
KONZERVATORSKO-RESTAURATORSKI RADOVI NA KERAMIČKOJ AMFORI S NATPISOM *FELIX ARBA*

THE CONSERVATION AND RESTORATION TREATMENT OF THE CERAMIC AMPHORA INSCRIBED WITH THE WORDS *FELIX ARBA*

Arheološki predmeti od pečene gline izloženi su brojnim procesima, mehanizmima i uzrocima propadanja tijekom dugotrajnog ukopavanja u tlo. Utjecajem kemijskih čimbenika same okoline (sastav tla, vlažnost, pH, temperatura) nastaju površinske nečistoće i naslage koje, osim što čine predmet estetski manje ugodnim, uzrokuju i njegovo fizičko propadanje. Za konzervatore-restauratore uklanjanje naslaga bitna je intervencija, a ipak kontroverzna s obzirom na to da je proces ireverzibilan. Prije čišćenja važno je obaviti sve predradnje, pogotovo kemijske analize pomoću kojih određujemo strukturne karakteristike uzročnika propadanja, što omogućuje ispravan izbor metode rada i restauratorskog materijala.

Ključne riječi: *Felix Arba*, amfora, pečena glina, konzervatorsko-restauratorski postupak

Archaeological objects of fired clay are exposed to various processes, mechanisms and causes of degradation while buried underground over an extended period of time. The surface dirt and deposits that, besides affecting an object's esthetic value, cause its physical degradation, occur as a result of the interaction with the chemical factors in the environment (soil composition, humidity, pH, temperature). For conservators-restorers, removal of deposits is an essential intervention; however, it is also controversial, given the irreversible nature of the process. Prior to the cleaning, complete preparatory work should be carried out, particularly the chemical analyses used for establishing the structural characteristics of the agents of degradation, required for choosing the right restoration method and material.

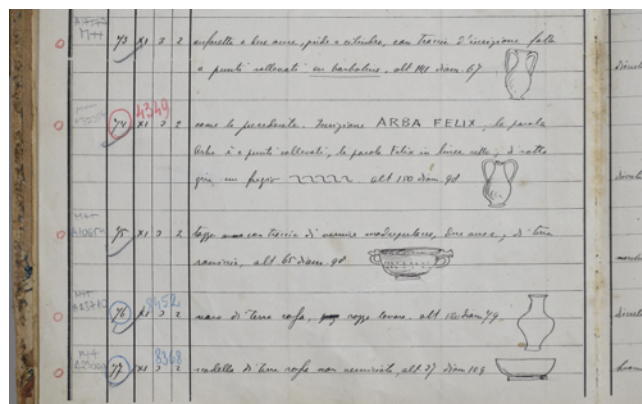
Key words: *Felix Arba*, amphora, fired clay, conservation-restoration treatment

ARHEOLOŠKI KONTEKST PRONALASKA

Keramička amfora s natpisom *Felix Arba* tema je mnogih znanstvenih objava.¹ Smještena je u čuvaonici Arheološkog muzeja Zadar i dio je starog fundusa.² Nisu poznate okolnosti njezina pronalaska, međutim zanimljiva su istraživanja starih inventarnih knjiga. U katalogu keramike (*Catalogo Cotti*)³ nalaze se tri predmeta koji potječu s istog lokaliteta i imaju istu godinu pronalaska, Nona, 1895. (Sl. 1–1a). Ti su predmeti također bili smješteni zajedno u ormaru XI, postava Arheološkog muzeja Zadar u crkvi sv. Donata. Riječ je o amfori s nečitkim natpisom pod rednim brojem 73 (plavom bojom dopisan je broj 3834), amfori s natpisom *Felix Arba* pod rednim brojem 74 (plavom bojom dopisan je broj 3693, a crvenom bojom 4349) i skifosu pod rednim brojem 75 (plavom bojom dopisan je broj 3879, a crvenom bojom 4358).⁴ Na prvoj stranici *Cataloga Cotti* stoji napomena: brojevi pisani plavom bojom odgovaraju oznakama na predmetima, dok crveno pisani brojevi odgovaraju brojevima glavnog kataloga (Sl. 2–2a). Iako je tema ovog rada konzervatorsko-restauratorska obrada provedena na posudi pod rednim brojem 74, odnosno novim brojem A32354, ovaj jedini kontekst nalaza treba uzeti u obzir za neke buduće objave.⁵

OPIS I ZATEČENO STANJE

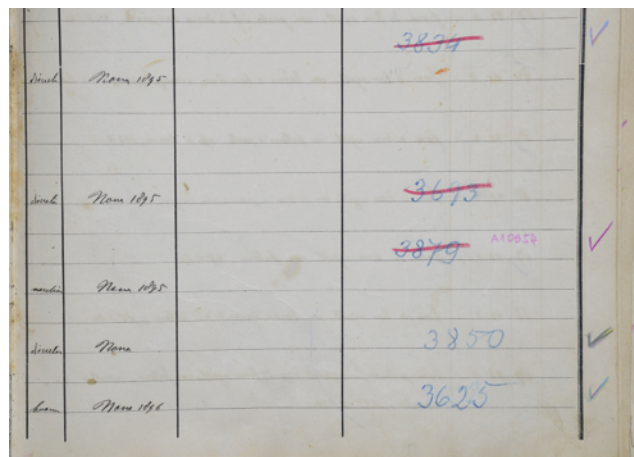
Keramička amfora svrstava se u kategoriju amforeta jer je manjih dimenzija: visina joj je svega 15,9 cm, dok najveća širina iznosi 9,9 centimetara. Sačuvana je gotovo cjelovita, nedostaje joj obod i veći dio ručke. Duž cijelog promjera ramena posude proteže se natpis, velikim slovima podijeljen *FELIX / ARBA*, izrađen barbotinskom tehnikom apliciranja kojom se dobiva reljefnost površine, a koja se često koristila kako bi se spriječilo klizanje posude iz ruku.⁶ Slova *ARBA F* izvedena su u pravilnom rasporedu točkica na polutvrdoj glini, a prije pečenja nanosila se još i glina u polutekućem stanju pomoću aplikatora u obliku tuljka, dok su slova *ELIX* i valoviti ukras ispod natpisa izrađeni apliciranjem trakica glinene paste (Sl. 3).⁷ Pojava natpisa na rimskom posuđu nije rijetkost, najčešći su nazivi proizvođača ili majstora, mogu se pojavljivati i kulturne poruke, ali i različite vrste zdravica, poklici koji su vezani za ispijanje pića (vina) što je bilo iznimno popularno u rimskom društvu. Na istočnoj obali Jadrana zabilježene



Slika 1. „Catalogo Cotti“, talijanska knjiga inventara, detalj lijeve stranice s tri upisana predmeta s istom godinom i lokalitetom pronalaska, Nona 1895.

