The 17th Century Wooden Shipwreck off Hatsushima Island, Japan

Hayato Kondo
Tokyo University of Marine Science and Technology
hkondo@kaiyodai.ac.jp

Akifumi Iwabuchi
Tokyo University of Marine Science and Technology
iwabuchi@kaiyodai.ac.jp

Toshiaki Hayashibara
Asian Research Institute of Underwater Archaeology
sea.museum@gmail.com

Abstract

The Asian Research Institute of Underwater Archaeology (ARIUA) at Fukuoka and Tokyo University of Marine Science and Technology, which is a member institution of the UNESCO Underwater Archaeology Unitwin Network, have researched upon the 17th century wooden shipwreck off Hatsushima Island in front of Atami city, Shizuoka Prefecture, since 2011. The shipwreck lies on the seabed at the depth of 20 metres, 200 metres from the western shore. It consists mainly of a cargo of roof tiles or grinding bowls and some parts of the wooden hull. Judging from them, the original vessel seems to have been a 17th or 18th century wooden freighter or kaisen (廻船), which left a port of western part of Japan for the capital town of Edo; most of well made roof tiles were not made in eastern part at that time. Because most of the roof tiles are high-quality and one of them is marked by the wild ginger trefoil coat of arms of the Shogunate family, they might mean to have been used for the Edo Shogunate castle. In 2011 and 2012, archaeologists with financial assistance from the Nippon Foundation, did the submersible survey upon this wreck site, about which local fishermen had already known to identify its exact position. In 2013, then, its bathymetry was made with a multibeam sonar. In order to make a precisely measured drawing of the 5 metre square wreck site, an AUV in 2013 and a ROV in 2015, both of which were developed uniquely by Tokyo University of Marine Science and Technology, and divers in 2016 were deployed to collect numerous underwater photos to generate 3D photogrammetric models with photogrammetry software Agisoft 'PhotoScan'.

Key words: Shipwreck, survey, Photogrammetry

Introduction

Hatsushima Island is approximately 4km around and located in the Sagami bay off east coast of Izu peninsula. In terms of its administration, it belongs to Atami city, Shizuoka Prefecture. From the mainland city, we could always see the island and vice versa, and regular ferry services are frequently available between them (Fig. 1). Hatsushima Island has approximately 200 inhabitants, most of whom engage in fishery and tourist industries. There is only one elementary school, about 30 guest houses, and a resort hotel on it. The surrounding sea around Hatsushima Island is managed by the Fisheries Cooperative Association of the Hatsushima Island; without permission from the association, neither recreation fishing nor fun diving around the island is allowed.

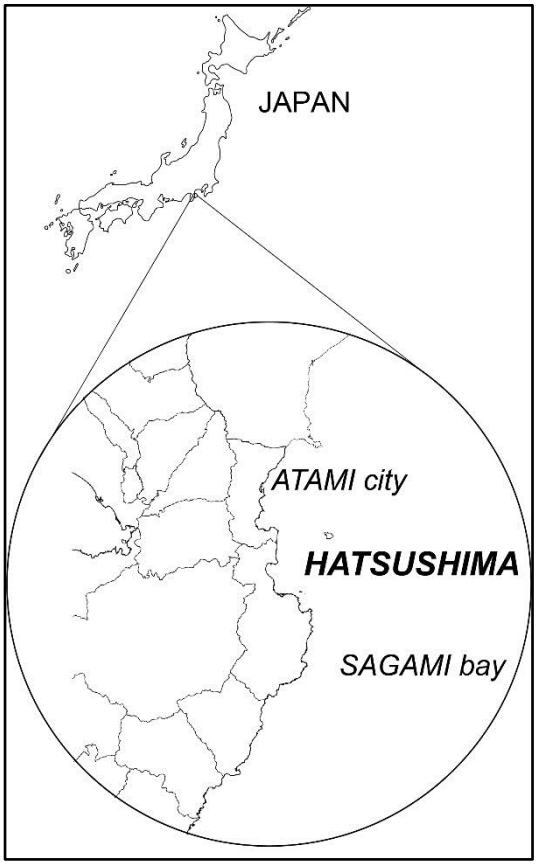

Fig. 1: Location of Hatsushima Island.

