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Pigments from the *Zuiddorp* (*Zuytdorp*) ship sculpture: red, white and blue?

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SUMMARY: The Dutch East India Company ship Zuiddorp *(also known as* Zuytdorp*) met its demise in 1712 at the base of steep cliffs along the Western Australian coast. Material from the shipwreck includes an extraordinary example of a caryatid herm from the ship's stern counter. A recent study of this sculpture and the pigments found on its surface demonstrates* Zuiddorp*'s archaic stern construction and adornment, which is more of a late 17th-century, than an early 18th-century, Dutch Indiaman. This paper discusses the results of this study and emphasizes how the smallest pieces of evidence can broaden our understanding of contemporaneous regional Dutch East India Company shipbuilding practices.*

INTRODUCTION

This paper aims to add to the dataset of existing pigment studies of Dutch Renaissance sculptures and provide comparative records for studies of ship decorations. It highlights one of the ongoing investigations on the caryatid herm of the early 18th-century Dutch East India Company ship *Zuiddorp*,[1] and is focused specifically on the white, red and blue pigments found on the herm's surface and inside surface cracks. These pigments were analysed using scanning electron microscopy (SEM), X-ray fluorescence (XRF), X-ray diffraction (XRD) and infrared spectroscopy in an attempt to identify their composition. The results assist in the identification of the types of pigments used by the craftsmen who specialized in ship decorations, in particular, those of the Dutch *Verenigde Oostindische Compagnie* (United East India Company or VOC) ships.

A small number of 17th- and 18th-century ship sculptures have survived in historical or archaeological contexts.[2] Two exceptional cases should be noted before discussing examples from Dutch ships. The first case — undoubtedly the best known and offering the most examples, some 200 in number — is that of the 1628 Swedish warship *Vasa*.[3] Secondly, sculptures and carved decorations found on European ships include a collection of spectacular French pieces, but dating mainly to the late 18th century and more recent times.[4]

From Dutch ships, there is a sculpted satyr from an unknown 17th-century historic context in the collection of the Maritime Museum in Rotterdam (object no. M2163). It once supported a ship's cathead and measures 1.78m in height.[5] Dutch maritime museum collections probably contain more ship decorations from the 17th and 18th centuries, but they have yet to be studied and published in great detail.[6] One such example is the well-preserved corner herm (*hoekman*) of a Roman warrior dated to *c*. 1650–75 in the Amsterdam National Maritime Museum (object no. S.3482[01]); it stands 1.63m tall, is 43cm in width and 41cm in depth, and weighs 80kg.[7]

More recently, archaeologists raised a *hoekman* — possibly that of a well-to-do merchant — from the so-called 'Ghost Ship', a possible flute or fluit

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(a Dutch cargo vessel)[8] found in Swedish waters in the Baltic Sea. Excavators also recovered three sculptures from the Swash Channel shipwreck, located in the Swash shipping channel at the entrance to Poole Harbour in Bournemouth, UK. Furthermore, archaeologists recorded transom carvings on the 'Lion Wreck', a Baltic trader that sank in the Stockholm Archipelago. The studies of these recent finds, all considered to be of Dutch origin from the second quarter of the 17th century, are ongoing and their results have yet to be published.[9] The *Zuiddorp* sculpture is the only example from early 18th-century Dutch India ships and, therefore, is a significant addition to the limited corpus of such archaeological remains.

BACKGROUND

The VOC ship *Zuiddorp*sank in 1712. The 1,152-ton vessel had made two successful voyages in 1702 and 1707 from the Wielingen shipping channel (the province of Zeeland, Netherlands) to Batavia (present-day Jakarta, Indonesia).[10] Its fateful third voyage commenced on 27 July 1711, when it set sail from the port of Vlissingen on the south coast of the Zeeland island of Walcheren. Due to unfavourable conditions encountered on route along the West African coast, the ship arrived at the Cape of Good Hope in South Africa having lost 112 of its 286 crewmembers. There, an additional 22 men jumped ship. Before *Zuiddorp* could continue its journey, more than 100 new crewmembers had to be enlisted. Severely delayed, it finally set sail for Batavia in April 1712, never to be seen again.[11]

Of all East India ships known to have wrecked off the west coast of Australia, *Zuiddorp* was the only one to vanish without trace. During the previous century, the VOC had expended a great deal of time and effort looking for survivors of wrecked ships, and had lost several boats and search crews in the process.[12] As a result, the Company abandoned *Zuiddorp*'s crew and passengers to their fate, thus rendering the archaeological remains their only record.

In 1927, local residents Ernest and Ada Drage and Tom and Lurleen Pepper first spotted wreckage from an unidentified ship north of the mouth of the Murchison River and the present-day town of Kalbarri in Western Australia (Fig. 1).[13] The remains strewn on top of the cliff and along the shoreline included the carved figure, glass sherds, breech blocks and other items. Tom Pepper was head stockman on Tamala Station and first reported the finds to authorities in 1931.[14] Later, in 1954, Phillip Playford organized an expedition with the backing of Western Australian Newspapers Ltd and found more relics along the shoreline, including coins, which confirmed the site as that of *Zuiddorp*. The coins were from a distinct 1711 mintage carried from the Netherlands to Batavia in convoy by the VOC ships *Zuiddorp* and *Belviet*. The latter arrived at its intended destination, whereas *Zuiddorp* did not.[15]

The *Zuiddorp* site is located at the foot of the precipitous Zuytdorp cliffs on the remote, rocky Western Australian coastline between Gantheaume Bay and Shark Bay (Fig. 2). Although lying only meters from shore, the submerged wreck site was not seen until 1964 due to the adverse surf conditions. Between 1971 and the late 1990s, the Western Australian Museum led extensive archaeological investigations of the wreck and its adjacent land sites.[16]

THE *ZUIDDORP* SHIP AND ITS CONSTRUCTION

The ship itself was constructed in 1701 by the Zeeland Chamber of the VOC. It was the last ship built under the supervision of resident shipwright Henrik Penne. *Zuiddorp*'s keel was laid in December 1700, but Penne died before he could see the completion of what would have been his 38th VOC ship. He was buried on 18 January 1701 and his replacement, Ani[y]as, completed *Zuiddorp*'s construction on 22 June 1701. Of the 38 ships commenced by Penne, only four, including *Zuiddorp*, were 160ft (*c.* 45m) in length; all others were of a smaller charter.[17]

According to VOC guidelines, ships built to the same charter as *Zuiddorp* were to be armed with 38 cannon: ten twelve-pounders, 20 eight-pounders, and eight four-pounders.[18] The manifest from *Zuiddorp*'s last voyage lists '38 stucken 6 [b]assen', which refers to 38 cannon plus, or including, six swivel guns.[19] The swivel guns were four-pounders located on the ship's quarterdeck, and included the only breech-loading armament aboard the vessel. Iron and bronze muzzle-loading cannon comprised all other armament. The swivel guns were made of bronze, as were two of the larger muzzle-loading cannon in the vicinity of the ship's compasses.[20]

One bronze cannon and two iron cannon have been recovered from the *Zuiddorp* shipwreck. In addition, the remains of at least seven bronze swivel guns were raised from the site, of which six are muzzle-loading and one breech-loading. Today, at least, fifteen iron cannon and one bronze ship cannon remain visible on the shipwreck site.[21] All other cannon aboard at the time of *Zuiddorp*'s sinking remain buried in sediments, lie encased in concretions or have completely eroded away in the dynamic and fierce surf zone in which the shipwreck lies. The turbulent surf that breaks upon the rock table and cliffs forms an extremely adverse environment detrimental to the ship's preservation, and

