

Iron nails recovered from the plank of the Shinan shipwreck

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Abstract

This is a short report on iron nails used for the Yuan Dynasty Shinan shipwreck in Korea. The Shinan shipwreck is the fourteenth century's oceangoing merchant ship that originated from China. Since its discovery in the late 1970s, a number of studies have been conducted on the hull and cargo artefacts. This report is the result of a first attempt to assess the nails from the hull plank highlighting the quality of iron used for the nails.

要旨

本論は韓国新安沈没船に使用されている鉄釘の研究の概要報告である。新安沈没船は中国を起源の14世紀の交易船である。1970年代の同船の発見以来船体と積荷についての多くの研究が進められてきた。しかしながら船釘についてはこれまで研究されていない。本報告では船体外板の釘について使用されている鉄に焦点を当てた研究に関するものである。

Introduction

Study on iron nails of the Shinan shipwreck, a Yuan Dynasty's trader sunk in Korean waters, has not previously been conducted. This is because all nail remains in the hull were presumed to have been fully degraded. Under agreement with the staff of the National Research Institute of Marine Cultural Heritage, an attempt to identify magnetite remains of iron nails was made as a part of the Shipwreck ASIA thematic studies. The goal of the study is to assess the quality of the iron used for the nails of the shipwrecks. A timber specimen that contains nail remains from the plank of the Shinan shipwreck was provided for metallurgical study. Due to the substantial degradation of the nails, the results of the metallurgical study is not sufficient to examine

the quality of the iron. Based on the result this report still provides some perspective regarding the manufacturing processes of the original nails by referring to the previous study of identified iron nails during the same period as the Shinan shipwreck.

State of iron nails remaining in the Shinan shipwreck

Magnetitic remains were barely identified in a part of the hull plank of the shipwreck by magnets. It was necessary to determine further whether this is a sign to contain iron remains and whether it would be used for metallurgical study. X-ray and CT-scan analyses to

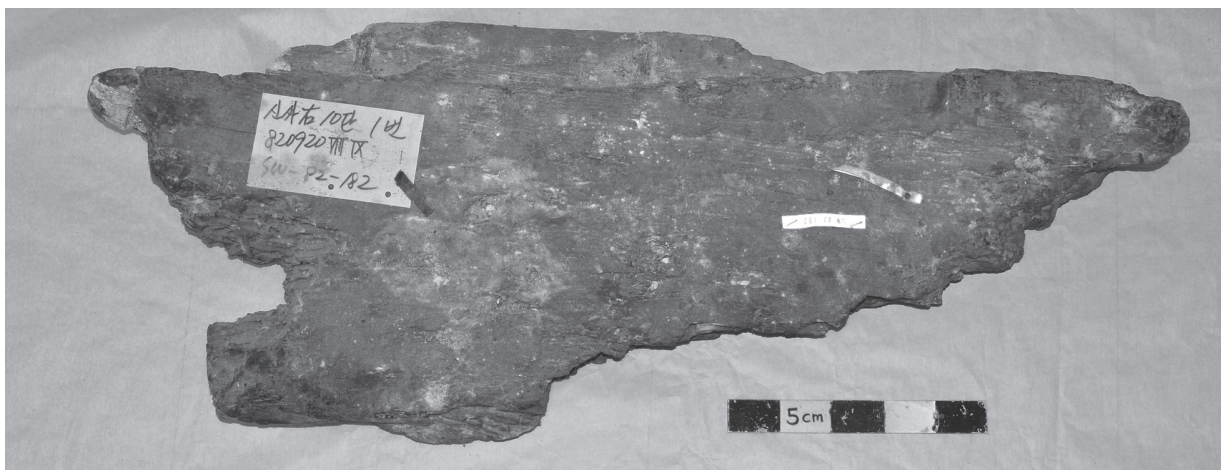


Figure 4.1 Hull plank (SW-82-182) from the Shinan shipwreck. (Photo by Jun Kimura)

