



BRODOLOM KOD OTOČIĆA GNALIĆA (*Gagliana grossa*, 1583.)

Shipwreck at the islet of Gnalić (*Gagliana grossa*, 1583)

Tijekom 1967., 1968., 1972. i 1973. godine na nalazištu brodoloma kod otočića Gnalića provedeno je pet zaštitnih istraživačkih kampanja. Probnim iskopavanjem 2012. potvrđen je velik znanstveni potencijal podmorskih nalaza pa se istraživanje tijekom idućih godina nastavilo u sustavnom obliku (Radić Rossi, Nicolardi 2019; Radić Rossi *et al.* 2021). Sustavno istraživanje 2013. započelo je od krmenog dijela broda i proširilo se prema njegovu središnjem dijelu, na kojem su otkriveni ostatci kaljužne pumpe i prve palube. Tijekom posljednjih nekoliko godina, uz nastavak čišćenja već prije otkrivenih dijelova brodske konstrukcije, istraživanje se nastavilo duž kobilice u smjeru pramca, a zahvaćen je i prostor na kojemu, iza krme na zapadnom kraju nalazišta, leži niz inkrustiranih željeznih elemenata (Radić Rossi, Yamafune 2024: Sl. 8). Utvrđeno je kako je riječ o metalnim spojevima za učvršćenje kormila na krmenu stavu, koji su detaljno dokumentirani i uneseni u situacijski plan.

Tijekom kolovoza 2024. istraživanje se nastavilo s ciljem izmjешtanja svih elemenata glavnog rebra, nastavka iskopa u smjeru pramca i uklanjanja

During 1967, 1968, 1972, and 1973, five rescue research campaigns were conducted at the shipwreck site near the islet of Gnalić. A trial excavation in 2012 confirmed the significant scientific potential of the underwater finds, prompting the start of systematic research in subsequent years (Radić Rossi, Nicolardi 2019; Radić Rossi *et al.* 2021).

Systematic research began in 2013, focusing initially on the stern of the ship and gradually extending toward its central section, where remains of the bilge pump and the first deck were uncovered. In recent years, alongside the continued cleaning of previously uncovered parts of the ship's structure, excavation has progressed along the keel toward the bow. The western end of the site, located behind the stern, was also explored, revealing a series of concreted iron elements (Radić Rossi, Yamafune 2024: Fig. 8). These were identified as metal joints used to secure the rudder to the stern post, and were thoroughly documented and incorporated into the site plan.

In August 2024, the research campaign re-



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... Pijljenje i uklanjanje dijelova uzdužnih elemenata čvrstoće broda (foto: K. Yamafune)
 ... Sawing and removing parts of the ship's longitudinal strength elements (photo: K. Yamafune)

bačava iz krmenog i središnjeg dijela broda. Financijska sredstva i logističku potporu osigurali su Ministarstvo kulture i medija RH, Ministarstvo regionalnog razvoja i fondova Europske unije, Sveučilište u Zadru, Institut za pomorsku baštinu ARS NAUTICA i Općina Pašman. U istraživačkoj ekipi, pod vodstvom Irene Radić Rossi, sudjelovali su arheolozi iz Hrvatske, Italije, Nizozemske, Omana i Australije te studenti arheologije iz Hrvatske, Njemačke, Malte i Cipra. Ulogu voditelja dokumentacije obnašao je Kotaro Yamafune iz Japana, a ulogu voditelja ronjenja Marko Lete iz Splita.