The so-called Hatsushima shipwreck lies on the seabed at the depth of 20 metres, being 200 metres from the western shore. Its cargo mainly consists of roof tiles or grinding bowls and some parts of wooden hulls. Judging from them, the original vessel seems to have been a 17th or 18th century wooden freighter or *kaisen* (廻船), which left a port of western part of Japan, might be Osaka or Hyogo, for the capital town of Edo, which is currently known as Tokyo. During the Edo period, Japan was in national isolation, called *sakoku* (鎖国); consequently, there was only limited contact with foreign countries, while domestic seaborne transportation systems were highly developed. Almost all areas in Japan were connected by the shipping traffic with wooden freighters. Using ships, rice was transported from northern Japan to Edo or Osaka, which was the largest town in western Japan; earthenware from western Japan to Edo; marine products from Hokkaido to western Japan, and so on.

The shipwreck site was officially found in the latter half of 1970s by a constructor of underwater pipelines which supplied pure water to Hatsushima Island from mainland. Even before, however, it has been known by fishermen that roof tiles and grindstones have sometimes been caught by fishing nets. In addition, the islanders have inherited legends testifying that at the shipwreck, night after night, a sodden samurai who wore armour used at that time, landed on the western shore of Hatsushima island from the bottom of the sea. Since the area was opened as a diving spot, some leisure divers have recognized the shipwreck. Because the Fisheries Cooperative Association of the Hatsushima Island has strictly managed the wreck, its destruction has been prevented somehow.

A series of surveys have been done mainly by the Asian Research Institute of Underwater Archaeology (ARIUA) and by Tokyo University of Marine Science and Technology, a member institution of the UNESCO Underwater Archaeology Unitwin Network. The Asian Research Institute of Underwater Archaeology is the only an active academic society for underwater cultural heritage in Japan. Although its headquarters is situated at Fukuoka city, Kyushu, the institute has not only Japanese members but also foreign scholars including from Korea and Germany. It was founded in 1986 under the name of the Kyushu Okinawa Society for Underwater Archaeology or KOSUWA, and then in 2005 it became a non-profit organization. The president director is Kenzo Hayashida, who is an expert advisor of the Submerged Sites Study Committee at the Agency for Cultural Affairs. The institute has regally published a journal titled *The Journal of Underwater Archaeological Studies* which is the only one periodical specialized about underwater cultural heritage in Japan.

In November 2011 and in February 2012, several ARIUA underwater archaeologists did the underwater survey upon the Hatsushima shipwreck site to locate its exact position. The third diving campaign was executed on April 2012, which was covered by a TV programme, and the fourth diving campaign was executed on October 2012 in order to create plans for future surveys and excavations. On March 2013, the multibeam sonar survey and pilot survey using an autonomous underwater vehicle (AUV), which was built by Tokyo University of Marine Science and Technology, were executed (Kondo, 2017). Figure 2 shows the bathymetry around the site generated by a multibeam sonar mounted. A group of embossments surrounded in a circle shows the wreck site. A sonar used for this multibeam survey was a SONIC 2024.