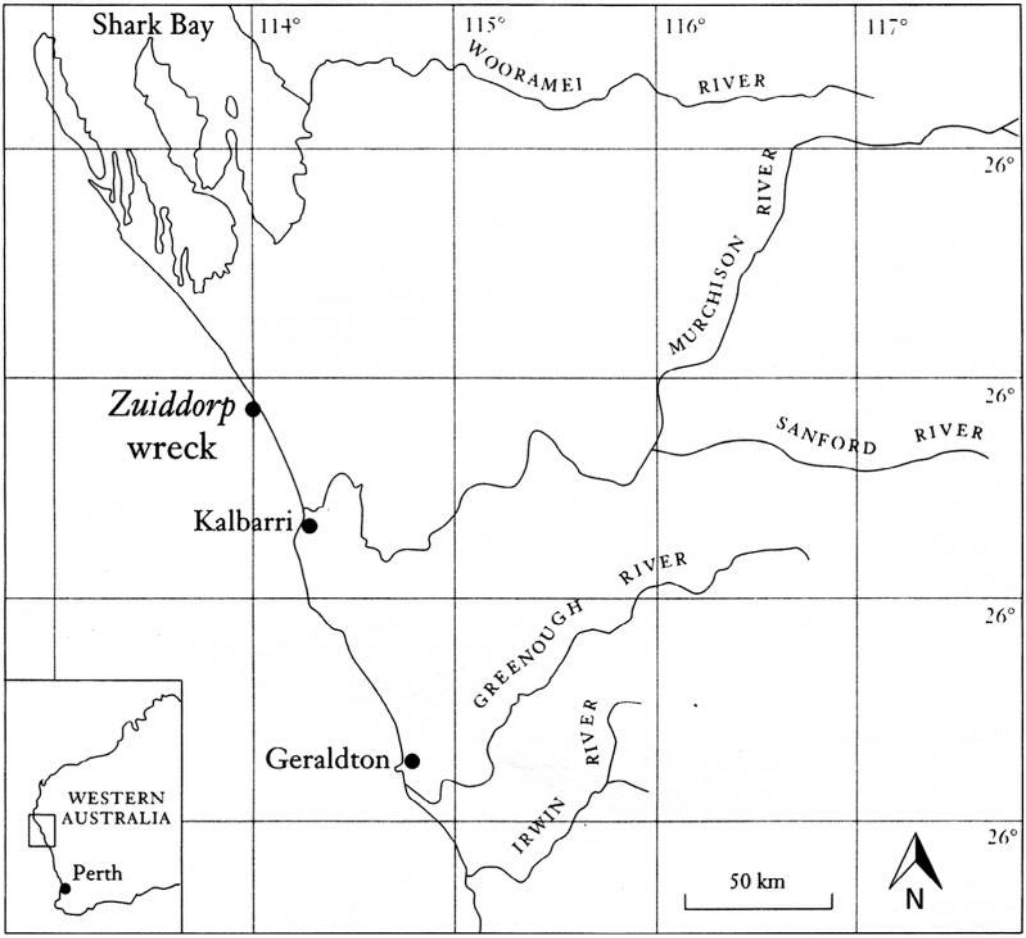

FIG. 1
Location of the *Zuiddorp* shipwreck site, Western Australia (illustration, Wendy van Duivenvoorde).

is the main reason that so little of *Zuiddorp*'s hull has survived.[22]

CARYATID HERM FROM ZUIDDORP'S STERN

The most interesting preserved piece of the *Zuiddorp* ship is one of the sculptures that adorned the ship's stern. Tamala Station stockman Tom Pepper found it in April 1927, wedged under a large rock among the boulders at the foot of the cliff (Fig. 3). He collected it years later, probably before the first *Sunday Times* expedition to the site in 1941, and safeguarded it for decades until the Pepper family loaned it to the Western Australian Museum in Geraldton in the 1970s.[23]

This unique sculpture is the only known surviving 18th-century caryatid herm from a Dutch East India Company ship. The figure is that of a grotesque female with a wreath on her head, a bust in the form of a lion's head, and a distinctly rounded potbelly. The *Zuiddorp* caryatid has no obvious breasts that would confirm the sex of the being, but male figures typically wore helmets or animal skulls rather than wreaths.[24]

Herms and caryatids, also known as 'terms', are 'pilasters in high relief, not rounded three-dimensional sculptured figures, intended to be attached to the curved and clinker-built gallery' and stern register of ships.[25] They are an example of supporting figures characterized by partial transformation, with the lower part of the body being an architectural

FIG. 2
The Zuytdorp Cliffs, Western Australia (photograph, Patrick Baker, © WA Museum, ZUYD_521).

form or a marine animal (typically fish tails, either two entwined or a single tail entangled in that of a fish or dolphin). As discussed by Soop, the words 'herm' and 'caryatid' (or 'caryatid herm') are used to distinguish between male and female herms, respectively.[26]

The *Zuiddorp* caryatid herm measures 145.5cm in height, 44cm in depth and 34cm in width, and weighs 34kg. The sculptor fashioned it from a solid piece of pine (*Pinus sylvestris*).[27] A contract with the VOC Zeeland shipyard from the year *Zuiddorp*was completed records that the total cost for all sculpting work on a VOC ship of its size was only 70 *Vlaamse ponden* (Flemish pounds, with an exchange rate of six Dutch guilders per pound). This is a negligible sum (less than half a per cent) in comparison to the overall cost of such a large Indiaman (a large merchant ship in service of the East or West India Companies), estimated to have been approximately 100,000 guilders.[28]

The sculpture either came from the ship's lower port register, directly above the counter and below the register with windows, or from the lower port quarter gallery (Fig. 4). Examination of the sculpture's shape, the size and orientation of its iron fastenings and a comparative study exclude the starboard side or other areas of the ship. Details of the sculpture were compared to those of caryatids and herms on *Vasa* and contemporary ship models, such as the 1664 model of warship *Hollandia* (Amsterdam National Maritime Museum, object no. A.0115[03]), as well as those depicted in period paintings and drawings.[29]

Stylistic comparisons and iconographic investigations into ship models, paintings and drawings from the mid 17th to the mid 18th centuries found that the *Zuiddorp* caryatid herm is most similar to the grotesque figurative decorations of the late 17th century. In particular, the lower register of the bell-shaped stern assembly of the aforementioned *Hollandia* model has caryatid herms with wreaths, breast decorations and distinct potbellies analogous to those of the *Zuiddorp* caryatid. Herms and caryatids of comparable style adorned lower registers of the mid 17th-century Dutch East Indiamen *Walcheren* (built 1661) (Fig. 4) and *Prins Willem*(built 1650) (Fig. 5) — both constructed at the same shipyard as *Zuiddorp*.[30]

FIG. 3
Phillip Playford with the *Zuiddorp* caryatid herm (photograph, Todge Campbell, © WA Museum, ZUYH_14).

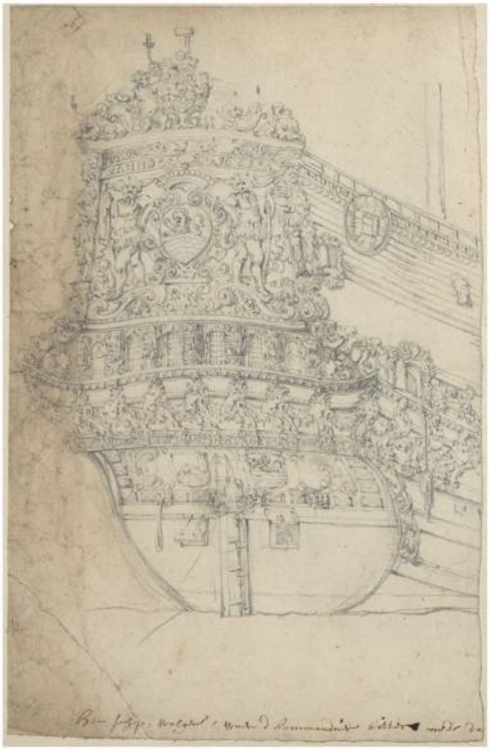

FIG. 4
Drawing of the stern of VOC ship *Walcheren, c*. 1666 (illustration, Willem van de Velde, © National Maritime Museum, Greenwich, object no. PAH1782).

STATE OF PRESERVATION AND CT-SCANS OF ZUIDDORPCARYATID HERM

The sculpture and preserved iron fasteners were observed with a computed-tomography (CT) scanner to determine their state of preservation. The CT-scanning was carried out by Bruce Lamont, director of Geraldton Radiology in St. John Hospital, Geraldton (Fig. 6). The scan consists of 445 sections made across the full length of the sculpture on intervals of 6.5mm, with a 3.2mm overlap, and at a resolution of 512 × 512 pixels.

The CT scans confirm that the wooden sculpture has numerous internal cracks and that its wood matrix has collapsed (i.e. there is no clear distinction between the timber's annual growth rings) (Fig. 7). This accounts for the lightness of the carving, which originally would have weighed over 85kg (based on 391kg/m^3 for juvenile wood, although wood density will vary with growth conditions and age).[31] The internal cracking could be the result of the wood being green when originally carved, or it could have been caused by post-depositional processes after *Zuiddorp*'s wrecking, when the woodwork was subjected to harsh environmental conditions. Lying exposed on the Zuytdorp cliffs, the wooden sculpture would have endured continuous contraction and expansion caused by cyclical weather conditions; the relatively cold and wet winters alternating with the hot and dry summers of Western Australia. The wood certainly also endured severe UV damage resulting from intense sun exposure, evinced by its soft, velvety surface texture (Fig. 8).

WHITE PIGMENT ON THE *ZUIDDORP* SCULPTURE

Study of the *Zuiddorp*sculpture included an investigation of the traces of pigments on its surface (Figs 8–13). White pigment is most prominent and also is found in some of the surface cracks, indicating perhaps

FIG. 5
Stern of VOC ship *Prins Willem*, 1651, ship model (© Rijksmuseum, Amsterdam, object no. NG-NM-11911).

that the wood already had fractures when the sculpture was painted (Figs 8–10). Samples of white pigment presented in this article came from cracks directly forward of the left upper arm attachment (sample no. 1, Figs 9–10), from cracks on the lower left garment rim on the left side of the frontal tassel (sample no. 2, Fig. 11), and from the surface of the proper right garland above the face (sample no. 3, Fig. 12).

X-RAY DIFFRACTION AND INFRARED SPECTROSCOPY

X-ray diffraction (XRD) and X-ray fluorescence spectrometry (XRF) analyses of a white pigment sample were performed by Luc Megens using a Bruker AXS D8 Discover microdiffractometer with CuKα radiation and a Bruker Artax XRF instrument, respectively. The

FIG. 6
Bruce Lamont (right), Wendy van Duivenvoorde (left) and a lab assistant (centre) lining up the *Zuiddorp* caryatid herm for CT-scan. Geraldton Radiology, St John Hospital (photograph, Jon Carpenter, © WA Museum).