Figure 1. “Catalogo Cotti”, Italian inventory book, left page with three entries with the same year and site of find, detail, Nona 1895

foto / photo: I. Čondić



Slika 1a. „Catalogo Cotti“, talijanska knjiga inventara, detalj desne stranice s tri upisana predmeta s istom godinom i lokalitetom pronalaska, Nona 1895.

Figure 1a. “Catalogo Cotti”, Italian inventory book, right page with three entries with the same year and site of find, detail, Nona 1895

foto / photo: I. Čondić

THE ARCHAEOLOGICAL CONTEXT OF THE FIND

The ceramic amphora inscribed with the words *Felix Arba* was a subject of many scientific papers.¹ Kept in the depot of Archaeological Museum Zadar, it is a part of the Museum's old holdings.² The details of the discovery are not known, but the research of the old inventory books yielded some interesting

1 Vidi M. Suić 1981, 249; B. Nedved 1990, 7; Z. Brusić 1999, 31; A. Konestra 2020, 43–68.

2 Stari fundus čine predmeti arheološke i povijesne građe do 1944. godine.

3 *Catalogo Cotti*, muzejski katalog keramike nastao za vrijeme talijanske uprave u Zadru.

4 Novi inventarni brojevi su A17577, A32354 i A10654.

5 Zahvaljujem kolegici, višoj kustosici Timki Alihodžić na nesebično ustupljenim podatcima.

6 Ukrasna bi dekoracija time imala sekundarnu funkciju, takvi su ukrasi najčešće jednostavnog geometrijskog oblika, o čemu ovdje svakako nije riječ.

7 R. Zlatunić 2005, 85–86.

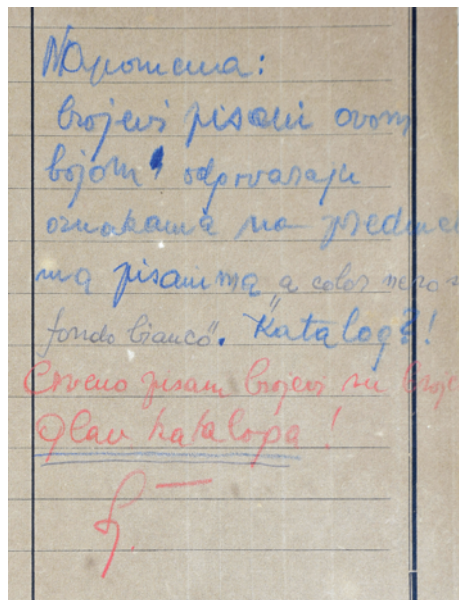
1 See M. Suić, 1981, 249; B. Nedved 1990, 7; Z. Brusić 1999, 31; A. Konestra 2020, 43–68.

2 The old holdings consist of the archaeological and historical objects found until 1944.



Slika 2. „Catalogo Cotti“, talijanska knjiga inventara, naslovna stranica
Figure 2. “Catalogo Cotti”, Italian inventory book, title page

foto / photo: I. Čondić



Slika 2a. „Catalogo Cotti“, talijanska knjiga inventara, detalj prve stranice s napomenom

Figure 2a. “Catalogo Cotti”, Italian inventory book, first page with remark, detail

foto / photo: I. Čondić

information. The pottery catalogue (*Catalogo Cotti*)³ contains three objects found at the same site and in the same year, Nona, 1895 (Figs. 1–1a). These objects were stored together in Closet XI of the Museum’s former display in St Donatus’ Church. These include an amphora No. 73 with an illegible inscription (with the blue number 3834 added subsequently), an amphora No. 74 with an inscription *Felix Arba* (with the blue number 3693 and the red number 4349 added subsequently) and a skyphos No. 75 (with the blue number 3879 and the red number 4358 added subsequently).⁴ The first page of *Catalogo Cotti* contains the following note: The numbers written in blue color correspond to the designations on the objects and the numbers written in red color correspond to the numbers in the main catalogue (Figs. 2–2a). The subject of this paper is the conservation-restoration treatment of the vessel No. 74 (new number A32354), but this single context of the find should be taken into consideration in some future papers.⁵

su dvije cjelovite posude s natpisima koji se odnose na toponime: jedna je *Felix Arba*, a druga vrč iz Pakoštana (lokalitet Janice) s natpisom *Salona*.⁸ Toj grupi predmeta svakako možemo priključiti i treću posudu s ninske nekropole⁹ iako je interpretacija njezina natpisa upitna (Sl. 4), zatim nekoliko ulomaka iz Zatona i Zadra s parcijalno sačuvanim mogućim natpisima,¹⁰ što svjedoči o domaćoj proizvodnji, ali i mogućnosti da je većina priobalnih i otočnih gradova imala svoje „suvrenire“ izrađene upravo na taj način, čemu u prilog ide činjenica da su te posude bile lagane i lako prenosive, namijenjene tržištu malih razmjera te da su svakako s eventualnim sadržajem mogle tvoriti memento putovanja.¹¹

Glina je vrlo rano u razvoju ljudi postala jedna od najvažnijih sirovina. Koristila se za izradu opeke, keramike, a kasnije i drugih keramičkih materijala. Nastala je kao mineraloški sediment, raspadanjem različitih magmatskih i silikatnih stijena pod djelovanjem atmosferilija i drugih utjecaja. Sastoji se od mineraloških čestica aluminijevih silikata, kao što su npr. kaolinit, montmoriloniti, iliti, haloziti, nontroniti, alofani, i raznih drugih primjesa: kremena,

THE DESCRIPTION AND CONDITION OF THE AMPHORA

This ceramic amphora can be classified as an amphorette because of its smaller size: it is only 15.9 cm high and its largest width does not exceed 9.9 centimeters. It is almost completely preserved – only the rim and most of one handle are missing. The inscription in capital letters, divided in two segments (*FELIX / ARBA*) stretches across the whole diameter of the amphora’s shoulder. The inscription was made using the barbotine appliqué technique, thus achieving the plastic appearance of the surface. The technique was often used to ensure a firm grip of a vessel.⁶ The letters ARBA F are rendered with dots orderly patterned on semi-hard clay; before firing, semi-liquid clay would also be applied by means of a cone-shaped applicator. As for the letters ELIX and the wavy decoration below them, they were made by applying clay-paste bands (Fig. 3).⁷ Inscriptions are rather common on Roman tableware; these are mostly names of manufacturers or potters, but there are

3 *Catalogo Cotti*, the Museum’s pottery catalogue composed during Italian administration of Zadar.