Istraživanje je započelo otklanjanjem privremene zaštite sa središnjeg dijela broda na kojemu se planirao nastavak radova na vađenju glavnog rebra. Osim toga, privremena je zaštita početkom istraživačke kampanje otklonjena i s istočnog dijela nalazišta na kojemu se planirao nastavak iskopa prema pramčanom dijelu broda. U središnjem dijelu započeli su radovi na oslobađanju očuvanog dijela rebrenice i rebrenih nastavaka glavnog rebra, koji su kontinuirano tekli tijekom prva dva tjedna istraživanja. Prije svega, dovršeno je uklanjanje elemenata koji su se protezali u uzdužnom smjeru (proveze i nosači palube), što je, s obzirom na odlično stanje drvene građe, zahtijevalo priličan napor. Nakon toga nastavio se rad na

sumed with the objectives of displacing all elements of the main rib, continuing excavation toward the bow, and removing barrels from the stern and central areas of the ship. Financial and logistical support for the campaign was provided by the Ministry of Culture and Media of the Republic of Croatia, the Ministry of Regional Development and EU Funds, the University of Zadar, the Institute for Maritime Heritage ARS NAUTICA, and the Municipality of Pašman. The research team, led by Irena Radić Rossi, consisted of archaeologists from Croatia, Italy, the Netherlands, Oman, and Australia, as well as archaeology students from Croatia, Germany, Malta, and Cyprus. The role of documentation manager was fulfilled by Kotaro Yamafune from Japan, while Marko Lete from Split served as the diving operations manager.

The research campaign began with the removal of temporary protective coverings from the central part of the ship, where continued work on the extraction of the master frame was planned. Simultaneously, temporary protection was also removed from the eastern section of the site, in preparation for ongoing excavation toward the bow of the ship. In the central sec-

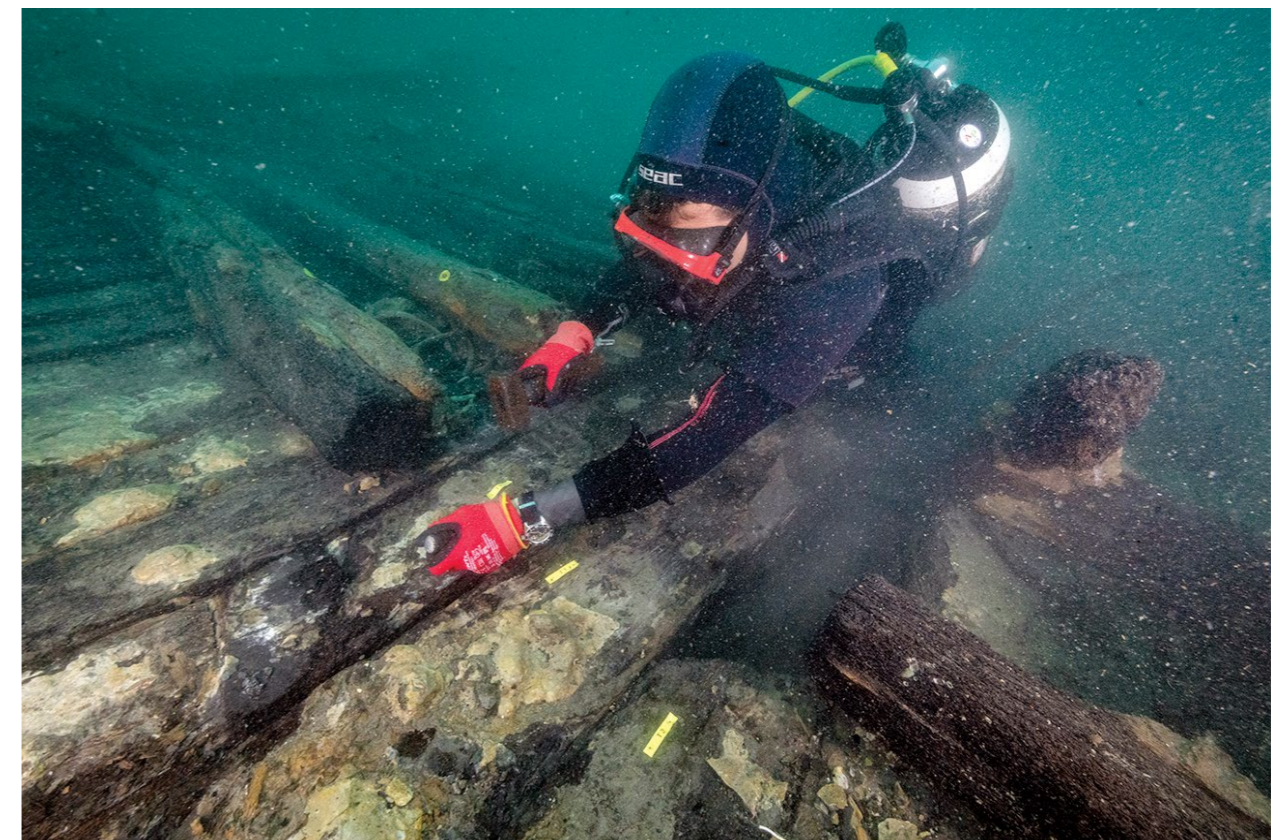
izmještanju svih dijelova glavnog rebra, koji je tekao relativno sporo zbog prisutnosti velike količine stvrdnutog materijala za koji za sada nije moguće reći je li originalno korišten pri gradnji broda ili je posljedica degradacijskih procesa tijekom proteklih stoljeća.