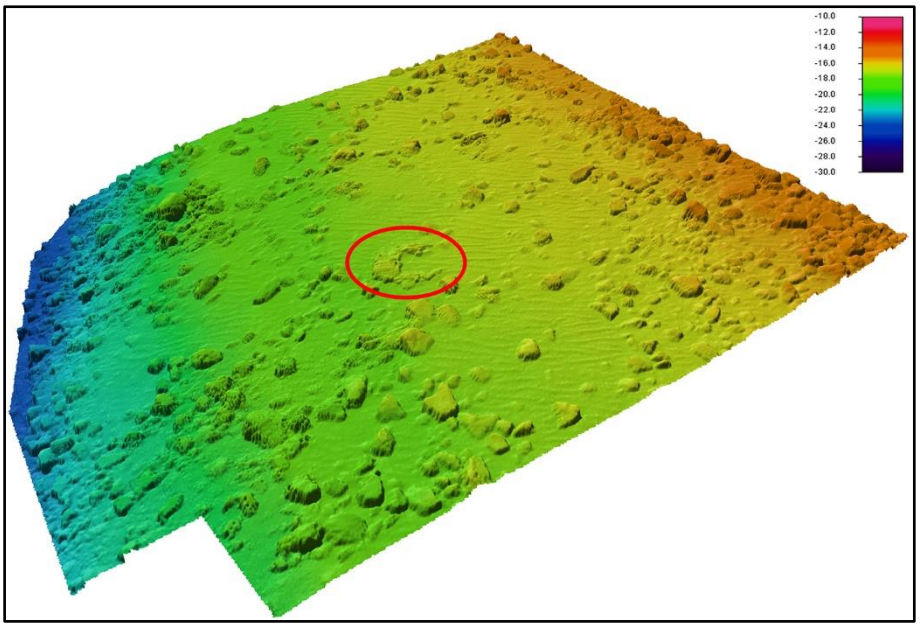

Fig. 2: Bathymetry of the archaeological site.

Archaeological Relics

The shipwreck site itself measures 4.7m from east to west and 5m from north to south. In an area of 5m square, the freighter's cargos, such as roof tiles, grinding bowls, and whetstones are spread (Fig. 3). Although decorative ridge-end tiles, pan eaves-tiles, and whetstones are found dispersedly, other cargo components such as pan-tiles, round eaves-tiles, and grinding bowls are well aligned. It could be imagined that, when this freighter sank, the heavy cargos might be placed bottom on the wooden hull. The number of pan-tiles, round eaves-tiles, and grinding bowls were spread far more than that of decorative ridge-end tiles, pan eaves-tiles, and whetstones. As for the hull, its greater part seems to be buried inside the sandy seabed; after the sand is push aside, a few wooden plates from the ship could be observed between the group of aligned pan-tiles and grinding bowls.