4 The new inventory numbers are A17577, A32354 and A10654.

5 I am indebted to my colleague Senior Curator Timka Alihodžić for providing me selflessly the information required.

6 The decorative function was of secondary importance in such cases. These decorations usually consist of plain geometric patterns, which is certainly not the case here.

7 R. Zlatunić 2005, 85–86.

8 M. Parica 2018, 220.

9 Keramička posuda s nejasnim natpisom A17577 zatečena je u iznimno lošem stanju. Prilikom prijašnje restauracije s naslagom je uništen i površinski originalni sloj, a trenutno je u procesu zaštite.

10 Z. Brusić 1999, 31.

11 A. Konestra 2020, 43–68.



Slika 3. Keramička amfora s natpisom *Felix Arba*, čuva se u Arheološkom muzeju Zadar, pod inventarnim brojem A32354
 Figure 3. Ceramic amphora inscribed with *Felix Arba*,
 Archaeological Museum Zadar, inv. no. A32354

foto / photo: I. Čondić

oksida,¹² kalcijeva karbonata,¹³ glinenaca (ortoklasa) te organskih ostataka (humusa i ugljenih materija).¹⁴ Važno i jedinstveno svojstvo gline jest da lako upija i gubi vodu. Kada se natopi određenom količinom vode, postaje plastična, tj. pogodna za manipulaciju, pritiskom dobiva tro-dimenzionalni željeni oblik koji se nakon pritiskanja zadržava, dok se prilikom sušenja ili pečenja stvrdnjava, o čemu ovisi sama čvrstoća i poroznost keramike.¹⁵ Glinu kao materijal odlikuje visoka vatrostalnost i izdržljivost na visokim temperaturama.¹⁶

Estetska vrijednost i kvaliteta postižu se izborom glinene mase (za oblikovanje), obradom površine keramičkog

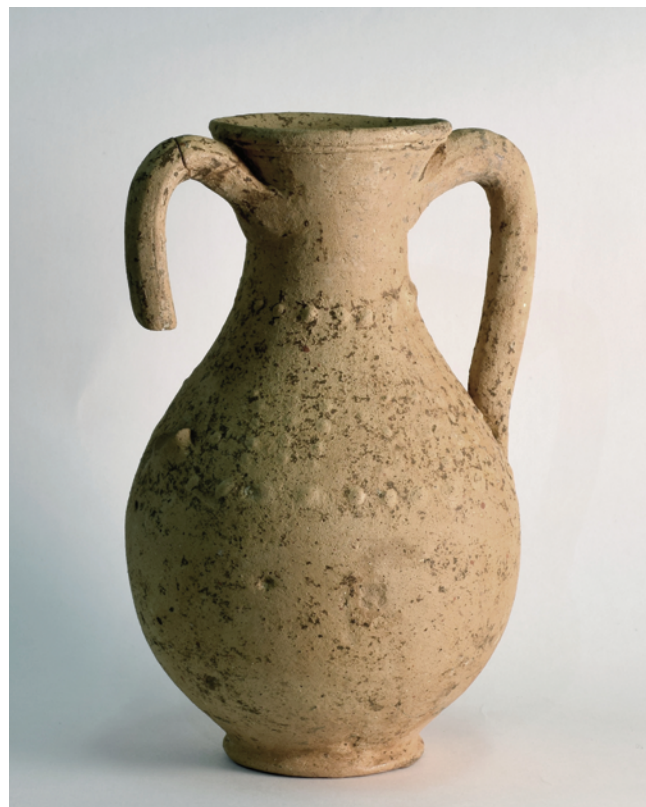
12 Željezovi oksidi (talitelji) djeluju na boju predmeta. Nakon pečenja boja keramičkog predmeta ovisi o vrsti minerala željezovih oksida i o tipu atmosfere (oksidacijska ili redukcijska), vidi R. Zlatunić 2005, 67; S. Buys, V. Oakley 2007, 20.

13 O raspoređenosti sitnih zrnaca kalcijeva karbonata ovisi kvaliteta gline, vidi R. Zlatunić 2005, 70.

14 R. Zlatunić 2005, 63.

15 Tijekom sušenja na zraku glina gubi veće količine vode, dok se kod pečenja gubi sva voda, vidi J. M. Cronyn 1990, 141.

16 Visoko vatrostalne gline označavaju se Sergerovim konusom (26 SK), omekšavaju se i otapaju na 1580 °C. U te gline spadaju: kaolini, škriljevci i gline bogate ugljikom, feldspati ili glinenci, neki oksidi metala i kalcijeva karbonata. Kaolinit se npr. tali tek na 1750 °C, vidi R. Zlatunić 2005, 68.



Slika 4. Keramička amfora s nejasnim natpisom, čuva se u Arheološkom muzeju Zadar, pod inventarnim brojem A17577
 Figure 4. Ceramic amphora with illegible inscription,
 Archaeological Museum Zadar, inv. no. A17577

foto / photo: I. Čondić

also cult-related messages and various toasts and exclamations used when drinking wine (very popular in Roman society). In Eastern Adriatic, two complete vessels with inscribed place-names have been recorded: one is the *Felix Arba* amphora and the other is a jug from Pakoštane (Janice site) with the inscription *Salona*.⁸ The following objects can also be included in this group: the third vessel from the Nin necropolis⁹ (despite the questionable interpretation of its inscription – Fig. 4) and a few fragments from Zaton and Zadar with partially preserved possible inscriptions.¹⁰ This can be seen as evidence of local production but it also suggests that most of the coastal and island cities had their own “souvenirs” of this type. Intended for small-scale markets, these vessels were light and easily portable and thus made good souvenirs, together with their possible contents.¹¹

8 M. Parica 2018, 220.

9 A ceramic vessel inv. no. A17577, with an unclear inscription, found in a very poor shape. The original surface layer was destroyed when the deposit was being removed during an earlier restoration. At the moment, it is undergoing a process of conservation.