Rebrenica i rebreni nastavci oslobađani su pomoću dlijeta i čekića, a kroz slobodan prostor provlačio se konop. Za njega su potom pričvršćeni ronilački baloni koji su se pod potiskom zraka kretali prema površini. Iako takav postupak u početku nije dao bitne rezultate, povećanje broja balona (do 2500 kg nosivosti) dovelo je do sile potrebne za izmještanje nalaza. Na oslobođenom prostoru pomoću okruglih žutih oznaka označena su mjesta na kojima su se nalazili željezni čavli pa je situacija fotogrametrijski dokumentirana. Svi izmješteni elementi postavljeni su sa sjeverne strane nalazišta, gdje su pažljivo očišćeni, a potom nacrtano, fotografski i fotogrametrijski dokumentirani. Nakon toga privremeno su zaštićeni geotekstilom i ostavljeni na morskom dnu do sljedeće istraživačke kampanje tijekom koje se planira njihovo vađenje iz mora i nastavak dokumentiranja na kopnu.

Usporedno s izmještanjem sastavnih dijelova glavnog rebra, istraživanje se usmjerilo na pramčani dio broda. Prije svega, nad dio nalazišta postavlj-

tion, excavation commenced with the release of the preserved portion of the floortimber and futtocks of the master frame, a process that continued steadily throughout the first two weeks of the campaign. The initial phase involved the removal of structural elements extending longitudinally (stringers and deck beams supports). Due to the excellent preservation of the timber, this stage required considerable physical effort. Subsequent efforts focused on the dislocation of all parts of the master frame, which progressed relatively slowly. This was largely due to the presence of a significant amount of hardened material, the origin of which remains unclear—whether it was intentionally used during the original construction of the vessel or formed as a result of degradation processes over the centuries.

The floortimber and futtocks were freed using chisels and hammers, after which a rope was threaded through the cleared space. Diving balloons were then attached and inflated to apply upward force. Although initial attempts were unsuccessful, increasing the number of balloons (up to a total load capacity of 2,500 kg) generated sufficient force to displace the structure. In the cleared area, the locations of the iron nails



... Oslobađanje glavnog rebra s pomoću dlijeta i čekića (foto: K. Yamafune)
 ... Freeing the master frame with the help of a chisel and hammer (photo: K. Yamafune)





no je pomoćno metalno mrežište koje se u početku sastojalo od niza kvadrata A23–A27, ali je ubrzo potom prošireno i na nizove B i C. Podmorski iskop započeo je s istočne strane nalazišta i odvijao se u smjeru zapada i juga. U kvadratu A detaljno je očišćena već prije istražena brodska konstrukcija, a u kvadratima B i C otkrivena je velika količina uglavnom raspadnutih bačava ispunjenih ingotima olovnog bjelila, tj. olovnog (II) karbonata, s mjestimičnim tragovima žarkožutog auripigmenta ili arsenova (III) sulfida.