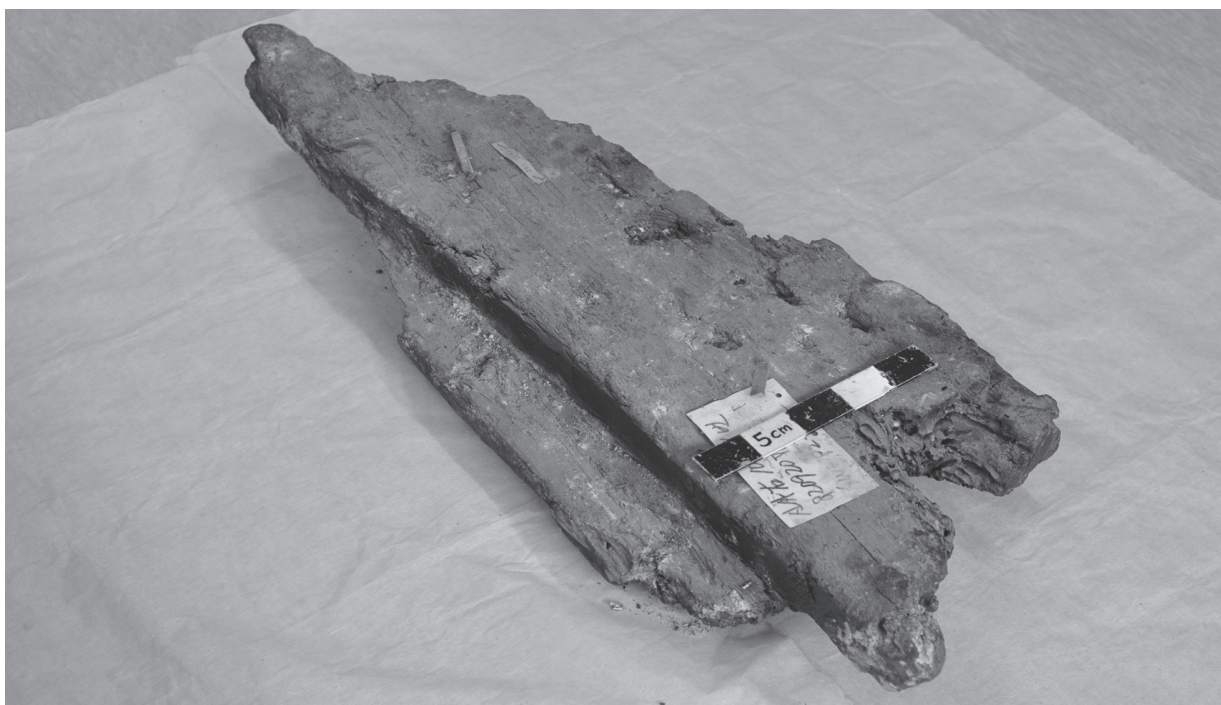


Figure 4.2 Rabbeted seam of the SW-82-182, and a scale is placed on the inner surface of the hull plank. (Photo by Jun Kimura)

determine the quality of iron remains were conducted on the hull plank (SW-82-182). X-ray and CT-scan analyses are non-destructive approaches to reveal the nails' position and driven patterns that cannot be visible from outside.

SW-82-182 is a portion of a hull plank from the Shinan shipwreck (Figure 4.1). Due to deterioration, the only remaining original dimension is the thickness of the plank (105 mm). Present dimensions are a maximum width of 395 mm and a maximum length of 1.02 m. The original placement of SW-82-182 is yet to be determined clearly. The rabbet, however, appears to be cut at only one seam that likely joins to the edge of the lower plank (Figure 4.2). Most parts of the hull planking of the Shinan shipwreck are

rabbeted clinker construction, except for the planking in the bow, forward of the first bulkhead shows gradual changes from clinker to carvel. The feature identified with the plank (the rabbet cuts at only one seam) must have been used in the clinker-built part. It appears that a few corroded nails are driven from outside of the rabbeted seam. The pattern indicates that the plank was located at the portside.

The x-ray and CT-scan images show that broken remains of four nail shafts are diagonally driven at the rabbeted seam (Figures 4.3 and 4.4). The interval of the four nail shafts shows slight irregularity. Two spaces between three of the nails measure 250 mm. The other two nails were very narrowly spaced at about 80 mm. Nail length ranges from 95 to 145 mm.



Figure 4.3 X-ray image of the SW-82-182 showing the two iron nails that have square cross-sections. (Courtesy of the National Research Centre of Marine Cultural Heritage)