10 Z. Brusić 1999, 31.

11 A. Konestra 2020, 43–68.

predmeta te njezinim oblikom. Obrada površine keramičke ovisi o tri faktora: obradi još nepečene površine glinene mase, nanošenju dodatnog nanosa na površinu gline (zaštitna ili ukrasna funkcija) i ukrašavanju površine predmeta. Obradena i poluosušena glinena površina jednako mjereno se izgladi i ispolira tako da se eliminiraju preostale manje površinske nepravilnosti. Nakon toga nanosi se dodatni sloj gline na površinski dio keramike, nanos se stavlja na glinu prije pečenja kao glineni premaz ili engoba,¹⁷ a na pečenu površinu predmeta kao glazura.¹⁸ Budući da je površina pečene keramike uglavnom porozna i lako upija vlagu, mnogi se predmeti premazuju tankim slojem glazure, čime se poboljšava kvaliteta, vitalnost i otpornost keramičkih posuda, ali i njihova estetska vrijednost. Glazure su tanke staklaste presvlake kojima postizemo da keramičke površine postaju glatke, tvrde, manje porozne na tekućine, plinove i masti, otpornije na atmosferilije i djelovanje različitih kiselina.¹⁹ Pečenje se odvija u oksidacijskoj atmosferi, dok boja ovisi o vrsti oksida, sastavu i granulaciji glazure, temperaturi pečenja i atmosferi u peći.

Keramička posuda s natpisom *Felix Arba* izrađena je od žučkaste pročišćene gline na lončarskom kolu oksidacijskim načinom pečenja, dok su ručke izrađene ručno i polukružnog su presjeka. Zatečena je u lošem stanju, a debeli sloj anorganske naslage prekriva gotovo cijelu površinu posude (Sl. 5). Ispod je vidljiv tanki sloj crvenkastog premaza, radi se o glinenom premazu nanesenom prije samog pečenja posude. Premaz je jako osjetljiv, veći dio nestao je moguće još prilikom upotrebe s obzirom na to da su izlizani dijelovi vidljivi na mjestima gdje se posudu hvatalo rukom, ali uništio ga je i debeli sloj naslage (Sl. 6).

Naslage često prekrivaju značajne ukrase i detalje, čime se ugrožavaju povijesne, društvene i umjetničke vrijednosti samog predmeta, no njihovo nestručno uklanjanje može štetiti predmetu, što se kod posude *Felix Arba* može primijetiti na prijelazu iz ramena u vrat gdje je



Slika 5. Zatečeno stanje keramičke amfore prekrivene debelim slojem anorganske naslage

Figure 5. Ceramic amphora covered with thick layer of inorganic deposit

foto / photo: I. Čondić

Very early in the history of mankind, clay became one of the most important raw materials. It was used for making bricks, ceramics and, later on, other ceramic materials. Clay is a deposit of the minerals formed by disintegration of various igneous and silicate rocks caused by weathering and other factors. It contains various aluminum silicates such as kaolinite, montmorillonites, illites, halosites, nontronites, alophanes and other admixtures such as quartz, oxides,¹² calcium carbonate,¹³ feldspars (orthoclase) and organic detritus (humus and coal substances).¹⁴ Clay has an important and unique feature – it both soaks up and loses water easily. When soaked with a certain quantity of water, it becomes plastic – in other words, suitable for handling: if pressed, it acquires the desired three-dimensional form that remains after pressing; if dried or fired, it solidifies, of which the very

17 Glineni premaz (engoba) tanki je sloj na keramici koji prekriva boju posude. To je glinasta smjesa s dodatcima željezovih oksida ili bez njih. Vidi R. Zlatunić 2005, 77.

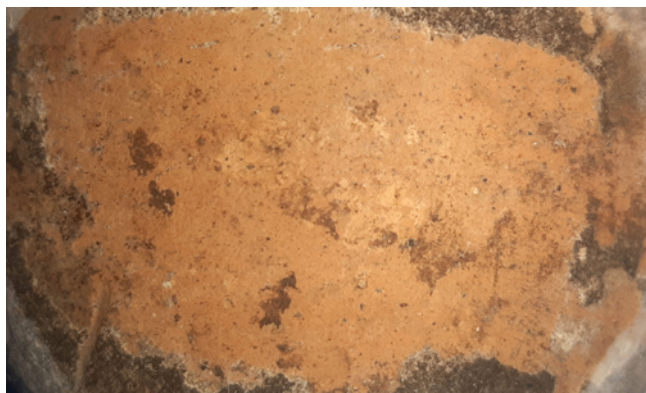
18 Glazura i caklina su oblici stakla (kad se mješavina silikatnog pijeska i sode zagrijava na relativno visokoj temperaturi, smjesa se stapa i stvara staklo) koji se koriste za premazivanje drugih materijala. Glazure se uglavnom koriste za oblaganje keramike, emajla, za presvlačenje metala i legura s tankim, zaštitnim i ukrasnim premazima. Objje su tekućine savitljive kad su vruće, a kad se ohlade, stvrdnu se u amorfne, krute i nepropusne čvrste tvari. Razlike među staklom, glazurom i caklinom nisu u njihovom sastavu, već uglavnom u načinu na koji se koriste: staklo se obično oblikuje u samostojeće predmete, dok se glazura i caklina nanose kao premazi na površinu artefakata izrađenih od drugih materijala. Sastoji se od tri komponente: vatrostalni elementi (kremen, glinenac), aluminijev oksid (koji sprječava iskliznuće tekućeg stakla s površine keramike) i talitelj (njegovim se djelovanjem svi sastojci stvrdnjavaju u glazuru), vidi R. Zlatunić 2005, 77–78; Z. Goffer 2007, 112.

19 Bojene glazure predstavljaju jednostavno i jeftino ukrasno sredstvo za keramiku, koje dijelimo u tri skupine: prozirne (mogu biti transparentne i bojene glazure – sadrže okside boja), neprozirne bijele glazure i neprozirne bojene glazure (sadrže okside boja). Bojenom glazurom ukrašava se cijela površina keramičkog predmeta, a nanosimo ju na već jedanput pečenu neglaziranu površinu. Postoji više načina nanošenja glazura: prelijevanjem (brzo i ravnomjerno prelije se cijela površina, uz istovremeno okretanje predmeta), uranjanjem, kistom i prskanjem, vidi R. Zlatunić 2005, 77–78.

12 Iron oxides (fluxes) have effect on an object's color. After firing, the color of a ceramic object depends on the type of iron oxides and atmosphere (oxidizing or reducing atmosphere), see R. Zlatunić 2005, 67; S. Buys, V. Oakley 2007, 20.