S obzirom na situaciju u kvadratima, odlučeno je da se istraživanje ne nastavlja do brodske konstrukcije, već da se pokuša ukloniti sediment s čim veće površine nalazišta kako bi se utvrdilo u kojim se sve kvadratima prostiru očuvane bačve. Najveća koncentracija bačava zabilježena je u kvadratima B25–B27 i C25–C26, a u kvadratima A–C 24–25 zabilježene su dvije okomite pregrade kojima se prostor broskog potpalublja pregrađivao pri utovaru tereta. S obzirom na bačve otkrivene tijekom prijašnjih godina u zapadnom i središnjem dijelu broda, koje su označene oznakama od B.1 do B.71, označavanje bačava u istočnom dijelu broda započelo je od B.100 i nastavilo se do B.134. Na novootkrivene elemente brodske konstrukcije postavljeni su brojevi T521a do T550a. Među bačvama u istočnom dijelu nalazišta zamijećena je velika količina većih kamenih oblutaka i pločastog kamenja iz broskog balasta, koja se pojavljivala i tijekom iskopavanja u središnjem dijelu broda. Sediment sastavljen od kamenih oblutaka teže se uklanja s nalazišta, ali je tijekom vremena dobro zaštitio brodsku konstrukciju od propadanja.

Istovremeno s radom u središnjem i istočnom dijelu nalazišta, nakon uklanjanja privremene zaštite, započelo se s izmještanjem već prije otkrivenih ve-

Dio brodske konstrukcije s označenim željeznim čavlima, nakon uklanjanja glavnog rebra (model: K. Yamafune)
Part of the ship's structure with marked iron nails, after the master frame has been removed (model: K. Yamafune)