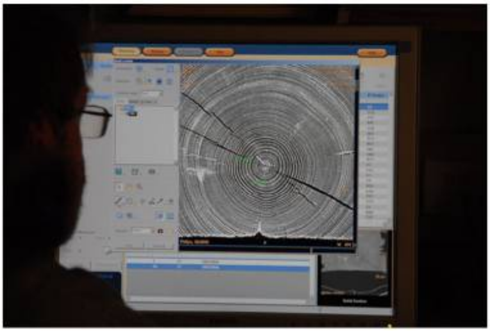

FIG. 7
CT-scan of *Zuiddorp* caryatid herm (photograph, Jon Carpenter, © WA Museum).

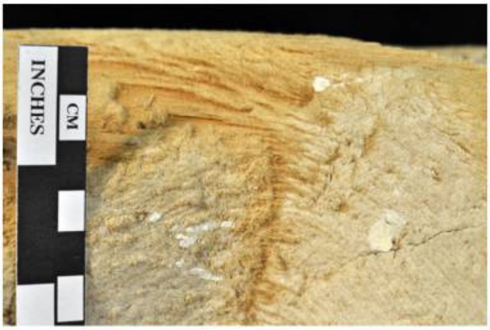

FIG. 8
White pigment on surface of *Zuiddorp* sculpture (reverse side) (photograph, Patrick Baker, © WA Museum).

FIG. 9
White pigment on left upper arm attachment of *Zuiddorp* sculpture, sample no. 1 (photograph, Patrick Baker, © WA Museum).

XRD analysis showed that the white pigment sample probably consists of a mixture of components, while XRF confirmed the main elements to be lead (Pb) and calcium (Ca). Basic lead carbonate, hydrocerussite ($Pb_3(CO_3)_2(OH)_2$), commonly known as lead white, is probably present in the sample, as well as calcium lead phosphate hydroxide (Fig. 14). The latter compound can be formed from hydrocerussite in a phosphate and calcium-containing environment, as found, for example, on a fragment of a Roman mural in the Dutch town of Nijmegen. Lead white probably was used for the original mural, but then transformed into calcium lead phosphate hydroxide while buried.[32]

Infrared spectroscopy of two additional samples confirmed the presence of calcium sulfate dihydrate ($CaSO_4 \times 2H_2O$), which naturally occurs as gypsum (Figs 15–17).[33] The infrared spectroscopy was conducted by Wilhelm van Bronswijk and Peter Chapman at Curtin University using a single-bounce diamond ATR (Attenuated Total Reflectance) accessory on a Perkin Elmer Spectrum 100 infrared spectrometer. Peaks of gypsum also were present in the diffractogram, confirming the infrared spectroscopy results. XRF also was able to corroborate the presence of silicon, titanium and iron, which typically occur in sand — a potential contaminant (Fig. 14). Iron likely also comes from the corroding iron fasteners inside the sculpture.

RED AND BLUE PIGMENTS ON THE ZUIDDORP SCULPTURE

Red pigments used on the *Zuiddorp* caryatid herm no longer survive, but traces of them can be observed in red-stained corners of the various features, such as the tassel and chiselled grooves on the obverse side of the figure. Additionally, there is one spot area with a bluish

FIG. 10
White pigment sample from left upper arm attachment of *Zuiddorp* sculpture, sample no. 1 (photograph, Patrick Baker, © WA Museum).

FIG. 11
Red discolouration and white pigments on lower left garment rim, left side above frontal tassel, sample no. 2 (photograph, Patrick Baker, © WA Museum).

pigment on the sculpture (Fig. 13), which could not be sampled due to its uniqueness. The red stains and blue pigment were analysed in situ using a handheld Bruker Tracer III–V+ XRF instrument. Six additional stainless areas on the caryatid herm were analysed with the same settings for comparison. Figure 18 shows all spots analysed with the handheld XRF analyser. Each area was analysed twice for five minutes each, first in 'lab rat' mode using settings of 40kV, 0.8µA, vacuum and no filter (Figs 19–21, Table 1), and then with settings of 40kV, 6µA, no vacuum and with a 'red' 0.001in (0.0254mm) copper, 0.001in (0.0254mm) titanium, 0.012in (0.3048mm) aluminium filter (Figs 22–23, Table 2).

Unfortunately, this method of analysis has yet to result in a positive identification of the red and bluish pigments. Analysis of the colour-stained areas and those without visible pigment yielded similar results, with calcium, iron and lead being the most prevalent elements on the surface of the *Zuiddorp* caryatid herm. Other elements present in lesser quantities include aluminium, bromine, chlorine, copper, potassium, silicon, strontium, sulphur, titanium and zinc.

The relative net number of photons from each element, collected in the five minutes of analysis at each location, are represented in Tables 1 and 2. It is apparent that most of the aluminium, nickel and copper photons in the spectra come from the Tracer system itself, that is, from the analysing-system excitation (with the exception of the copper in spot analysis no. 5) (Fig. 20). They all have the same intensity, while the other elements demonstrate significant variations (Figs 19–20). They are, therefore, excluded from the following discussion.

Lead (Pb) M-line photons were undetected, but the Pb L-line photons are significant at all locations (Tables 1–2). The Pb M-line photons are only 2,500eV

FIG. 12
White pigment sample from proper tight garland above the face, sample no. 3 (photograph, Patrick Baker, © WA Museum).

FIG. 13
Blue pigment with white ground from lower left arm or other attachment (photograph, Patrick Baker, © WA Museum).

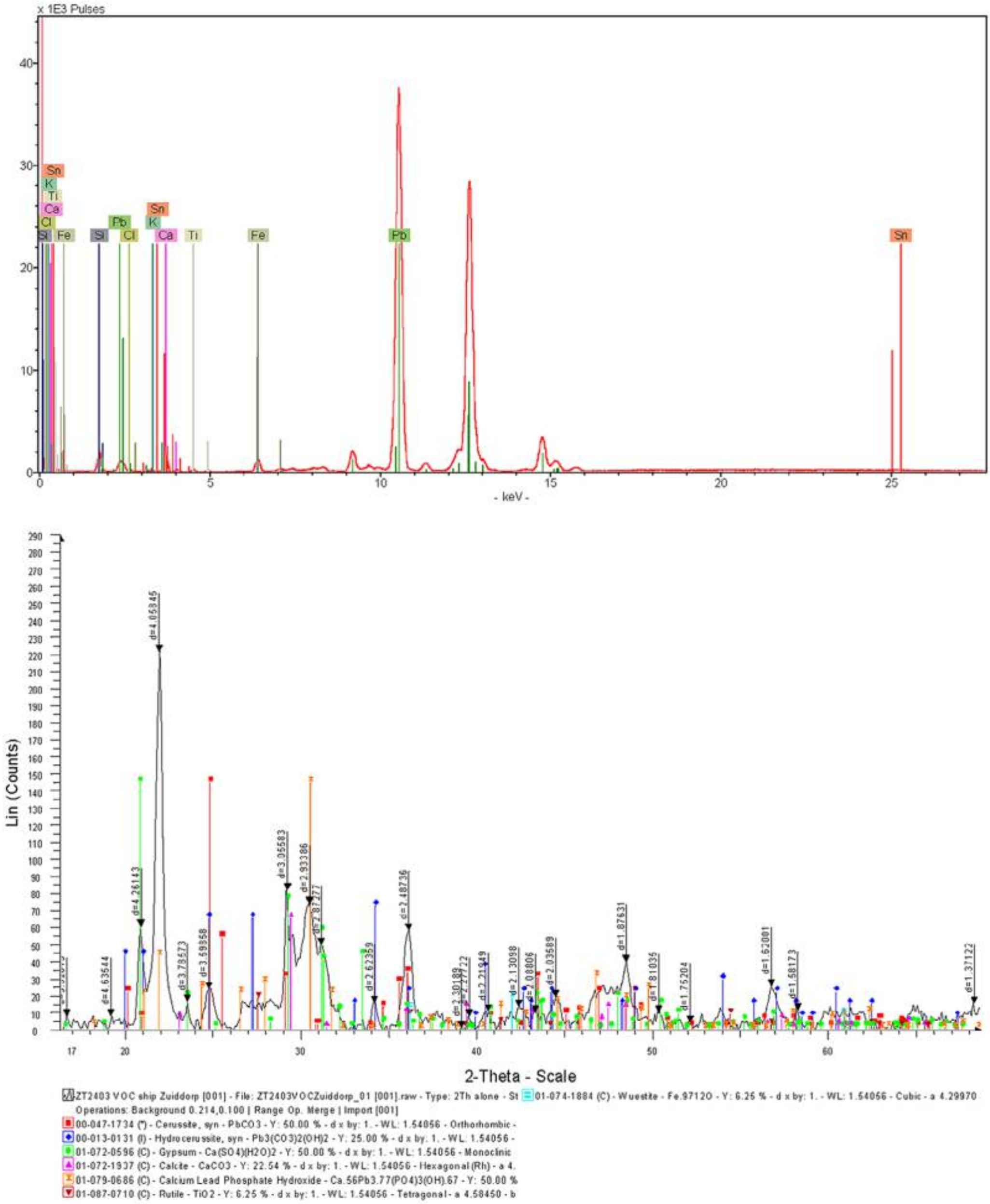

FIG. 14
X-ray diffraction spectrum of *Zuiddorp* pigment sample no. 1 (illustration, Luc Megens).

and cannot penetrate a thin coating, while the Pb L-line photons (10,500eV) excited underneath the coating easily penetrate it to reach the detector if excited. Thus, lead appears everywhere and seems situated underneath a coating of something. The question remains: a coating of what?