13 The quality of clay depends on the distribution of tiny calcium carbonate grains, see R. Zlatunić 2005, 70.

14 R. Zlatunić 2005, 63.



Slika 6. Detalj sačuvanog glinenog premaza ispod debelog sloja naslage

Figure 6. Clay slip under thick layer of deposit, detail

foto / photo: M. Rajzl

prilikom prijašnjeg pokušaja uklanjanja naslage uništen i površinski sloj keramike (Sl. 7). Stoga je za konzervatore-restauratore bitno određivanje kemijskih i strukturnih karakteristika anorganskih naslaga taloženih na arheološkoj keramici tijekom dugotrajnog ukopavanja u tlu.²⁰

Površinske nečistoće i naslage, osim što predmet čine estetski manje ugodnim, uzrokuju fizičko propadanje keramičkih predmeta s obzirom na to da se u njima i ispod njih talože i akumuliraju štetne topive soli koje ubrzavaju proces propadanja materijala. Anorganske naslage nastaju godinama, izmjenom vlažnih i sušnih razdoblja. Po svom sastavu sadrže netopive ili manje topive soli: kalcijev karbonat i kalcijev sulfat, ali mogu sadržavati i amorfni silicijev dioksid (zasićen topivim solima klorida, fosfata, nitrata) ili primjese željeza, bakra i mangana.²¹ Rezultati kemijske analize velikog broja keramičkih ulomaka poteklih s arheoloških istraživanja različitih talijanskih nalazišta pokazuju da se guste anorganske nakupine uglavnom sastoje od kalcijeva karbonata, a vrlo rijetko sadrže i kalcijev sulfat ili željezne i manganove okside.²²

Kalcit, oblik kalcijeva karbonata, najčešće se kristalizira na površini u obliku nakupina bijele i sive boje.²³ Po svemu sudeći, može se pretpostaviti da je *Felix Arba*, keramička posuda porozne strukture, smještena u grob u funkciji funeralnog predmeta, bila izložena ili podzemnoj vodi koja

hardness and porosity of ceramics depends.¹⁵ As a material, clay is distinguished by high fire resistance and resistance to high temperatures.¹⁶

The esthetical value and quality of a ceramic object depend on the choice of clay mass (for modelling) and the object's surface work and form. The surface work on a ceramic object depends on three factors: processing of the still unfired surface of clay mass, applying an additional coating onto the surface (protective or decorative function) and decorating the surface. The processed and semi-dried clay surface should be evenly smoothed and polished in such way that the remaining minor surface imperfections are eliminated. After that, an additional clay coating is applied on the surface; the coating is applied on clay before firing as a clay coating (engobe)¹⁷ and on the fired surface of the object as a glaze.¹⁸ As the surface of fired ceramics is usually porous and absorbs humidity with ease, ceramic vessels are often coated with a thin layer of glaze in order to improve their quality, longevity and endurance, as well as their esthetical value. Glaze is a thin, glassy coating that makes ceramic surfaces smooth, harder, more resistant to liquids, gases, grease, various acids and weathering.¹⁹ Firing takes place in an oxidizing atmosphere. The color depends on the type of oxide, composition and granulation of the glaze, firing temperature and kiln atmosphere.

The ceramic vessel inscribed with *Felix Arba* was made of yellowish purified clay on a potter's wheel, using oxidizing firing, while the semicircular-section handles were made manually. The vessel is in poor condition, with a thick inorganic deposit covering the almost entire surface (Fig. 5). A thin layer of a reddish coating can be seen underneath; it is a clay coating applied before firing. The coating

20 Arheološki predmeti od pečene gline izloženi su brojnim procesima, mehanizmima i uzrocima propadanja, neki su usko povezani sa suštinskim svojstvima i prirodom materijala, kao što su mineralogija i tekstura (pore i pukotine), dok su drugi inducirani izvana agensima poput mikroklima, zagađenja okoliša i utjecaja kemijskih čimbenika same okoline u kojoj su predmeti pohranjeni (poput sastava atmosfere i tla, vlažnosti, pH-vrijednosti, temperature, Sunčeve svjetlosti).

21 O topivim i netopivim solima vidi S. Buys, V. Oakley 2007, 32; Z. Goffer 2007, 416; M. P. Casaletto *et al.* 2008, 35–36.

22 M. P. Casaletto *et al.* 2008, 37.

23 U literaturi se spominje pod imenom inkrustacija, *white crust* ili kalcitne kruste, tip naslage na keramici, čvrste bjelkasto-sive nakupine koje se vrlo teško i sporo otapaju u vodi, vidi K. Hraste, Zagreb 2015, 214.

15 When air dried, clay loses plenty of water; when fired, it loses all water, see J. M. Cronyn 1990, 141.

16 The highly fire-resistant clays are classified using Seger cone (26 SK); they soften and liquefy at 1580 °C. These clays include: kaolins, shales and carbon-rich clays, feldspars, some metal oxides and some calcium carbonate oxides. For example, kaolinite melts only at 1750 °C, see R. Zlatunić 2005, 68.

17 Clay coating (engobe) is a thin layer on a ceramic vessel that covers the vessel's color. It is a clayish mixture with or without iron oxides. See R. Zlatunić 2005, 77.

18 Glaze and enamel are variants of glass (when a mixture of silicate sand and soda are heated at a relatively temperature, it melts and turns into glass) used for coating of other materials. Glaze is usually used for coating ceramics, enamel, metals and alloys with thin protective and decorative layers. Both liquids are elastic when hot; when cooled down, they solidify and become hard, amorphous and impermeable. Glass, glaze and enamel differ from each other not by their composition, but by the way they are used: glass is usually shaped into freestanding objects, while glaze and enamel are applied as coatings on the surface of the artefacts made of other materials. The glaze consists of three components: fireproof elements (quartz, feldspar), aluminum oxide (which prevents liquid glass from slipping off the ceramic surface) and flux (required for solidifying all components into a glaze. See R. Zlatunić 2005, 77–78; Z. Goffer 2007, 112.

19 Colored glaze is a simple and cheap decoration for ceramic objects. There are three types of it: transparent glaze (it can be transparent and colored – containing color oxides), nontransparent white glaze, and nontransparent colored glaze (containing color oxides). Colored glaze is used for decorating the entire surface of a ceramic object. It is applied on the non-glazed, once fired surface. There are several ways to apply glazes: pouring (the glaze is swiftly and evenly poured over the entire surface, while spinning the object at the same time), dipping, brushing and spraying, see R. Zlatunić 2005, 77–78.