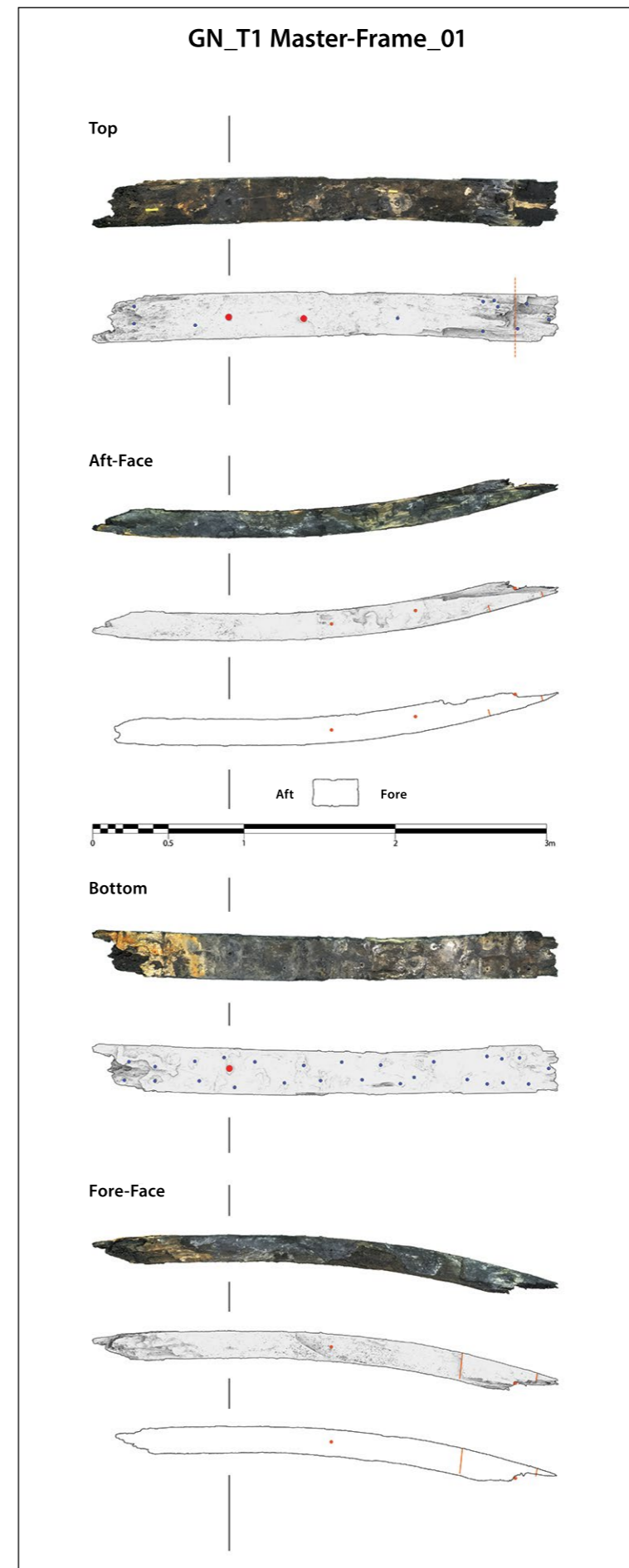


were marked with round yellow tags, and the situation was documented photogrammetrically. All displaced elements were relocated to the northern side of the site, where they were carefully cleaned and documented through drawing, photography, and photogrammetry. Following documentation, the elements were temporarily protected with geotextile and left on the seabed. They will be recovered and further documented on land during the next research campaign.

In parallel with the removal of the master frame components, research activities focused on the bow section of the ship. An auxiliary metal grid was installed over part of the site, initially covering the square series A23–A27, and later extended to include series B and C. Underwater excavation began on the eastern edge of the site and progressed westward and southward.

In the A-series squares, previously exposed portions of the ship's structure were thoroughly cleaned. In squares B and C, a large number of mostly degraded barrels were uncovered, many of which were filled with lead white ingots, i.e. lead (II) carbonate, with occasional traces of bright yellow orpiment or arsenic (III) sulphide.

Given the complexity and density of finds in these squares, it was decided not to excavate further down to the ship's structure at this stage. Instead, the focus shifted to removing sediment across a broader area to determine the precise locations of preserved barrels. The highest concentrations were recorded in squares B25–B27 and C25–C26. Additionally, in squares A–C 24–25, two bulkheads were documented, which served to divide the lower deck of the ship during cargo loading. Building on the previous classification, where barrels discovered in the western and central parts of the ship were numbered B.1 to B.71, the newly discovered barrels in



the eastern section were numbered starting from B.100 to B.134. Newly uncovered structural elements of the ship were assigned numbers ranging from T521a to T550a.

Among the barrels discovered in the eastern part of the site, a significant quantity of larger stone pebbles and flat stones, interpreted as ship ballast, was observed. Similar ballast material had also been noted during earlier excavations in the central part of the ship. Although sediment composed of such material is more difficult to remove, it has, over time, provided effective protection for the ship's wooden structure, helping to preserve it from decay.

Simultaneously with the work in the central and eastern sections of the site, the relocation of previously discovered large barrels filled with Venetian red, or iron (III) oxide, and smaller barrels containing lead white ingots also began, following the removal of temporary protective coverings. Based on the existing site plan, the barrels were re-marked with their appropriate identification numbers. This was followed by the removal of sediment, extraction of lead ingots, and marking of all individual components to facilitate easier documentation and future referencing.

The cleaning and relocation process progressed relatively slowly, but the remains of several barrels were successfully removed, including the large barrel B.4 and smaller barrels B.23, B.24, B.24a, B.25, B.27, B.29, B.30, B.33, B.35, B.36, B.37, B.38, B.43, B.44, B.45, B.48, B.52, and B.54. A significant quantity of elemental mercury was found during sediment removal. As in previous years, it was extracted using the syringe, and handed over

Primjer dokumentiranja glavnog rebra – očuvani dio rebrenice (model i crtež: K. Yamafune)
An example of documenting the master frame – the preserved part of the floortimber (model and drawing: K. Yamafune)

likih bačava ispunjenih venecijanskim crvenilom ili željeznim (III) oksidom i manjih bačava s ingotima olovnog bjelila. U skladu s ranijim planom nalazišta, bačve su ponovno obilježene pripadajućim oznakama, nakon čega je započelo otklanjanje sedimenta, vađenje olovnih ingota i označavanje svih njihovih sastavnih elemenata, s ciljem olakšanog snalaženja u dokumentaciji.

