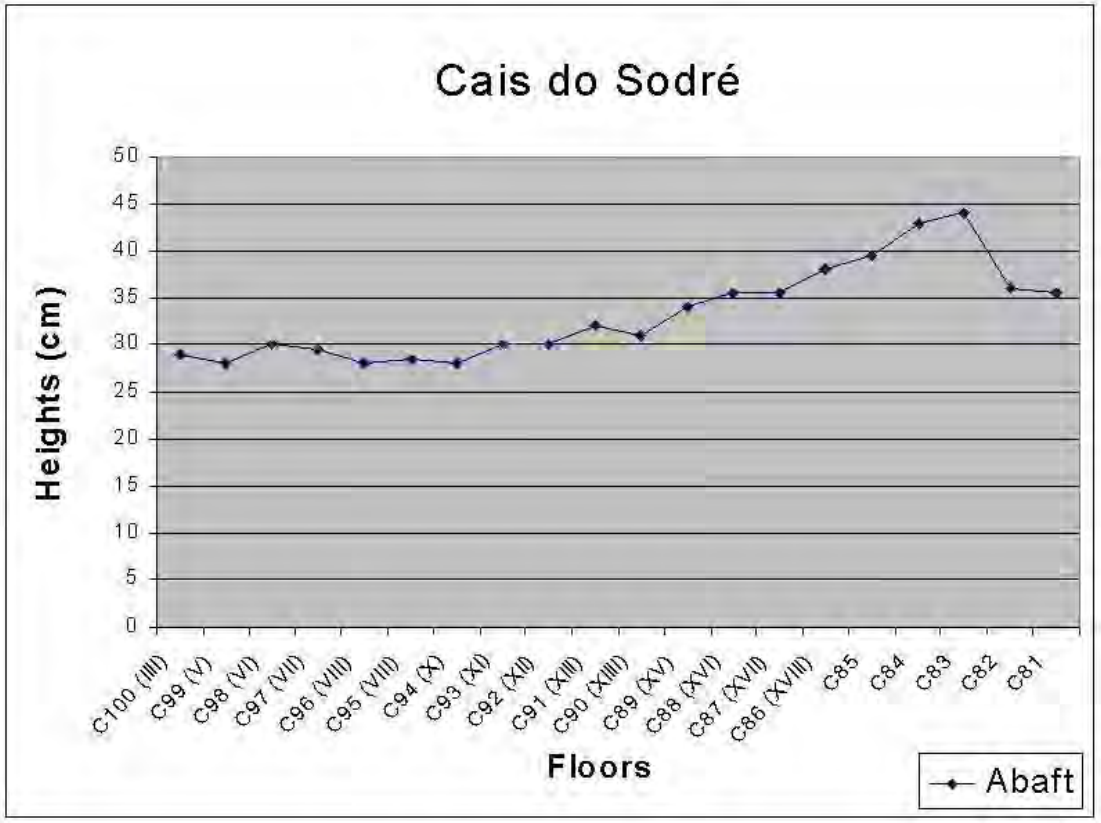


In 2017 by Paul Bloesh:

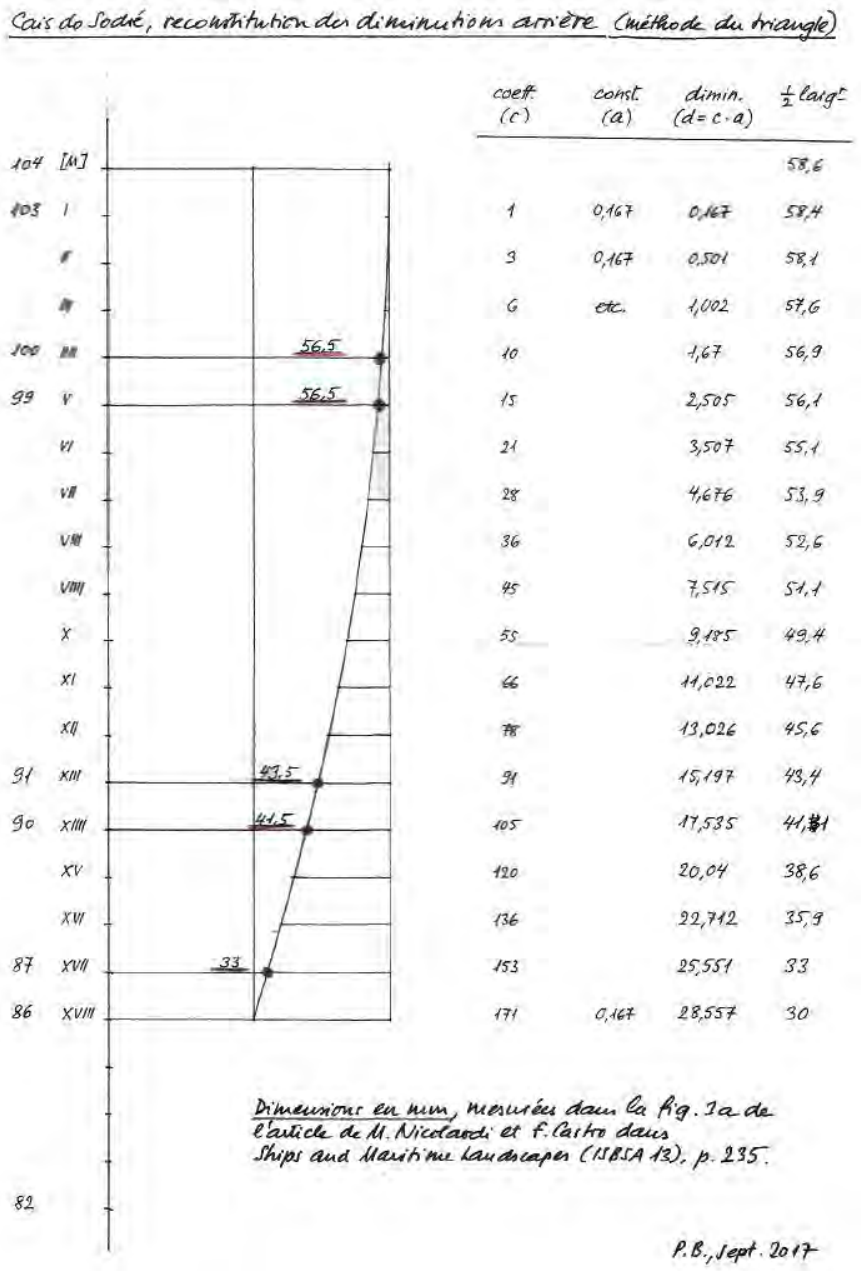




Paul Bloesh calculated the narrowing of the floor timbers abaft from 5 known values and obtained a fair and plausible curve.



We encourage any other scholars to try their own reconstruction.




The timbers have been stored, waiting to be re-studied.
5.1
5.2
5.3
5.4
5.5
4.1
4.2
4.3
4.4
4.5
3.1
3.2
3.3
3.4
3.5
2.1
2.2
2.3
2.4
2.5
1.1
1.2
1.3
1.4
1.5


Thank you!