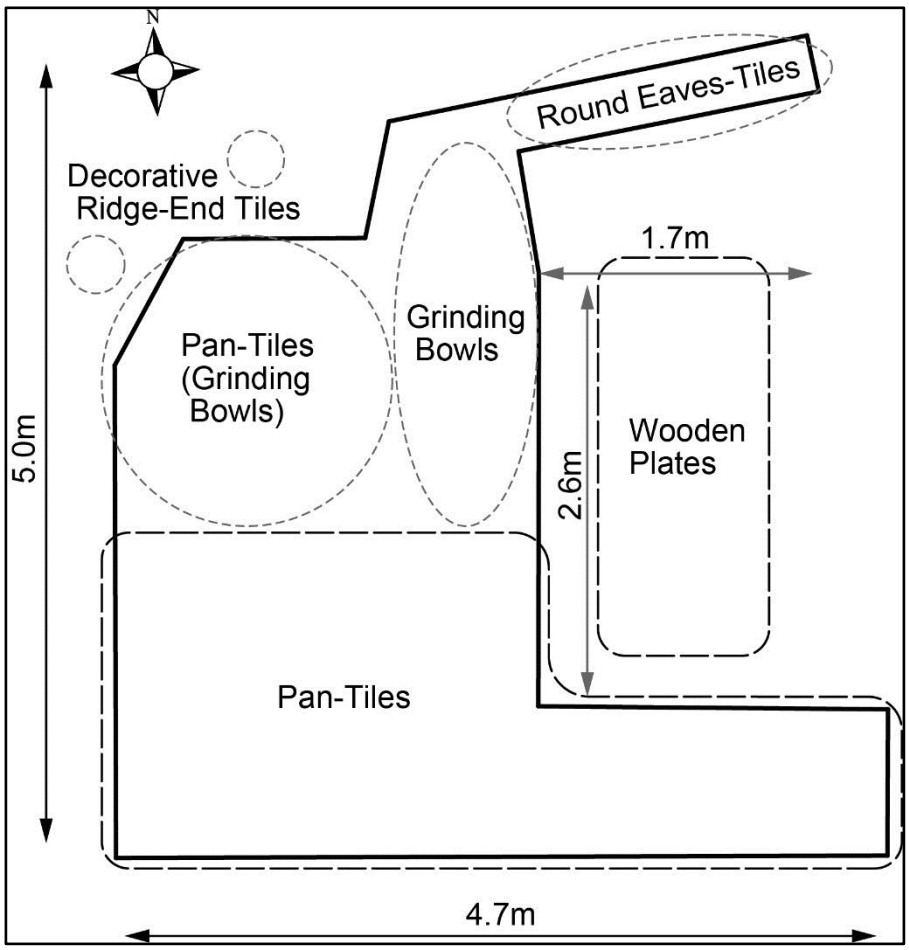

Fig. 3: Rough drawing of the wreck site.

At the southern part of the relics-concentrated site, pan-tiles are aligned in five rows and two layers to the east-west directions; and others are aligned in one row and one layer to the north-south directions. About the northern part, round eaves-tiles are aligned in two rows and two layers. Contrarily, pan eaves-tiles and decorative ridge-end tiles are sporadically spread to relatively outside of the relics-concentrated site.

Judging from their forms and characteristics, the grinding bowls were produced from the middle of the 17th century to the beginning of the 18th century in the Tamba region of western Japan, which is now in Hyogo Prefecture. This Tamba ware or Tamba-Tachikui ware had started to be made around 1000 years ago, and then became famous in Japan

especially for its grinding bowls. Before the 18th century almost all Japanese grinding bowls came either from the area of Tamba or from Seto. After the middle of the 18th century, however, the cheap bowls produced in a town of Sakai, near Osaka, became much more popular.

As for roof tiles, the original production area might be Awaji Island, which is also now in Hyogo Prefecture. Throughout Japanese History, we had three famous roof tile production areas, viz. Awaji Island at Hyogo, Sanshu at Aichi, and Sekishu at Shimane. The roof tile production at Awaji Island is said to have started around the 6th or the 7th centuries. The roof tiles produced at Awaji Island are characterized by their beautiful silvery colour, which could be observed on some roof tiles at the Hatsushima wreck. Indeed, it would be possible that not all roof tiles belonging to the wreck came from Awaji Island, but other roof tiles might have also been produced at some tile kilns, at least near Awaji Island, such as kilns around Osaka or Kyoto.

Most of roof tiles found on the shipwreck seem to be relatively high-quality products. One of the decorative ridge-end tiles has a well-known mark, its centre displays the wild ginger trefoil coat of arms (三葉葵文) of the Tokugawa Shogunate family or clan. The decorative cap of each round eaves-tile presents the crest of three comma-shaped figures (連珠三巴文) in a circle without circular line. On the other hand, the decorative cap of each pan eaves-tile has the 'Osaka-typed' motif of arabesque (均整唐草文) which is marked by elongated calyxes and y-shaped sides both on the right and left. All the roof tiles were polished-up beautifully that even did not display trace of polishing marks.

These high-qualitied roof tiles seem to have been produced especially for the Edo Shogunate castle as one of the decorative ridge-end tiles that has the crest of the Tokugawa family or clan. In 1657, the Great Fire of Meireki burned down more than the half districts of Edo, including the castle; therefore, the roof tiles of the Hatsushima wreck might be ordered for the reconstruction attempt of the castle after the fire. Also, there is a record that the Genroku earthquake hit Edo in 1703, yet the physical damage on the castle against the Edo castle was minor; only some gates or guard houses were reported to be collapsed. Consequently, it is natural to consider that the roof tiles were to be used for the repair works after the fire rather than the earthquake.