Čišćenje i izmještanje nalaza teklo je relativno sporo, ali su s nalazišta uklonjeni ostatci velike bačve B.4 te manjih bačava B.23, B.24, B.24a, B.25, B.27, B.29, B.30, B.33, B.35, B.36, B.37, B.38, B.43, B.44, B.45, B.48, B.52 i B.54. Pri otklanjanju sedimenta uočena je veća količina elementarne žive, koja je izvađena s pomoću injekcije i, kao i ranijih godina, predana Zavodu za istraživanje mora i okoliša Instituta *Ruđer Bošković*. Ingoti olovnog bjelila iz svake bačve izvađeni su, dokumentirani i izva-

to the Department of Marine and Environmental Research at the Ruđer Bošković Institute for further handling. The lead white ingots from each barrel were removed, documented and weighed, and then mostly bagged to the seabed, in the immediate vicinity of the central part of the site. The wooden parts of the barrels were stored in a laboratory for documentation, and after professional processing they will be returned to the site due to the lack of financial resources needed for conservation.

During the work on the western part of the site, under the previously known barrels, an excellently preserved barrel was found, with all its components preserved. The barrel is marked B.71, and on its western side there are barrels B.51 and B.31, which are slightly damaged. The three mentioned barrels were documented graphical-

gani, a potom većinom vraćeni na morsko dno, u neposrednu blizinu središnjeg dijela nalazišta. Drveni dijelovi bačava pohranjeni su u laboratorij radi dokumentiranja, a nakon stručne obrade bit će vraćeni na nalazište zbog nedostatka financijskih sredstava potrebnih za konzervaciju.

Tijekom rada na zapadnom dijelu nalazišta, pod već otprije poznatim bačvama naišlo se na jednu odlično očuvanu bačvu kojoj su se očuvali svi sastavni dijelovi. Bačva je označena oznakom B.71, a s njezine zapadne strane nalaze se bačve B.51 i B.31, koje su lakše oštećene. Tri spomenute bačve dokumentirane su nacrtno, fotografski i fotogrametrijski, a potom su pokrivene geotekstilom do sljedeće istraživačke kampanje.