The elemental photon data, shown in Figs 19–21 and Table 1, were sorted by the number of calcium photons (from most to least) gathered from each sample.

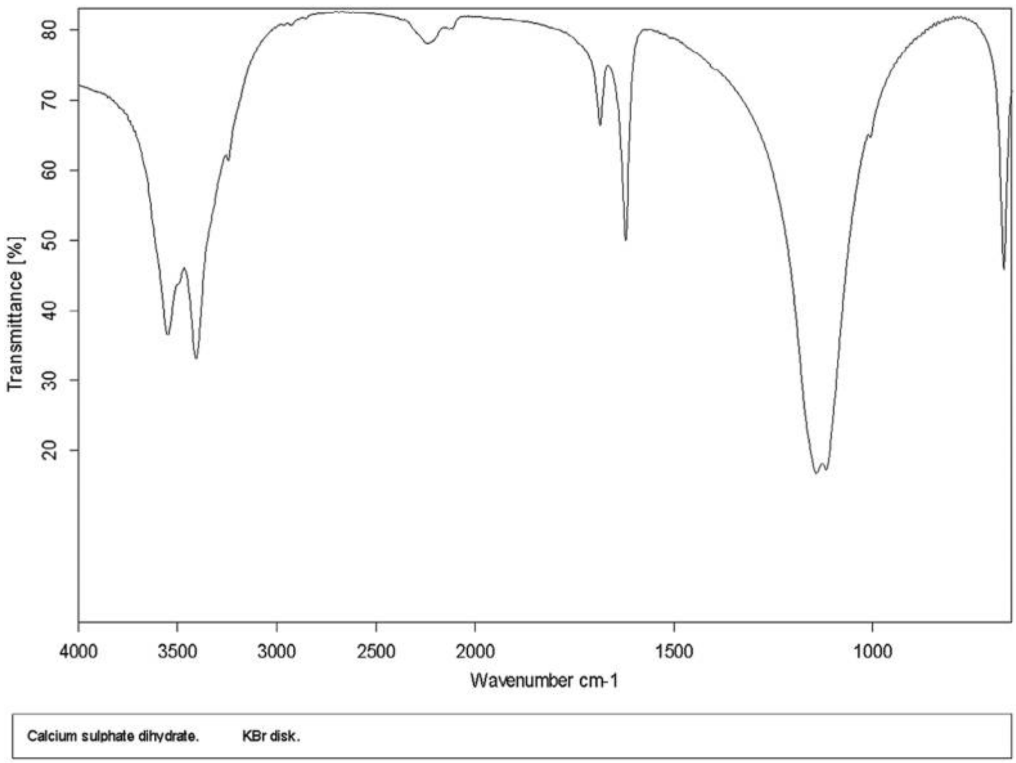

FIG. 15
Infrared spectrum of gypsum (illustration, Wilhelm van Bronswijk & Peter Chapman).

TABLE 1
Results of net area analysis, Bruker Tracer III–V+ XRF machine, 40kV, 0.8μA, vacuum, no filter.

	Al	Br	Ca	Cl	Cu	Fe	K	Ni	Pb L1	S	Si	Sr	Ti	Zn
1. Red pigment stain: right vertical groove in centre panel	1152	2010	49726	1141	356	22094	326	573	6075	1482	1006	2438	966	639
2. Red pigment stain: right side of frontal tassel, third tier	1084	433	483	1	260	449	0	477	798	1	116	326	193	264
3. Red pigment stain: left side of frontal tassel, fourth tier	1141	2711	33149	1809	599	19931	1135	785	13273	3687	1283	3412	1477	1170
4. No pigment traces: centre panel right of tassel	1089	2042	49218	1232	540	19198	636	810	15929	4152	1725	3754	1504	795
5. No pigment traces: top left of pedestal	1209	2472	36604	6413	2408	67997	840	845	3770	2476	1557	3719	2460	9000
6. No pigment traces: directly above belly button	1398	3948	17581	1737	811	11477	1241	1007	3928	3668	1298	4584	874	1976
7. No pigment traces: chin	1207	3908	11666	5394	762	6190	332	821	5159	3047	599	4499	959	1141

TABLE 2
Results of net area analysis, Bruker Tracer III–V+ XRF machine, 40kV, 6µA, no vacuum, red filter.

		Al	Br	Ca	Cl	Cu	Fe	K	Ni	Pb L1	S	Si	Sr	Ti	Zn
1.	Red pigment stain: right vertical groove in centre panel	2200	2474	7700	8	202	6650	31	408	8782	82	427	5131	122	445
2.	Red pigment stain: right side of frontal tassel, third tier	1813	749	546	1	179	1430	1	301	3005	78	336	1986	1	282
3.	Red pigment stain: left side of frontal tassel, fourth tier	2157	3308	5671	14	289	8279	82	344	19809	164	347	6338	210	939
8.	No pigment traces: pedestal of caryatid herm	2242	7553	2567	261	696	9533	15	436	10451	273	416	6527	244	5320
9.	No pigment traces: reverse centre	2006	8512	1168	602	292	6886	10	409	757	106	456	10237	203	1109
10.	Blue pigment: left side top pedestal below attachment	2498	4348	6848	70	166	5004	39	410	15088	256	348	18987	31	2052

The surface of the *Zuiddorp* caryatid herm has been painted with an under-layer of lead white and over-layers including pigment(s) containing calcium (Ca), sulphur (S) and iron (Fe). Sulphur and iron concentrations vary directly to that of calcium, whereas chlorine (Cl), strontium (Sr) and bromine (Br) all vary inversely to calcium concentrations (Figs 19–21). This indicates that the latter elements come for a common source and one that is different from that of the lead and calcium coatings. They also could come from the surrounding

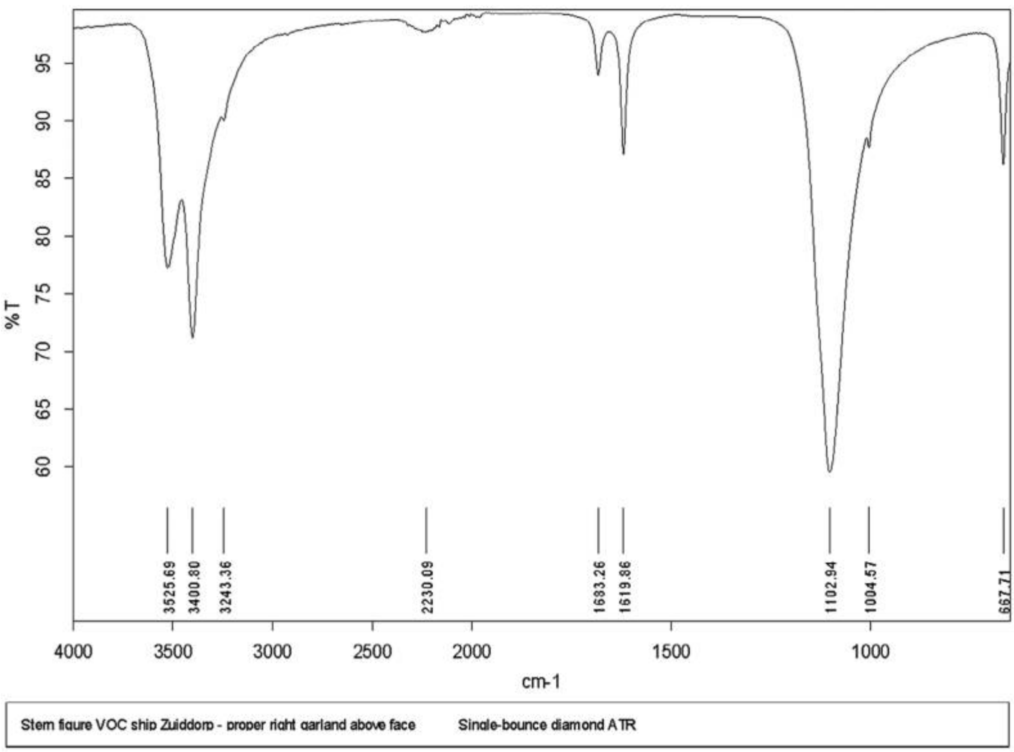

FIG. 16
Infrared spectrum of *Zuiddorp* pigment sample no. 3 (illustration, Wilhelm van Bronswijk & Peter Chapman).