Slika 7. Oštećenje površinskog sloja, nastalo prilikom prijašnjeg pokušaja uklanjanja debele anorganske naslage

Figure 7. Damage on surface layer, inflicted during earlier attempt to remove thick inorganic deposit

foto / photo: M. Rajzl

se ulijevala u groblje ili velikoj vlazi, što je uvjetovalo stvaranje tako debele naslage. Prije samog čišćenja, da bi se utvrdio sastav naslage, kirurškim nožićem uzet je uzorak te je postavljen na stakleni tanjur. Pomoću kapaljke na uzorak je dodana kap dušične kiseline te je praćeno njegovo pjenjenje. Pjenjenje je bilo jako, što znači da naslaga najvećim dijelom sadrži kalcijev karbonat, stoga ćemo ju u daljnjem tekstu navoditi pod pojmom *kalcifikacija*.²⁴

POSTUPAK ČIŠĆENJA I KONSOLIDACIJA

Za daljnji rad presudan je izbor postupka čišćenja s obzirom na to da je proces ireverzibilan i može izazvati nepovratnu štetu. Uobičajeno usvojena procedura uglavnom se temelji na mehaničkom čišćenju koje se mora provesti vrlo nježno i pažljivo, izbjegavajući eventualna oštećenja površine, što može dovesti do gubitka materijala, ali i informacija. Budući da je debeli sloj kalcifikacije na mjestima bio izuzetno tvrd, prije samog mehaničkog čišćenja bilo je nužno naslagu kemijski omekšati. Rađene su male probne sonde 4 × 4 cm, a prilikom njihove izrade korištena su razna kemijska sredstva, ostavljena na djelovanje u različitim vremenskim intervalima, kao npr. alkohol,²⁵ C2000,²⁶

is very delicate; most of it probably disappeared when the vessel was still in use, because it is particularly worn-out on the places where the vessel was held. The thick deposit also contributed to its worn-out condition (Fig. 6).

Deposits often cover significant decorations and details of an object, thus affecting its historical, social and artistic values. Their unskilled removal can damage the object: in the case of the *Felix Arba* vessel, an earlier attempt to remove the deposit resulted in destroying the surface ceramic layer on the transition from the shoulder to the neck (Fig. 7). This is why it is important for conservators-restorers to determine the chemical and structural characteristics of the inorganic deposits created on archaeological pottery while buried underground over an extended period of time.²⁰

Besides affecting a ceramic object's esthetic value, the surface dirt and deposits cause its physical degradation because the damaging soluble salts that catalyze the process of degradation accumulate in them and underneath them. Inorganic deposits accumulate over years as a result of alternating wet and dry periods. They contain insoluble or less soluble salts such as calcium carbonate and calcium sulfate, but they can also contain the amorphous silica (saturated with soluble chloride, phosphate and nitrate salts) or admixtures of iron, copper and manganese.²¹ A chemical analysis of numerous pottery fragments from various Italian archaeological sites showed that dense inorganic accumulations mostly consisted of calcium carbonate and very rarely contained calcium sulfate or iron and manganese oxides.²²

Calcite – a calcium carbonate – usually crystallizes on the surface as a white and gray accumulation.²³ The porous ceramic vessel inscribed with *Felix Arba* and placed in a grave as a funerary object was probably exposed either to the underground water that had penetrated the cemetery or to very high humidity. This is why the accumulated deposit is so thick. Before the cleaning, a sample of the deposit was taken with a scalpel and placed on a glass plate in order to establish the deposit's composition. One drop of nitric acid from a burette made the sample froth. Frothing was intensive, which meant that the deposit mostly consisted of calcium carbonate; this is why we will refer to it as *calcification* in the rest of this text.²⁴

24 Ako pjenjenje nije jako, moguće je da su prisutni sulfati, a to se može potvrditi dodavanjem dviju kapi barijeva klorida što bi trebalo rezultirati pojavom bijelog taloga, vidi S. Buys, V. Oakley 2007, 90.

25 Korišten je etilni alkohol, 96 % denaturirani.

26 Contrad 2000 vodena je emulzija anionskih i neionskih površinskih aktivnih sredstava, prikladna za uklanjanje ugljičnih i masnih tvari te proteinskih materijala s kamenih i keramičkih predmeta, <https://www.ctseurope.com/en/scheda-prodotto.php?id=2655> (pristupljeno 2. veljače 2021.).

20 Archaeological objects made of fired clay are exposed to various processes, mechanisms and causes of degradation. Some are closely connected with the inherent features and the nature of the material, such as mineral composition and texture (pores and cracks), while the others occur as the result of the interaction with such external agents as microclimate, environmental pollution and environmental chemical factors (atmosphere and soil composition, humidity, pH, temperature, sunlight).

21 For soluble and insoluble salts, see S. Buys, V. Oakley 2007, 32; Z. Goffer 2007, 416; M. P. Casaletto *et al.* 2008, 35–36.

22 M. P. Casaletto *et al.* 2008, 37.

23 The terms used for it in literature are incrustation, white crust and calcite crusts. It is a hard, whitish-gray deposit that accumulates on pottery. It dissolves in water very slowly and with difficulty. See K. Hraste 2015, 214.

24 If frothing is not intensive, it is possible that the deposit contains sulfates. This is easily verified if a white sediment occurs when two drops of barium chloride are added. See S. Buys, V. Oakley 2007, 90.



Slika 8. Probne sonde 2, 3 i 4

Figure 8. Test Trenches 2, 3 and 4

foto / photo: M. Rajzl



Slika 9. Probna sonda 5

Figure 9. Test Trench 5

foto / photo: M. Rajzl

EDTA,²⁷ New Des 50.²⁸ Korištena su kao otopina koja se u postotcima dodavala gelovima i papirnoj pulpi (Sl. 8–10). Rezultati proba prikazani su u Tab. 1.

Tijekom provedenih proba čišćenja utvrđeno je da je 1-postotna otopina New Des 50 najadekvatnije sredstvo za omekšavanje tvrdokorne naslage. Čišćenje je vršeno u segmentima, a prvo bi se na manji dio površine stavio oblog celulozne pulpe tretirane s 1-postotnom otopinom New

CLEANING AND CONSOLIDATION

Further steps depend on the choice of cleaning procedure because the process is irreversible and the damage could be irreparable. A procedure based on mechanical cleaning is used in most cases. It must be carried out very softly and carefully in order to avoid damaging of the surface and thus losing both the material and the information. As the thick layer of calcification was very hard in places, it had to be softened chemically before mechanical cleaning. Small test holes (4×4 cm) were made in it, using various chemical agents that were left to react over various intervals, such as alcohol,²⁵ C2000,²⁶ EDTA,²⁷ New

27 EDTA – dinatrijeva sol, dihidrat etilendiamintetraoctene kiseline, poznata još pod imenom kompleksal III. Otopina je blago kiselkasta, treba se koristiti pažljivo s obzirom na to da može potaknuti slabljenje mehaničkih svojstava keramike jer također otapa kalcijev karbonat iz samog sastava gline, stoga je nakon korištenja predmet potrebno temeljito isprati; <http://kemika.hr/dokumenti/242.pdf> (pristupljeno 19. ožujka 2021.).