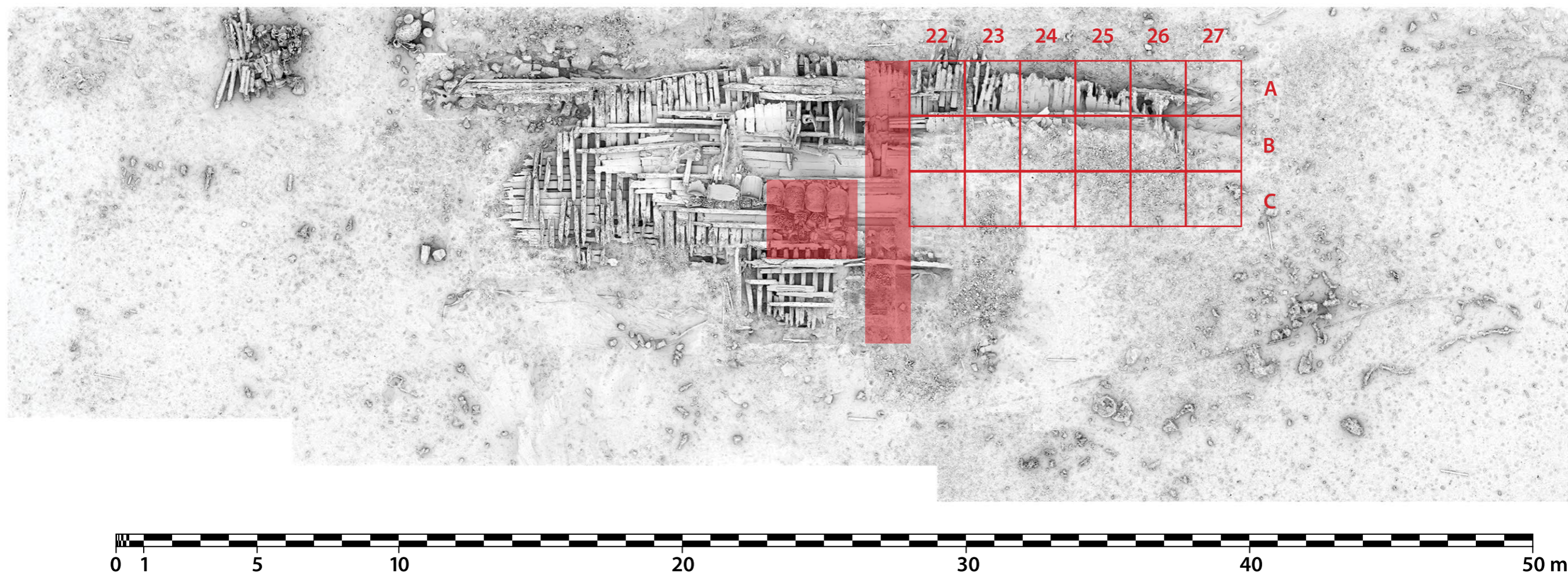
Rezultati ovogodišnje istraživačke kampanje dodatno su potvrdili velik znanstveno-istraživački potencijal nalazišta koje svake godine donosi nova

ly, photographically and photogrammetrically, and then covered with geotextile until the next research campaign.

The results of this year's research campaign have further confirmed the significant scientific and archaeological potential of the site, which continues to yield new and unexpected discoveries each year. Due to ongoing exposure to both human impact and natural degradation, particularly affecting organic materials, it is essential that research efforts continue in order to gather as much information as possible about ship-building techniques, material culture, and maritime trade during the late Renaissance period.

However, limited financial resources remain a major challenge in organizing and executing the work. A considerable amount of time must be dedicated to opening sections of the site for

Raspored kvadrata u istočnom dijelu nalazišta i zone istraživanja u središnjem i zapadnom dijelu (podloga: K. Yamafune)
Layout of squares in the eastern part of the site, and the research zones in the central and western parts (background: K. Yamafune)





Odlično očuvana bačva B.71 (foto: K. Yamafune)
 Excellently preserved barrel B.71 (photo: K. Yamafune)



Ortogonalna snimka pramčanog dijela nalazišta sa žutim oznakama na novopronađenim bačvama (model: K. Yamafune)
 Orthomosaic of the bow section of the site with yellow tags on the newly discovered barrels (model: K. Yamafune)



Vađenje elementarne žive s nalazišta (foto: K. Yamafune)
 Extraction of elemental mercury from the site (photo: K. Yamafune)

iznenađenja. S obzirom na izloženost devastaciji te prirodnoj degradaciji svih nalaza, a osobito nalaza od organskih materijala, istraživanje je potrebno nastaviti kako bi se prikupilo čim više podataka o brodogradnji, proizvodnji i pomorskoj trgovini tijekom kasnorenesansnog doba. Ograničena financijska sredstva priličan su problem u cjelokupnoj organizaciji radova, jer se velika količina vremena ulaže u otvaranje dijelova nalazišta predviđenih za istraživanje te njihovo ponovno pokrivanje po završetku istraživačkih aktivnosti. Usprkos tomu, radovi na nalazištu znatno su napredovali što ulijeva nadu da će nalazište tijekom idućih nekoliko godina biti većim dijelom istraženo.

investigation and re-covering them afterward to ensure their preservation. Despite these constraints, the 2024 campaign made substantial progress, offering encouraging prospects that the site may be comprehensively explored in the coming years.

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