The roof tiles of the Hatsushima wreck must be specially ordered products by the Tokugawa Shogunate family or clan, while the grinding bowls seem to have been general-purpose products. As this freighter carried both products, it was not a ship owned by the government but rather a private merchant vessel. During the Edo period, two types or systems of mercantile operations were recorded. One was '*kaizumi* (買積)', in which vessels itself went to productions, factories, or industrial areas to buy goods directly in order to bring those goods back home ports or to bring them to the big cities such Edo or Osaka to sell. The other one was '*unchinzumi* (運賃積)', in which vessels carried cargos for customers, for instance the government and other merchants, based on orders and requests of customers. The Hatsushima wreck did belong to the latter system. The wreck of the same trading type was discovered off of Kozushima Island (Iwabuchi, 2012).

Survey after 2015

The main purpose of the survey after 2015 was to map the wreck site accurately using a 3D photogrammetry technique. The obtained data will help us to understand the whole archaeological site off Hatsushima Island including the shipwreck. Presumably the evaluation of this site by using this data would open a way that the site will be registered as a place of buried cultural properties which will be a legal evidence to help the site. Another purpose of this survey is to consider the potential usage of underwater vehicles and underwater photogrammetry for archaeological site.

Methodology: A remotely operated vehicle (ROV) was operated to take pictures while keeping close distance over the wreck for mapping. Divers were attended at the seabed to prevent any accidents. To complement for the mapping, visual inspections and measuring were operated by divers. The survey area was set to 5m square focusing on the relics-concentrated area. A small boat was locally hired to serve as a research vessel which delivered divers and instruments from pier to the site; and operation of the ROV was also done from the boat. The survey operations were completed by both photo-shooting by the ROV and visual inspection by divers; any destructive operations such as excavation and rising artefacts of the relics were not executed.

Homemade Remotely Operated Vehicle: A simple ROV was designed and constructed by Kondo laboratory of Tokyo University of Marine Science and Technology. Figure 4 shows the general arrangement of the vehicle. The length of the ROV is 1m, width is 0.58m and the depth is 0.48m (excluding hanging points). The weight is about 70kg, yet it is neutrally buoyant in seawater. Four propeller thrusters are mounted on the vehicle; two horizontal thrusters are mounted horizontally to make the vehicle

move forward and backward; the other two thrusters are mounted vertically (see Fig. 4) to make the vehicle to move upward and downward.

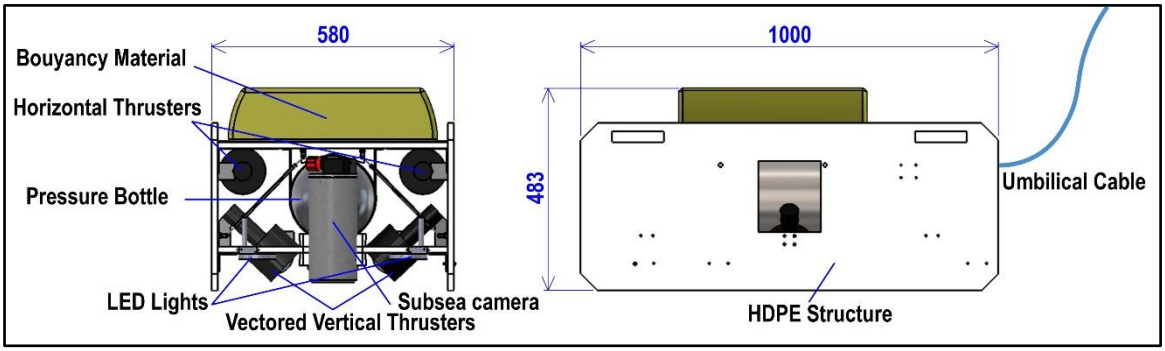

Fig. 4: General arrangement of the homemade ROV.