28 S obzirom na to da je naslaga na nekim mjestima bila tvrde vapnenačke strukture, izgledom slična naslagama koje nastaju na kamenu, inače dobro uklonjive tretiranjem s amonijevim bikarbonatom, odlučeno je da će se probati s blažim sredstvom na bazi amonijevih soli, jer je ovdje ipak riječ o keramici. Korištena je otopina New Des 50 u demineraliziranoj vodi. New Des 50 komercijalni je naziv proizvoda vodene otopine (50 %) didecildimetilamonijeva klorida (DDAC), na bazi kvartnih amonijevih soli, koji na tržište stavlja C.T.S. s.r.l. Koristi se s ostalim reagensima za pripremu obloga za čišćenje koji se nanose na kamene i keramičke materijale. Najpoznatiji oblog za kemijsko čišćenje unutar kojeg New Des 50 potvrđuje svoju učinkovitost jest AB 57 (formulacija I.C.R. – Rim) <https://www.ctseurope.com/en/scheda-prodotto.php?id=471> (pristupljeno 3. veljače 2021.).

25 96 % denatured ethanol was used.

26 Contrad 2000 is a water emulsion of anionic and non-ion surfactants, suitable for removing carbon and grease substances and protein materials from stone and ceramic objects, <https://www.ctseurope.com/en/scheda-prodotto.php?id=2655> (accessed 2 February 2021).

27 EDTA – disodium salt, dehydrate of ethylenediaminetetraacetic acid, known also as Complexal III. The solution is lightly sour and should be used with care because it can affect the mechanical features of the ceramics (it also dissolves the calcium carbonate in clay, which is why the ceramic object must be rinsed thoroughly after use); <http://kemika.hr/dokumenti/242.pdf> (accessed 19 March 2021).



Slika 10. Probna sonda 7

Figure 10. Test Trench 7

foto / photo: M. Rajzl

Desa 50 u demineraliziranoj vodi. Nakon 45 minuta djelovanja oblog se skidao, a mjesto tretiranja temeljito ispiralo vodom radi postizanja pH-ravnoteže. Kako bi se pojačalo svojstvo apsorpcije štetnih tvari i uklonili mogući zaostatci kemijskih sredstava iz otopina, keramička je posuda svaki dan nakon radova tretirana oblogom od celulozne pulpe, demineralizirane vode i mineralne gline atapulгите (Sl. 11),²⁹ što se pokazalo odličnom kombinacijom jer se nakon toga naslaga odvajala u vidu ljuskica, bez oštećenja originalne površine i glinenog crvenkastog premaza.

Čišćenje je izvedeno mehanički, strpljivo i precizno, kirurškim nožićem s nastavkom najmanje profilacije (T. 1: 1–6).³⁰ Po sredini posude nalazio se stari inventarni broj, napisan na debelom sloju naslage (T. 1: 7). U dogovoru s kustosicom, nakon temeljite dokumentacije, provedeno je njegovo uklanjanje. Posuda je temeljito isprana demineraliziranom vodom

29 Mineralne gline imaju svojstva adsorpcije (vezanja na površinu) i svojstva apsorpcije (upijanja) tvari, stoga ih je dobro koristiti u kombinaciji s papirnom pulpom koja, kad se osuši, na sebe veže štetne tvari. Oblog se ostavljao da djeluje preko noći i sljedeći se dan uklanjao.

30 Na dva-tri mjesta proces se ponavljao u nekoliko navrata, dok kalcifikacija nije uklonjena do kraja.



Slika 11. Oblog od celulozne pulpe, demineralizirane vode i atapulгите

Figure 11. Poultice of cellulose pulp, demineralized water and atapulгите

foto / photo: M. Rajzl

Des 50.²⁸ They were used as a solution added in various percentages to gels and paper pulp (Figs. 8–10). The test results are shown in Tab. 1.

Test cleanings showed that the 1 % solution of New Des 50 was the most adequate agent for softening the hardened deposits. The cleaning was carried out in segments. First, a cellulose-pulp poultice treated with a demineralized 1% aqueous solution of New Des 50 would be placed on a small part of the surface. After 45 minutes the poultice would be removed and the treated spot would be thoroughly rinsed with water so as to achieve pH balance. In order to increase

28 As the deposit had a hard limestone structure in places, visually resembling the deposits found on rocks and usually easily removable when treated with ammonium bicarbonate, it was decided that a milder, ammonium-salt-based agent would be applied as more appropriate for ceramics. New Des 50 demineralized aqueous solution was used. New Des 50 is the commercial name for the product of a 50 % aqueous solution of didecyldimethylammonium chloride (DDAC). Based on quaternary ammonium salts, it is sold by C.T.S. s.r.l. Together with other reactants, it is used for preparing the cleaning poultices which are to be applied to stone and ceramic objects. The best known chemical cleaning poultice inside which New Des 50 is efficiently used is AB 57 poultice (formulation by the I.C.R. – Rome) <https://www.ctseurope.com/en/scheda-prodotto.php?id=471> (accessed 3 February 2021).

i stavljena na sušenje. S obzirom na to da se radi o keramici osjetljive strukture, konsolidacija je provedena u dva navrata. Prvo je korišten konsolidant Estel 1100³¹ na bazi etil-silikata i polisiloksana za učvršćivanje glinene strukture, a zatim 2-postotna otopina Paraloid B72³² u acetonu za površinsku zaštitu.

ZAKLJUČAK

Keramička posuda *Felix Arba* već dugi niz godina u arheološkoj struci pobuđuje zanimanje. O njoj i njezinoj svrsi postoje mnoge teorije i polemike, no tek je 126 godina nakon pronalaska prvi put podvrgnuta cjelovitom procesu zaštite. Prije obrade je pomoću kemijskih analiza određena metoda rada i izbor restauratorskog materijala, a temeljita dokumentacija vođena je prije, tijekom i po završetku radova. Čišćenje debele kalcificirane naslage izvođeno je kemijski i mehanički po manjim segmentima, dok je konsolidacija provedena u dva navrata.