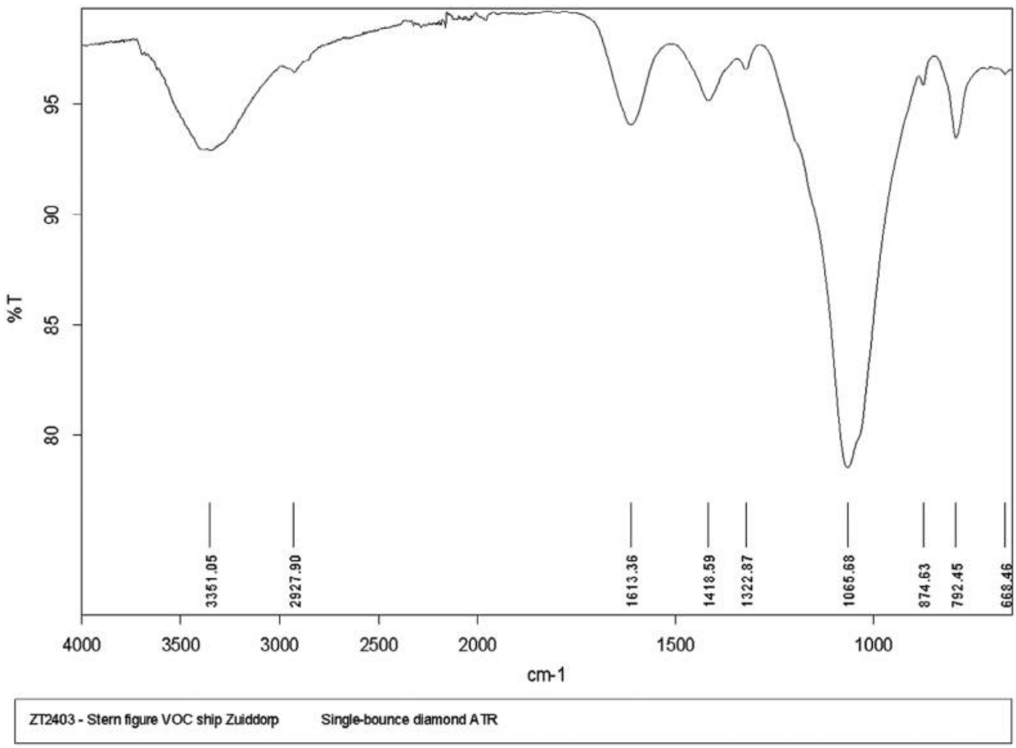

FIG. 17
Infrared spectrum of *Zuiddorp* pigment sample no. 2 (illustration, Wilhelm van Bronswijk & Peter Chapman).

post-depositional environment of the sculpture. Silicon (Si), titanium (Ti) and potassium (K) all vary in unison and are different from any other element. Their low levels probably indicate that they are contaminants. Photons from these elements would only come from the surface because they are low energy. Similarly, to the aforementioned contaminants in the analyses of the Pb white, it is likely that silicon, titanium and potassium are contaminants from beach sand and soil. Copper and zinc, the other two elements present in some of the analysis, exhibit no pattern and appear to result from random environmental events.

The stains could have been from red pigments such as red lead or iron oxide (e.g. hematite), but XRF analysis cannot differentiate these from lead white or iron corrosion products from the fastenings. It is obvious that lead white — lead compounds and gypsum — is still extant over the entire surface and within the sub-surface pore structure of the wood of the sculpture, even if not visible to the naked eye. The high peaks of iron in certain spots may simply be related to the extant iron fastenings and their corrosion products, as is evident at the top of the pedestal (Fig. 18:5).

DISCUSSION

This study confirms that the remnants of white pigment from the *Zuiddorp* sculpture's surface are white lead mixed with gypsum. According to the Italian author Armenini, writing in the second half of the 16th century, several Dutch painters used a mixture of gypsum with a third part of lead white for their primer.[34] As a matter of economy, Dutch painters mixed the more expensive pure lead white with cheaper fillers such as gypsum or calcium. The painter of the *Zuiddorp* caryatid herm used the lead-white–gypsum mixture as a preparatory layer for grounding and as filler for some of the small irregularities and surface cracks. Minute amounts of this lead-white mixture are visible over the entire surface of the sculpture.

In addition to lead-white pigment, red grounding was commonly applied to sculptures and murals, and Dutch artists used it for both gilded and polychrome sculptures — many examples of which are found in medieval churches in the Netherlands.[35] For gilded surfaces, red ground was used as an under-coating to provide an iron-rich bole grounding that would allow gold leaf to be polished, resulting in a shiny surface that

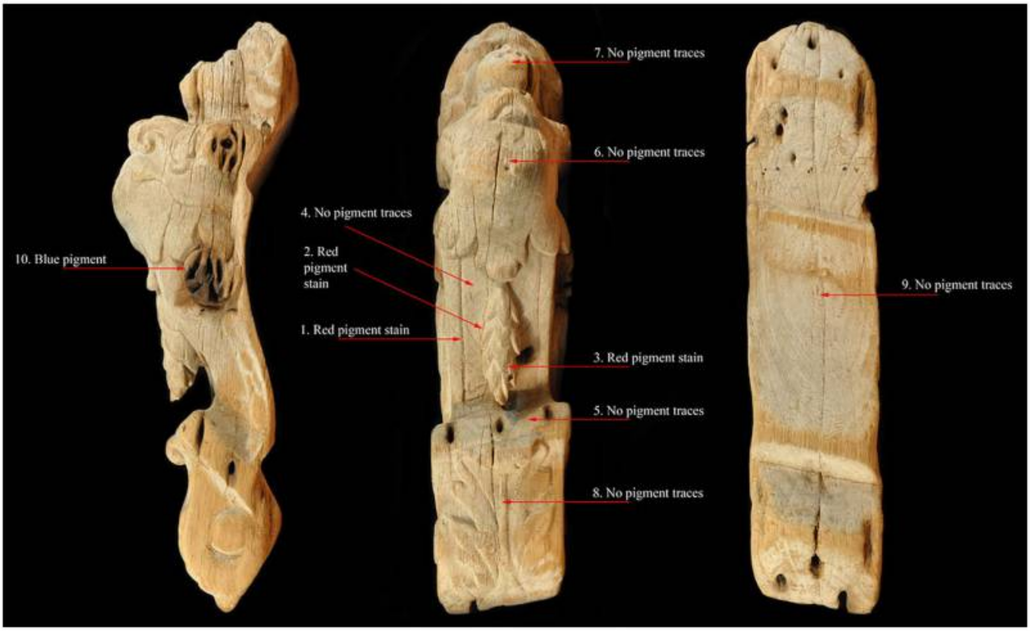

FIG. 18
Spots on the caryatid herm (145.5cm high, 44cm deep and 34cm wide) analysed with handheld XRF machine (photograph, Patrick Baker, © WA Museum).

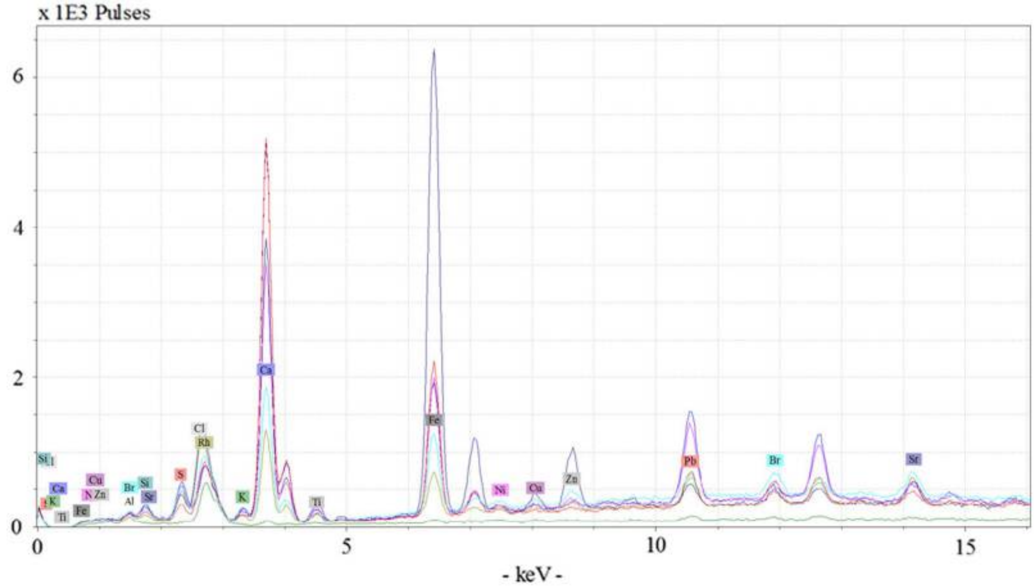

FIG. 19
Spectra spot analysis, Bruker Tracer III–V+ XRF machine, 40kV, 0.8μA, vacuum, no filter (illustration, Bruce Kaiser).