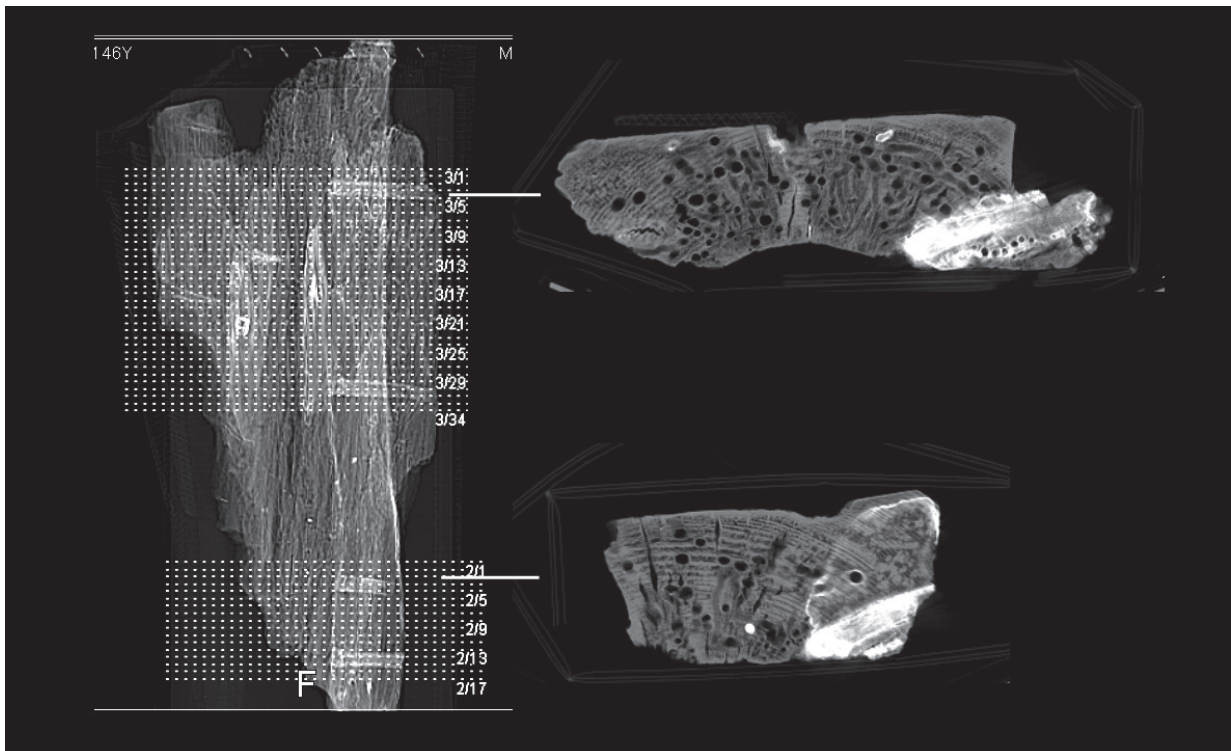


Figure 4.4 CT-scan image of the SW-82-182 and images of the cross-sections where the iron nails are driven. (Courtesy of the National Research Centre of Marine Cultural Heritage)



Figure 4.5 A cut piece from the SW-82-182 for metallographic analysis. (Photo by Jun Kimura)