Four cameras are mounted on the vehicle as observational equipment. Main camera has Type 4/3 sized, 3296 x 2472 resolution CCD. An F mount lens was attached to the camera. The camera is sealed in a homemade pressure bottle with underwater connectors. Still images are transmitted from the ROV to the surface boat via an umbilical cable, and stored in a laptop computer. This main camera is mounted vertically/perpendicularly as the camera face-down to the seabed. Other used cameras were wearable cameras (GoPro), one camera was mounted perpendicularly to take top-view movies. Other two were paired as works as stereo cameras, and mounted slightly diagonally angled down to take slant-view movies of the site. Three original underwater LED lights were also mounted to provide lighting.

A syntactic foam, which is a buoyancy material made of glass microspheres and compound was mounted on top of the vehicle. A main pressure bottle made of aluminum alloy was attached beneath the buoyancy material. Microcomputers, control units, a depth sensor and batteries were stored in the main bottle. The main bottle was relatively

heavy to make the long separation between centers of buoyancy and gravity to provide better stability for the vehicle's motions.

An umbilical cable which encloses ethernet and power lines connected the main bottle and a laptop computer on the boat. Operator can control the vehicle's motion and onboard equipment from the laptop. The structure of the ROV consists of High Density Poly Ethylene (HDPE), which is positively buoyant in seawater, free from corrosion and easy to let any equipment to be mounted.

Results: Although divers supported the ROV (Fig. 5) because of electric failure of thrusters, an orthophoto mosaic of the wreck (Fig. 6) was obtained from 3D spatial data generated by photogrammetric processing using digital images taken by the ROV. Agisoft 'PhotoScan' was used for photogrammetric processing. Although blank parts can be seen on the orthomosaic because of the bad image conditions, distortions of the orthomosaic are minimum, and this orthomosaic can be used for archaeological drawings.

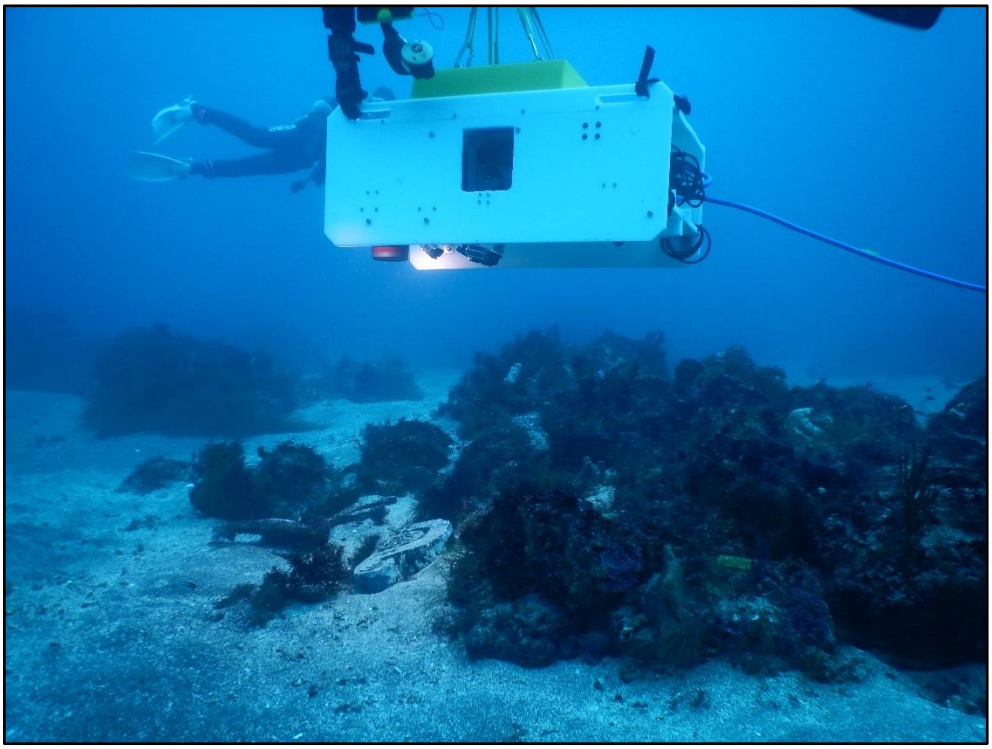

Fig. 5: A photo taken by a diver during the Survey.