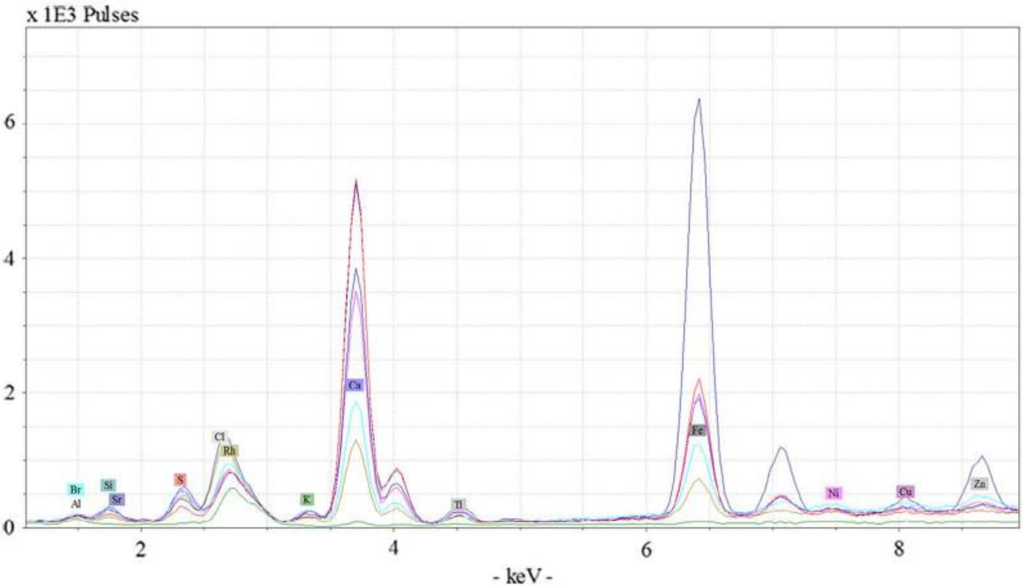

FIG. 20
Spectra spot analysis, Bruker Tracer III–V+ XRF machine, 40kV, 0.8µA, vacuum, no filter. Detail showing aluminium, nickel and copper (Al, Ni and Cu) peaks (illustration, Bruce Kaiser).

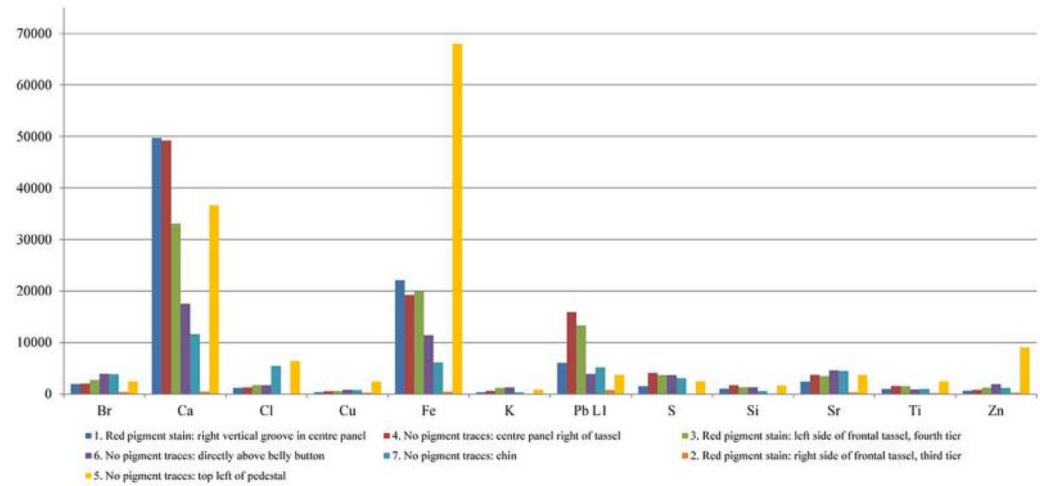

FIG. 21
Chart of net area analysis, Bruker Tracer III–V+ XRF machine, 40kV, 0.8µA, vacuum, no filter (illustration, Bruce Kaiser).

imitated metal.[36] However, its use was not exclusive to gilded surfaces. In the 17th century, red ground was actually used in the Netherlands to prime both gilded and coloured statues, as well as murals, painted tapestries and canvas paintings. For example, Rembrandt and his studio primed more than half of their painting canvases with red-coloured preparatory layers. This technique was common in the Netherlands and continued into the 18th century.[37]

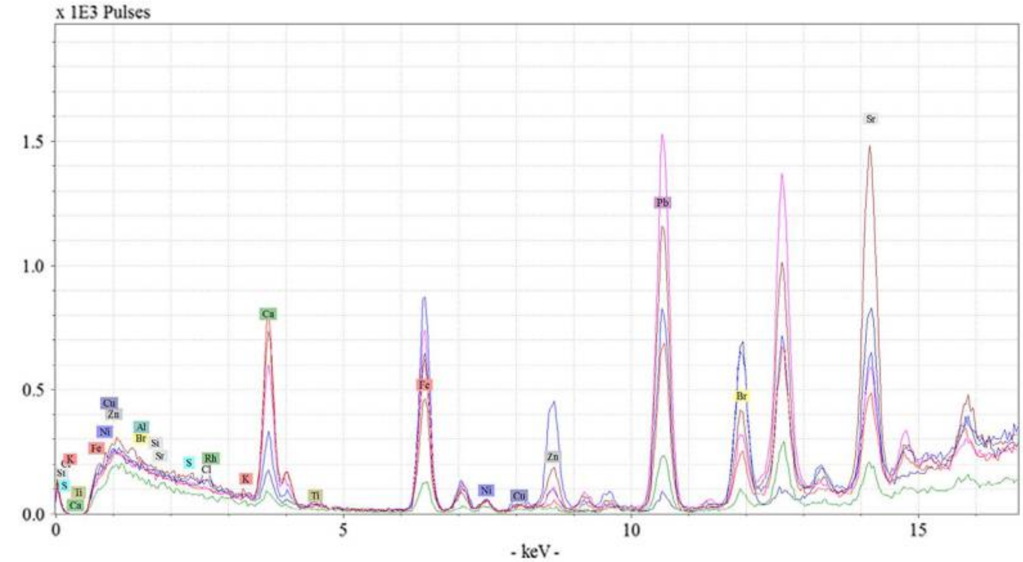

FIG. 22
Spectra spot analysis, Bruker Tracer III–V+ XRF machine, 40kV, 6μA, no vacuum, red filter (illustration, Bruce Kaiser).

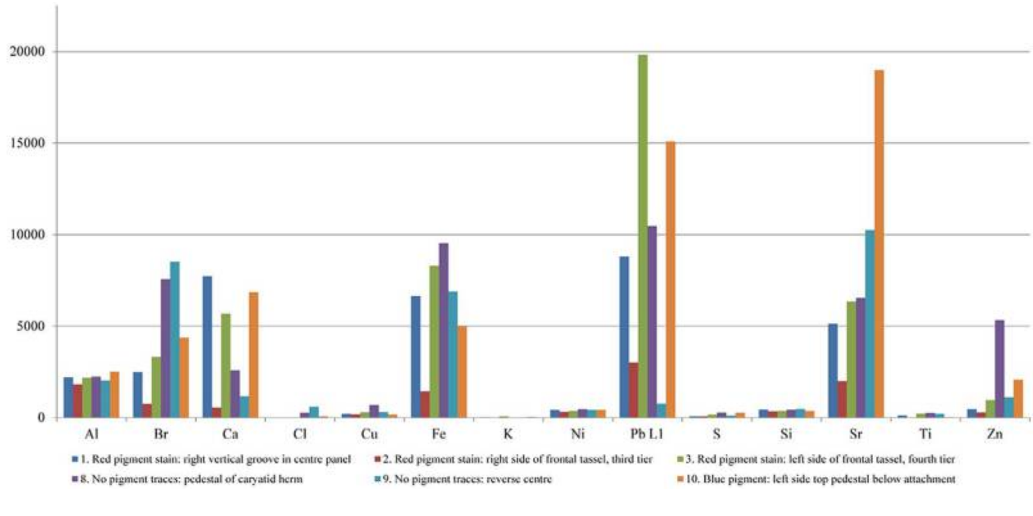

FIG. 23
Chart of net area analysis, Bruker Tracer III–V+ XRF machine, 40kV, 6μA, no vacuum, red filter (illustration, Bruce Kaiser).

It cannot be confirmed with any certainty whether the red pigment of the *Zuiddorp* caryatid herm was part of a preparatory layer or a top coat. The red and white pigments are both present on the obverse centre panel (Fig. 11), but microscopy could not determine whether they were used together as under coats. No red pigment was found underneath the sampled lead white — it survives only as stains on the wood.

If red pigment traces on the *Zuiddorp* caryatid herm are remnants of a primer layer, the question

FIG. 24
Stern of Dutch East India Company Ship *Peter en Paul* (painting, Abraham Storck, © Fries Scheepvaartmuseum, G-041).

FIG. 25
Stern of *Zuiddorp* ship model by Cees de Heer (photograph, Patrick Baker, © WA Museum, ZUYM_019).

arises whether the sculpture was monochrome or polychrome? The red traces were found only in specific areas: on the front centre panel, around the shoulders, tassel and pedestal below and on the arm attachments. Perhaps red was used to prepare this surface area for a specific top-coat colour, implying that the painter applied different colours elsewhere. No trace of red pigment was found on the decoration of the caryatid's face or head, nor was any such colouring found on its central sides and reverse surfaces. Furthermore, the bluish pigment, even though its composition remains unidentified, was clearly applied over a layer of lead white, implying the use of multiple colours (Fig. 13).

By the time of *Zuiddorp*'s construction, stern figures on Dutch warships generally were entirely yellow-painted to mimic gold leaf. This decorative style went hand-in-hand with a trend towards less figurative stern assemblies with an inverted horseshoe-shaped stern counter. This is well demonstrated by the stern of *Zeven Provinciën* depicted in the painting of the Battle of Vigo Bay (1702), and by the late 17th-century ship model of *William Rex*.[38] Although the use of colours had been discontinued on warships, it obviously was still being practised at the VOC shipyard of Zeeland, indicating a curious use of somewhat archaic practices.