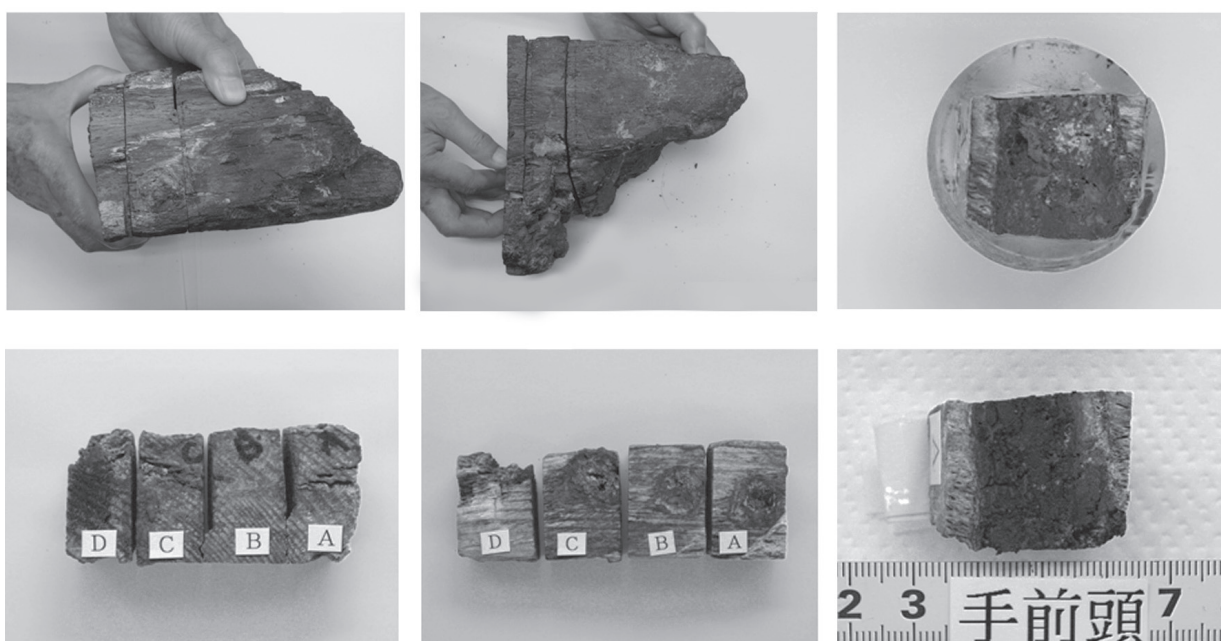


Figure 4.6 Specimens containing a nail remain from the cut piece. (Courtesy of the Kyushu Techno Research Inc)

The nail shaft is slightly skewed and tapered (as seen in the CT-scan image Figure 4.4). The configuration of the nail shaft remaining at this seam evidences that original nails were skewed nails. From the remains of the nail shafts at both the upper and the lower seams, the original length could reach 250 mm but is less likely to have exceeded 300 mm. The cross-section of these nails measures a square 20 mm on each side and the section of one of the nails is exposed on the broken part of the lateral of the plank.

From the analyses, the quality of the iron remains seems to be different. The x-ray and CT-scan images present a fully-corroded iron remain that is shown as a black hollow image with a only thin magnetite layer that indicates the presence of the original

surface. Some nail remains show white blur images, which suggest possible mineral remains or slugs inside the nail. With regard to the white blur images, it is difficult to determine the detailed corrosion status by just looking at the x-ray and CT scan images.

Metallographic analysis

A specimen of the timber was cut from the hull plank (SW-82-182) for metallographic analysis and provided to the Kyushu Techno Research Inc (Figure 4.5). The specimen was further cut to expose the sections of the nail (Figure 4.6). The sections of the microscopic images were produced (Figure 4.7). The microscopically observed structure shows that iron

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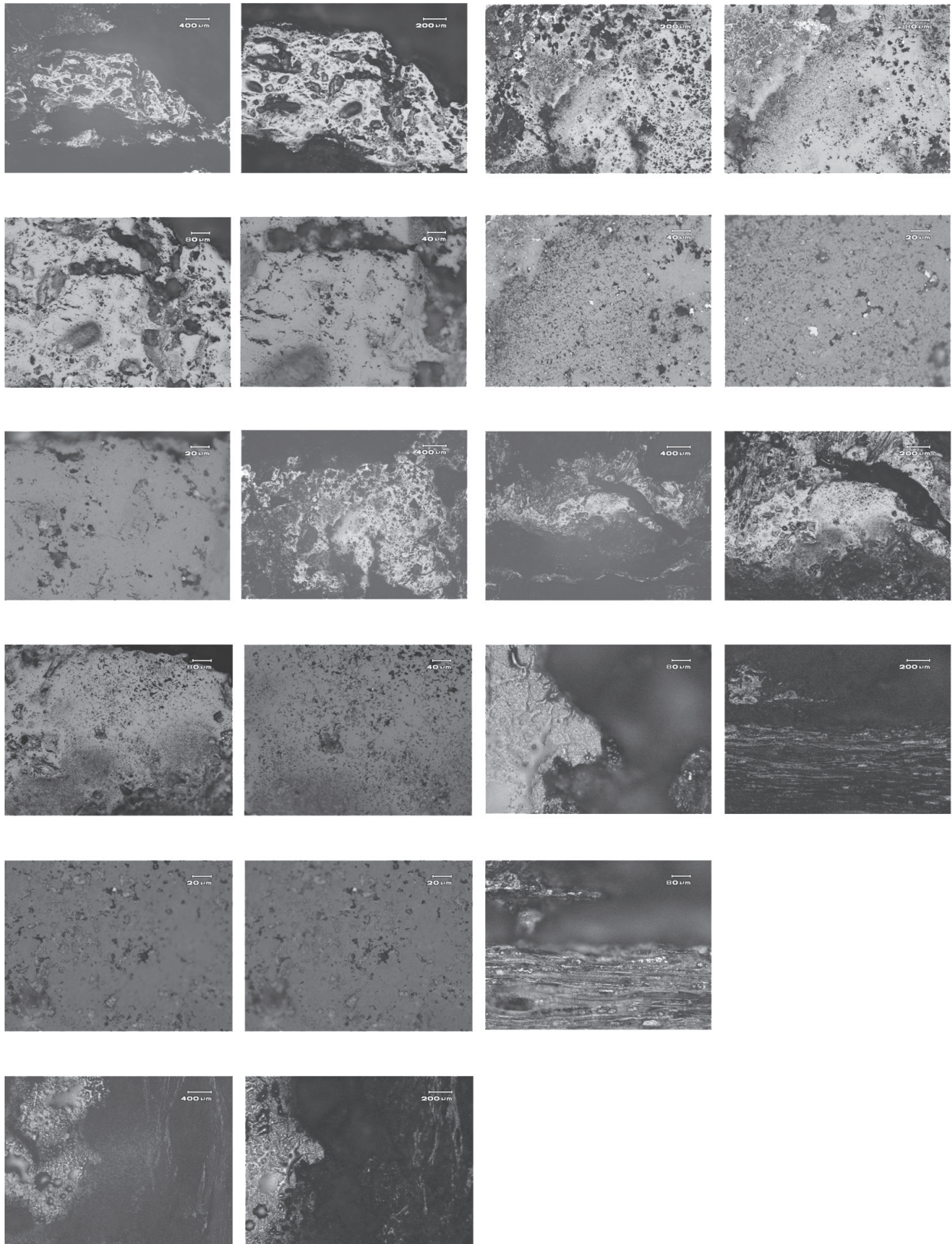