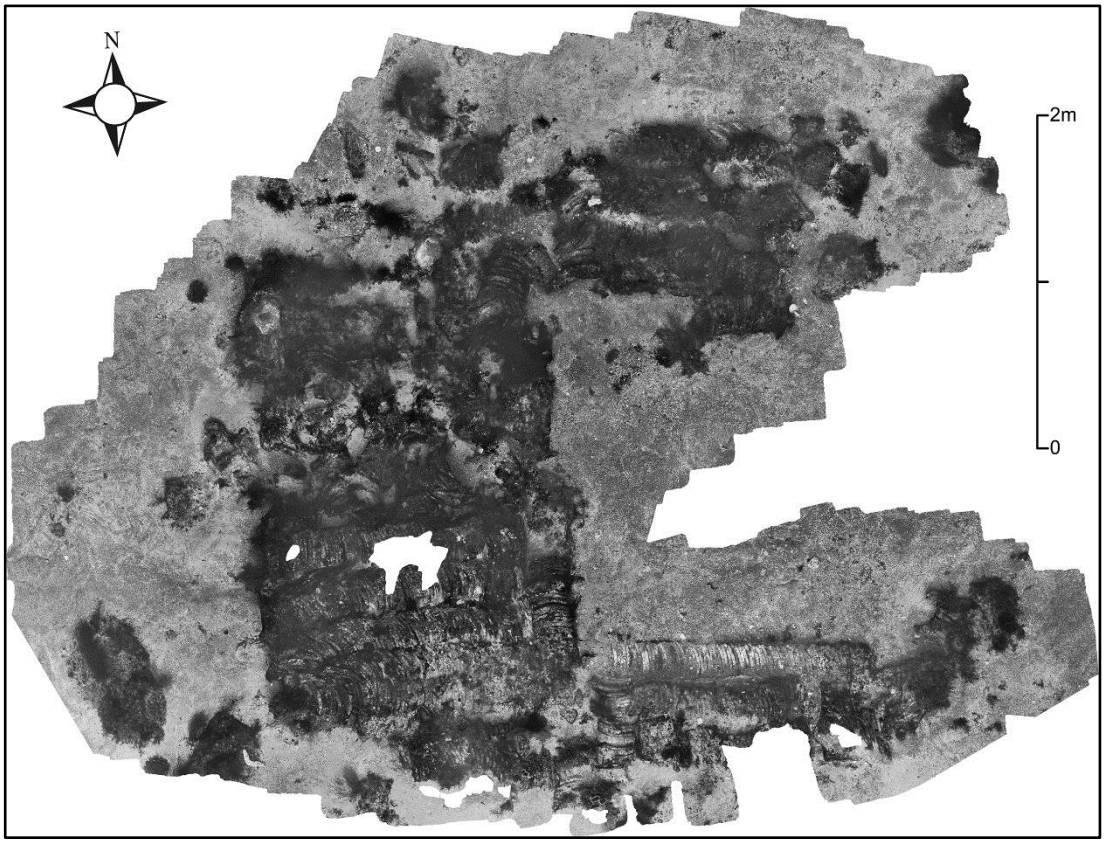

Fig. 6: Orthophoto mosaic of the wreck site.

In November 2016, to obtain better 3D photogrammetric data, several ARUIA divers took numerous underwater photos of the Hatsushima shipwreck. At that time, two grapnels were discovered at north-east from the wreck site (about 10 metres apart from the site). However, the relationship between these anchors and the wreck is still under investigation. Both in 2015 and in 2016, the open briefing sessions of the survey for the general public living in Hatsushima Island were organized by ARIUA and Tokyo University of Marine Science and Technology during the campaigns. Many islanders, including members of the Fisheries Cooperative Association of the Hatsushima Island, attended the sessions and displayed their high interests to this underwater cultural heritage (Hayashibara et al., 2016). We have once again understood that working together with local people is necessary.