Dutch East Indiamen in the previous half-century had bell-shaped upper stern assemblies and polychrome figurative decorations (see, for example, Figs 4 and 5).[39] The *Zuiddorp* sculpture, being figurative and polychrome, most likely comes from a ship with such a stern assembly, one similar to that of the late 17th-century vessels *Walcheren* and *Hollandia*(Fig. 4). Around 1700, the bell-shaped stern counter became lower and more elliptical in shape. It was eventually replaced by an inverted, horseshoe-shaped stern counter, and the stern rails and tafferel (from the Dutch *tafereel*, which refers to a scene and here refers to the main decorative panel of the counter), were adorned with less figurative art — a development toward stern decorations with acanthus and floral elements.[40] Moreover, the sculptures became entirely yellow-painted. This can be seen, for example, on the Dutch East India Company ship *Peter en Paul*, built at the VOC's Amsterdam shipyard in 1697 with assistance from Russian Tsar Peter the Great (Fig. 24).

Cees de Heer built a model of *Zuiddorp* in the 1970s while assisting with the research of the vessel's shipwrecking (Fig. 25). He used archaeological timber recovered from the ship itself to fashion the model's masts and spars.[41] The model's stern counter is typical for VOC ships built decades after *Zuiddorp*, examples of which include sister ships *Blijdorp* (1723) and *Patmos* (Rotterdam shipyard, 1722), *Valkenisse* (Middelburg, 1716) and *Den Ary* (never built, but constructed in model form in 1727). Models of these ships all have inverted, horseshoe-shaped stern counters, less figurative decorations and yellow-painted sculptures. The model of *Valkenisse*, a 1,150-ton ship like *Zuiddorp*, is the earliest example of such a stern counter.[42] The figurative and polychrome nature of the *Zuiddorp* caryatid herm, however, suggests that the ship that this sculpture once adorned was much closer in appearance to *Walcheren* than it was to *Blijdorp*, *Patmos*, *Valkenisse*or the model by De Heer.

Detailed information on shipbuilding from the VOC archives is limited, especially references to ship decorations and sculptures. Much more information on this is available, for example, in the archives of the Dutch admiralties.[43] In 1666, the detailed charter for a new warship to be built by the Rotterdam Admiralty, possibly *Vrijheid*, outlines the vessel's sculptures and decorations, their appearance and meaning.[44] However, from the late 17th century onwards, Dutch warships were different in design, function and appearance than the armed merchant vessels built by the VOC. Also, warships were built on the admiralties' shipyards, not VOC shipyards. Thus, it is risky to try to draw meaningful conclusions about VOC ships from data related to warships, or to apply our knowledge of admiralty shipyard practices to those of VOC shipyards.

Counsellor and historian Pieter van Dam devoted many pages to the company's ships in his multi-volume description of the VOC published in 1699. His discussion of ship decoration is limited to two paragraphs, in which he clearly states that the VOC's shipyards were to spend as little as possible on 'sculptures, gilding, and the likes'. The use of gold leaf, or gilding, on VOC ships was considered unnecessary and wasteful. On 2 August 1608, the VOC capped the allowance for the painting of its ships to a maximum of 72 Dutch guilders. Company archives detail that officials revisited the amount and endorsed it again in 1621. Furthermore, any expenditures on paint over 72 Dutch guilders would be charged to the individual responsible. On 22 August 1630, the company issued a resolution explicitly forbidding the use of gilding on ship decorations. By this time, VOC shipyards were allowed to spend 80, 100 or up to 150 Dutch guilders on paint depending on the charter (i.e. size) of the vessel.[45] No specific information is available on the appearance, shape, design and decoration of ships' stern counters.

The archaic construction, shape and decoration of *Zuiddorp*'s stern counter discussed in this article relates to the appearance of the ship's stern and its assembly only. It must be noted, however, that changes in the shape, appearance and decorative themes of ships' stern counters in the late 17th and early 18th centuries were part of a dynamic development in Dutch shipbuilding. During this period, Dutch shipbuilders converted to a new, more standardized construction method for VOC and other sea-going ships that was more sustainable. They eliminated multiple layers of hull planking, using a single layer only; abandoned their bottom-based construction method for a frame-based system; applied the basic principles of naval architecture to ship design; and altered the overall shape and appearance of their vessels.[46]

Dutch shipbuilders of the late 16th and early 17th centuries constructed large ocean-going ships using what is known as a bottom-based construction method, typical for north-western Europe.[47] They assembled the bottom of the ship's hull in a shell-based method, in which the planks were held together with temporary wooden cleats until the frame floors and first futtocks were installed. Once they had fixed the latter and removed the temporary cleats, the shipwrights erected the second futtocks of the vessel's framework and then fastened the side planking to the frames in the new plank-on-frame method. This shipbuilding practice developed over many centuries, at least since Roman times. While it combined features of shell-first and frame-first construction, it was not a combined application of those methods. It also was not an intermediate phase between the shell-based and frame-based methods, as some scholars have suggested in the past.[48] VOC shipwrights and carpenters built in this manner without predesigning their ships on paper.

The coexistence of the bottom-based and frame-based construction methods was first noticed by scholars studying the late 17th-century manuscripts of Nicolaes Witsen (1671) and Cornelis van IJk (1697). Van IJk remarked that some people in the *Noorderkwartier*, the region of Holland situated north of the river IJ, were still using bottom-based construction to build ships.[49]Shipyards in this area, such as at Zaandam, Enkhuizen and Hoorn, continued to use the bottom-based construction sequence as described by Witsen until the late 17th century.[50]A Frenchman named Arnoud, who visited English and Dutch shipyards on an assignment for Admiral Colbert, confirmed that this construction method was still in use in 1670. He stated that the Dutch shipwrights did not insert frames until the first ten or twelve planks of the bottom were erected, and that they adjusted the hull shape by eye as they worked.[51] It is not known when Dutch shipbuilders first started using frame-based construction, which Van IJk described, but it must have been sometime after 1650.

By the early 18th century, it is likely that frame-based construction was established only on the Amsterdam Admiralty shipyard. From 1725, Dutch shipbuilders from the admiralties also started to rely on design and construction drawings. This allowed for a more standardized method of shipbuilding.[52] This more modern, technological approach gave shipwrights more control over a ship's shape, more exact determinations of the materials needed for the construction, and greater optimization of labour and resources.

Detailed information on VOC shipbuilding was not written down — probably to safeguard trade secrets — and anything that may have been recorded has not survived. VOC shipwrights used the overall dimensions from the charters and applied these to known proportional rules that were learned through a master–apprentice relationship and verbally communicated from one generation to the next.[53] The charters only defined the main purpose of a ship and its dimensions. They were instructions in which the VOC, West India Company, Admiralties and other large establishments laid down standardized guidelines for the construction of their ships.

It is unclear, though, whether VOC shipyards did in fact start employing frame-based construction in the 18th century.[54] VOC officials and shipyard personnel were certainly eager for more standardization. In 1697, the master shipwrights of the six chambers, which included Penne, came together for extensive consultations to discuss and resolve the issue of unnecessary diversity and differentiation in their shipbuilding charters and the sizes of their vessels. The VOC's authorities in Batavia had complained about this matter for years. After strenuous discussions, the master shipwrights decided to limit their builds to only three rates of ships, and to better supervise the constructions. The new charter included ships measuring 160ft (45.30m), 145ft (41.05m) and 130ft (36.80m) in length, plus a *hekboot*, a flute ship and a small vessel type for service in Asia. The shipwrights also agreed on a system of controls for the observance of these measurements, placing nine control measurements at different places on the ship's hull, which ultimately locked in the entire design.[55]

The VOC shipyards had to follow company regulations as prescribed in the shipbuilding charters, but they did not operate according to a specific norm when it came to the details of constructing and outfitting their ships.[56] Regional differences therefore certainly existed. For example, by 1697 the workmen of the VOC shipyard in Amsterdam were already building ships with less figurative stern counters that had yellow-painted decorations, as evidenced by ships like *Peter en Paul* (Fig. 24). Shipwrights and carpenters of the VOC's Zeeland shipyard, on the other hand, were still working with ornate sculptures painted in different colours when they built *Zuiddorp* in 1701 (cf. Figs 5–6).

Although the appearance of *Zuiddorp*'s stern counter may have been consistent with those of late 17th-century VOC ships, the caryatid herm does not inform us how the ship's hull was constructed, whether with bottom- or frame-based construction, nor about its shape and design. As *Zuiddorp* was the last ship built in the eighteen-year tenure of shipwright Penne, it is unlikely that he would have significantly modified its design, shape or appearance other than as required by the new instructions prescribed four years earlier in the 1697 charter.

CONCLUSION

This study of the *Zuiddorp* caryatid herm has provided important information about the appearance of the ship, which suggests that the Dutch East India Company shipyard at Zeeland was employing somewhat archaic construction practices around 1700. The figurative character and different colours used to paint the *Zuiddorp* caryatid herm indicate that the shape and decoration of the ship's stern probably were more similar to those of late 17th-century Indiamen than to ships of the early 18th century. This evidence helps to broaden our understanding of Dutch shipbuilding practices on the Zeeland shipyard, the shape and construction of ships' stern counters, craftsmanship of ship decorations, and the use of pigments during this period.