Figure 4.7 Microscopic images of the structure of the nail remain. (Courtesy of the Kyushu Techno Research Inc)

has been fully oxidised and the nail does not contain metal structures. The corrosion status of the nail is hydrated iron oxide (goethite: Fe₂O₃/H₂O). The substantial oxidization caused the loss of the metal structure. Under this condition, it is difficult to assess the quality of the original iron.

Perspective on manufacturing processes of the iron nails

To assess nails used in the construction of the Yuan Dynasty's Shinan shipwreck, a few iron nail remains found at the Avraga Site are suggested as a comparable resource. The site is related to the Genghis Khan's mausoleum where workshops to manufacture iron materials existed. The result of archaeological excavations at the site is available and includes a study on iron material remains.¹ Identified iron manufacturing technologies may be applicable to the technologies used to produce nails of the Shinan shipwreck, as the date of the two sites is relatively close.

Manufacturing processes of nails from the Avraga Site suggest that thin rectangular ingots of cast iron were initially produced by using moulds with 10–15 mm cross-sections. The cast iron ingots might have been too brittle to be used for nails (Table 4.1). Consequently, annealing processes must have been conducted by heating them under a temperature of 900–950 degrees F for a few days during which decarbonisation of the iron occurred. As a result, the quality of the iron turned soft and pliable. The iron was then further forged for nail production. The quality of the iron product through the processes is defined as an iron casting decarbonised steel.

C	Si	Mn	P	S	Cu	Ti	V	Cr	Zr
2.80	0.89	0.05	0.339	0.53	0.45	0.02	0.01	0.04	<0.01

Table 4.1 Chemical composition of the iron ingot from the Avraga Site (mass %). (Osawa 2005a)

Iron nails of the Yuan Dynasty's ships are identified on timbers recovered from the Takashima Underwater Site, associated with the Mongolian fleet that attacked Japan in 1281. Metallographic analysis was conducted on the nails. While these nails had fully corroded, a similar perspective regarding their manufacturing procedures has been presented.²

Conclusion

The use of iron for ship nails is one of the lasting traditions in constructing ocean-going ships in East Asia. However, iron nails are not commonly retrieved from East Asian shipwrecks. Because of this, detailed nail studies have yet to be successfully conducted for East Asian excavated ships. Under current estimation, ships' nails around the medieval period were probably produced by casting iron ingots first and then manufacturing them into nails. The details of the quality of iron nails, however, have yet to be assessed with better preserved ship nails.

Notes

- Osawa, M. (2005a). 'One of the forms of iron producing in the Mongol Empire Obtained from forge-related objects found at Avraga Site: Approach based on metallurgical study', *The Avraga Site: Preliminary Report of the Excavation of the Palace of Genghis Khan in Mongolia 2001–2004*. Kokugakuin University. Niigata.
- Osawa, M. (2005b). 'Takashima Kaitei Iseki Shutudo Tetsukugi no Kinzokugakuteki Chosa (Metallurgical analysis on the iron nails from the Takashima Underwater Site 鷹島海底遺跡出土鉄釘の金属学的調査 (速報))'. *Takashima Kaitei Iseki XI (Takashima Underwater Site XI)*. Nagasaki-ken Takashima-cho Board of Education. Nagasaki.