Additionally, foreign researchers participated in the surveys at Hatsushima Island both in 2015 and in 2016. In 2015, one Indonesian student from the graduate school of Tokyo University of Marine Science and Technology received hands-on training of underwater archaeology in this field campaign. This was a part of the programmes of the UNESCO Underwater Archaeology Unitwin Network at TUMSAT. In 2016, two Italian scholars from the International Research Institute for Archaeology and Ethnology, one Dutch from ICOMOS Netherlands, and one American from the Oxford Centre for Maritime Archaeology, attended the survey to help the underwater investigations. Complying with the UNESCO international standard, ARIUA and Tokyo University of Marine Science and Technology are planning to make good use of this underwater archaeological site for education and training, not only as a touristic attraction.

Conclusions and Perspectives

An orthophoto mosaic of the wreck was generated from 3D spatial data generated by photogrammetric processing using digital images taken by the ROV and divers. Line art (2D site plan) for the cultural heritage documentation is under drawing. Currently, the team is planning more data collection in order to obtain sectional drawings. The ROV operation was executed twice and its total time is about one hour; this is a large saving for divers' underwater operation time for underwater archaeological sites. The advantage of underwater vehicles for archaeological survey has been confirmed by the orthophoto mosaic of the wreck. Also, we are planning to evaluate the validity of increasing the image quality and usage of underwater technological instruments.

The goal of these investigations is to produce a site map as an orthophoto mosaic, and share detailed and accurate information of the site with the Board of Education of Atami city. Although it has already recognized its existence, the Hatsushima shipwreck has not designated as a 'Buried Cultural Property' or 'Historic Site' under the Japanese domestic law of the Cultural Properties Protection Act (Hayashibara, 2013). The board of education believes that more detailed information is required, for instance its historical values or current situation including the complete picture of the hull buried beneath the seabed. Without raising all archaeological components of the site, which is against the Convention on the Protection of the Underwater Cultural Heritage, its general view of the site could not be appeared and observed. The other reason why the board of education does not want to protect this site under the civil law is that the Agency for Cultural Affairs has ordered every board of education to execute the Cultural Properties Protection Act upon all sites before the Middle Age,

but this order also implies that it is not priority to apply this order to heritage sites dated after the Early Modern Age.

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Biographies

Hayato Kondo is Associate Professor at Tokyo University of Marine Science and Technology. His research interests include ocean-related autonomous system, high-resolution ocean observation, AUV system design, and its payload system including optical and acoustic sensors. He received his PhD from the University of Tokyo in 2002 on naval architecture and ocean engineering, M.Eng. and B.Eng. from Waseda University on mechanical engineering. He is a co-chair of the technology committee on unmanned

maritime vehicles and submersibles, Oceanic Engineering Society, IEEE. He is also a member of the Japan ICOMOS National Committee.

Akifumi Iwabuchi is Professor of Maritime Anthropology and Nautical Archaeology at Tokyo University of Marine Science and Technology, a member institution of the UNESCO Underwater Archaeology Unitwin Network. He is the ICOMOS-ICUCH National Representative for Japan, being also Directors of the Japan Society for Nautical Research, of the Asian Research Institute of Underwater Archaeology, and of the Forum on the Oceanic State of Japan. He received his PhD from the University of Oxford in 1990. His publications include The People of the Alas Valley (Clarendon Press, 1994) and Cultural Heritage under the Sea: An Introduction to Underwater Archaeology (Kagaku-Dojin, 2012).

Toshiaki Hayashibara was born in Tokyo in 1960. He received his MA from Toyo University in 1986. He is a director of the Asian Research Institute of Underwater Archaeology at Fukuoka and lecturer in underwater archaeology at Tokyo University of Marine Science and Technology. He is also a member of the Japanese Archaeological Association. His archaeological specialties include prehistorical bronze wares in Japan, underwater cultural heritage, and heritage management. In the process of participating in underwater researches all over Japan, he has most gradually come to have his doubts about treatments of underwater archaeological sites and their managements in Japan.