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NOTES

[1] The spelling of ship names in this article is consistent with the convention introduced by Bruijn, Gaastra and Schöffer (1979a, 1979b & 1987) in their seminal work *Dutch-Asiatic Shipping in the 17th and 18th Centuries*. This three-volume publication offers a uniform and modern-Dutch spelling for the generally inconsistent and numerous varieties of ship names given in historic sources. Bruijn, Gaastra and Schöffer refer to the four Dutch VOC ships that sank along the Western Australian coast as *Batavia* (1629) (the same as in old Dutch), *Vergulde Draak* (1656) (old Dutch: *Vergulde Draak*, *Vergulden Draeck*, *Vergulde Draeck*), *Zeewijk* (1727) (old Dutch: *Zeewyck*, *Zeewick*, *Zeewijck* or *Zeewijk*) and *Zuiddorp* (old Dutch: *Zuytdorp*). Geographical designations, such as the Zuytdorp cliffs, however, are used as they are gazetted as formal place names in the *Gazetteer of Australia 2012* (*Gazetteer of Australia* 2012; Van Duivenvoorde 2015).

[2] Peters 2013.

[3] Hocker 2011, 67–81; Soop 1992, 1985.

[4] Musée National de la Marine 2003, 45–57, 100; Mourot & Béland 2001, 45–57, 100.

[5] Van Beylen 1970, 310; Van der Heide n.d., 27, fig. 21.

[6] Maritiem Digitaal.

[7] Daalder & Spits 2005, 104; Schokkenbroek & Zonnevylle-Heyning 1995, 20, 24, fig. 17; Spits *et al.* 2013, 135.

[8] See also Antczak *et al.,* this issue.

[9] Berry 2012a; 2012b; Eriksson 2014, 151–76; 2012, 23–4, fig. 5; Eriksson & Rönnby 2012, 8; Hocker 2010; RCE 2012; Koehler 2012; Koehler *et al.* 2012.

[10] Bruijn *et al.* 1979a, 1884.1, 2033.2; 1979b, 6140.1, 6216.2.

[11] Bruijn *et al.* 1979a, 2147.3.

[12] Sigmond & Zuiderbaan 1995.

[13] Playford 2006, 82.

[14] Pendal 1994, 14.

[15] Pendal 1994, 14; Playford 2006, 45, 110–39.

[16] McCarthy 2009; 2008; 2006.

[17] Matthaeus 1759, 12–13; Paesi 2010, 65.

[18] Van Dam & Stapel 1927, 510.

[19] NA 1.04.02, inv. nr. 10459, loose papers.

[20] Van Dam & Stapel 1927, 510. Playford (2006, 35) claims *Zuiddorp* carried 40 cannon including eight swivel guns, four of which would have been muzzle-loading and four breech-loading, but he does not cite a source for these numbers.

[21] Michael McCarthy pers. comm.

[22] Van Duivenvoorde 2015, 170–2; 2012a.

[23] McCarthy 2009, 3; Playford 2006, 2, 84–6.

[24] Van Beylen 1970, 224.

[25] Soop 1992, 147.

[26] Soop 1992, 147.

[27] The wood was identified up to species level by Nili Liphschitz at the Botanical Laboratories of the Institute of Archaeology, Tel Aviv University.

[28] NA 1.04.02, inv. no. 11336, 7 July 1701, f. 16.

[29] cf. Soop 1992, 48–52, cat. 7, 82–93, group 3.

[30] Ketting 1979.

[31] Gryc *et al.* 2011, 19.

[32] Megens 2010.

[33] Bell *et al.* 1997, 2165, fig. 33.

[34] Van de Graaf 1962, 471.

[35] Groen 2005, 21–3.

[36] Groen 2005, 25.

[37] Groen 2005, 19, fig. 2.

[38] Hoving 2005, 8, figs 7–8.

[39] Peters 2013, 68–72; Schokkenbroek & Zonnevylle-Heyning 1995, 17–18.

[40] Peters 2015, 78–9.

[41] De Heer 1978.

[42] Napier 2008.

[43] NA 1.01.02.

[44] NA 1.01.02, inv. no. 12561.154.1 (Stukken betreffende de aanbesteding).

[45] Van Dam & Stapel 1927, 453.

[46] Hoving & Lemmers 2001; Van Duivenvoorde 2015.

[47] Hocker 2004.

[48] Unger 1994, 124.

[49] Van IJk 1697, 77–8; Parthesius 1996, 81.

[50] Van der Woude 1972, 19–30.

[51] Hocker 2004, 83.

[52] Hoving and Lemmers 2001.

[53] Van Duivenvoorde 2015, 21.

[54] Hoving & Lemmers 2001, 49–50.

[55] Bruijn *et al.* 1987, 44; Hoving and Lemmers 2001, 45.

[56] Van Duivenvoorde 2015; 2012b.

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ABBREVIATIONS

CT Computed tomography
NA National Archives of the Netherlands
SEM Scanning electron microscopy
RCE *Rijksdienst voor het Cultureel Erfgoed* (National Cultural Heritage)
VOC *Verenigde Oostindische Compagnie* (United East India Company)
XRD X-ray diffraction
XRF X-ray fluorescence

SUMMARY TRANSLATIONS IN FRENCH, GERMAN, ITALIAN AND SPANISH

RÉSUMÉ

Les pigments de la sculpture du navire de *Zuiddorp* (*Zuytdorp*) : rouge, blanc et bleu ?

Le navire de la Compagnie néerlandaise des Indes orientales *Zuiddorp* (aussi connu sous le nom de *Zuytdorp*) a disparu en 1712 au pied des falaises le long de la côte occidentale australienne. Le matériel provenant de l'épave comprend un exemple extraordinaire d'hermès caryatide provenant de la poupe du navire. Une récente étude de cette sculpture et des pigments trouvés sur sa surface montre que la construction et la décoration archaïques de la poupe de *Zuiddorp* correspondent à celles d'un indiaman hollandais datant plus probablement de la fin du XVII[e] siècle que du début du XVIII[e] siècle. Cet article présente les résultats de cette étude et montre comment les plus petits indices peuvent élargir notre compréhension des pratiques contemporaines régionales de la construction navale de la Compagnie néerlandaise des Indes orientales.

ZUSAMMENFASSUNG

Pigmente von der *Zuiddorp* (*Zuytdorp*) Schiffsskulptur: rot, weiß und blau?

Das Schiff der Holländischen Ost-Indien Kompanie *Zuiddrop* (auch bekannt als *Zuytdrop*) fand sein Ende in 1712 am Boden eines steilen Kliffs an der westlichen Küste Australiens. Das Material des Schiffwracks enthält auch ein außerordentliches Beispiel einer weiblichen Pfeilerstatue, der Gallionsfigur, die am hinteren Schiff angebracht ist. Eine kürzlich veröffentlichte Studie dieser Figur und ihrer Oberflächen-Farbpigmente zeigt eine alte Art der Konstruktion und Dekoration des Achterschiffs der *Zuiddrop*, die eher aus dem späten 17. als aus dem frühen 18. Jahrhundert eines ‚Dutch Indiaman', eines Schiffs der Ost-Indien Kompanie, stammt. Dieser Artikel befasst sich mit dem Resultat der Studie und betont, wie sogar die kleinsten Beweisstücke unser Verständnis des derzeitigen Schiffbaus der Holländischen Ost-Indien Kompanie erweitern kann.

RIASSUNTO

Pigmenti dalla scultura di poppa della *Zuiddorp* (*Zuytdorp*): rosso, bianco e blu?

La *Zuiddorp* (nota anche come *Zuytdorp*), una nave della Compagnia Olandese delle Indie Orientali, incontrò il suo destino nel 1712 ai piedi di scoscese scogliere lungo la costa dell'Australia occidentale. Il materiale recuperato dal naufragio comprende uno straordinario esemplare di cariatide intagliata collocata a poppa. Un recente studio di questa scultura e dei pigmenti rinvenuti sulla sua superficie ha messo in luce l'antica struttura e la decorazione della poppa della *Zuiddorp*, impiegata nella flotta Olandese delle Indie, e databile al tardo XVII secolo piuttosto che all'inizio del XVIII. L'articolo presenta i risultati di questo lavoro, sottolineando come anche il più piccolo dettaglio possa ampliare la nostra comprensione sulla tecnica costruttiva impiegata a quel tempo per la flotta della Compagnia Olandese delle Indie Orientali.

RESUMEN

Los pigmentos de la escultura del barco *Zuiddorp* (*Zuytdorp*): ¿rojo, blanco y azul?

La nave *Zuiddorp* (también conocida como *Zuytdorp*) de la Compañía Holandesa de la India Oriental naufragó en 1712 en la base de los acantilados de la costa occidental de Australia. Entre el material del naufragio figura un extraordinario ejemplo de una cariátide de la popa del barco. Un estudio reciente de esta escultura y de sus pigmentos superficiales demuestra que tanto el sistema de construcción de la popa del Zuiddorp como su decoración pertenecen a un sistema arcaico, más de finales del siglo XVII que de principios del XVIII. Este artículo habla de los resultados de este estudio y destaca cómo incluso las piezas más pequeñas de evidencia pueden ampliar nuestra comprensión de las prácticas regionales contemporáneas de la construcción naval empleada por la Compañía Holandesa de la India Oriental.

The Zuiddorp caryatid is in the collection of the Department of Maritime Archaeology, Western Australian Museum in Fremantle, Australia (object no. ZT 2403)

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