Konzervatorsko-restauratorskim radovima posudi je vraćena njezina estetska vrijednost, pa napokon u svom punom sjaju može biti na raspolaganju budućim interpretacijama (T. 2: 4).

the absorption of harmful substances and remove any remaining chemical agents from the solutions, a poultice of cellulose pulp, demineralized water and attapulgitite (a mineral clay) was applied to the ceramic vessel on a daily basis (Fig. 11).²⁹ This turned out to be an excellent combination because it made it possible to remove the deposit by coming off in scales, without any damage to the original surface and reddish clay coating.

Mechanical cleaning was carried out patiently and very accurately, using a scalpel with a minimum-section attachment (Pl. 1: 1–6).³⁰ The earlier inventory number was written in the central portion of the vessel, on a thick deposit (Pl. 1: 7). In agreement with the curator, it was properly documented and removed. The vessel was thoroughly rinsed with demineralized water and then dried. Because of the delicate structure of the ceramic vessel, the consolidation was carried out two times – first with the ethyl-silicate and polysiloxane-based Estel 1100 consolidant³¹ for solidifying the clay structure and then with a 2 % acetone solution Paraloid B72³² for surface protection.

CONCLUSION

The ceramic vessel inscribed with *Felix Arba* has been attracting interest of archaeologists for years. Its purpose has been a subject of numerous theories and polemics, but this is the first time in 126 years after it was found that it has undergone a complete conservation process. Prior to the treatment, the method of work and restoration material were selected on the basis of chemical analyses. Detailed evidence was kept before, during and after the treatment. The chemical and mechanical cleaning of the thick calcified deposit was carried out by smaller segments, while the consolidation was performed two times.

As the conservation and restoration treatment restored the vessel's esthetical value and its full splendor, it is now available for any future interpretations (Pl. 2: 4).

31 Gotovo sredstvo za učvršćivanje na bazi etil-silikata i polisiloksana u otopini White Spirit D40. Estel 1100 posebno je prikladan za konsolidaciju silikatnih kamenih materijala, opeke i žbuke <https://www.ctseurope.com/en/scheda-prodotto.php?id=223> (pristupljeno 12. veljače 2021.).

32 Paraloid B-72 akrilna je smola na bazi etil-metakrilatnog kopolimera, topiva u acetonu, etanolu, toluolu i ksilenu. Dosta se koristi u restauraciji za zaštitu drvenih, kamenih, mramornih i metalnih umjetničkih djela.

29 Mineral clays are both adsorbents (capable of adhesion of substances to a surface) and absorbents (capable of soaking substances in), which is why they are particularly useful when combined with paper pulp which, when dried, binds harmful substances. The poultice would be left overnight to take effect and removed the next day.

30 On two or three spots, the process had to be repeated several times before the calcification was completely removed.

31 A ready-to-use consolidant based on ethyl silicate and polysiloxanes in a White Spirit D40 solution. Estel 1100 is particularly suitable for consolidation of silicate stone materials, bricks and plaster <https://www.ctseurope.com/en/scheda-prodotto.php?id=223> (accessed 12 February 2021).

32 Paraloid B-72 is an acrylic resin based on ethyl-methacrylate copolymer. It is soluble in acetone, ethanol, toluene and xylene. It is used for the restoration of wooden, stone, marble and metal works of art.

Probna sonda / Test hole	Postotak / Percentage	Otopina / Solution	Vrsta obloga / Type of poultice	Vrijeme tretiranja / Duration of treatment	Rezultat / Result
Sonda 1 / Hole 1	50/50	demineralizirana voda + 96% alkohol / demineralized water + 96% alcohol	celulozna pulpa / cellulose pulp	30 min	Proba nije dala do kraja zadovoljavajući rezultat, omekšao je samo površinski sloj naslage. <i>The test was not fully satisfactory; only the surface layer of the deposit became soft.</i>
Sonda 2 / Hole 2	5 %	C 2000	celulozna pulpa / cellulose pulp	30 min	Rezultat nije zadovoljio, naslaga je ostala tvrdokorna. <i>The result was not satisfactory; the deposit remained hardened.</i>
Sonda 3 / Hole 3	1%	EDTA	celulozna pulpa / cellulose pulp	15 min	Naslaga je lagano omekšala. <i>The deposit softened a bit.</i>
Sonda 4 / Hole 4	2,5 %	Asepsol	celulozna pulpa + atalpigita / cellulose pulp + attapulgite	18 h	Oblog se ostavio preko noći kako bi imao što veći efekt, Asepsol je otopio naslage prljavštine i zemlje. <i>The poultice was left overnight in order to increase its effect. Asepsol dissolved the deposits of dirt and earth.</i>
Sonda 5 / Hole 5	1%	EDTA	karbosilmetil celuloza / CarboSil methylcellulose	30 min	Naslaga je omekšala površinski. <i>The deposit softened on the surface.</i>
Sonda 6 / Hole 6	1%	New Des 50	celulozna pulpa / cellulose pulp	15 min	Vidljivo je potpuno omekšavanje mekših dijelova naslage, dok se na tvrdim dijelovima produžilo vrijeme tretiranja. <i>Full softening of the softer parts of the deposit is visible. The duration of the treatment was extended on the harder parts of the deposit.</i>
Sonda 7 / Hole 7	1%	New des 50	celulozna pulpa / cellulose pulp	45 min	Nakon probi, na dio posude koji je tretiran, stavio se oblog od gline, demineralizirane vode i celulozne pulpe. Sutra dan na djelu sonde 7, naslaga je potpuno popustila te se pomoću kirurškog nožića skidala u ljuskicama. <i>After the testing, a poultice of clay, demineralized water and cellulose pulp was wrapped around the treated part of the vessel. The next day, the deposit on part of Hole 7 fully fell apart and started coming off in scales with the hel of a scalpel.</i>

Tablica 1. Rezultati probnih sondi

Table 1. Test trench results



Tabla 1. 1.–6. Mehaničko čišćenje po segmentima pomoću kirurškog nožića s nastavkom najmanje profilacije, 7. Stari inventarni broj, odgovara broju u „Catalogo Cotti“, upisanim plavom bojom
 Plate 1. 1.–6. Mechanical cleaning by segments; scalpel with a minimum-section attachment, 7. Old inventory number, corresponding blue-ink entry number in “Catalogo Cotti”

foto / photo: M. Rajzl



1



2



3



4

285

Tabla 2. 1. Stanje keramičke amfore nakon provedenih konzervatorsko-restauratorskih radova, pogled na stranu s natpisom *Felix*, 2. Stanje keramičke amfore nakon provedenih konzervatorsko-restauratorskih radova, pogled na ručku kojoj nedostaje dio, 3. Stanje keramičke amfore nakon provedenih konzervatorsko-restauratorskih radova, pogled na stranu s natpisom *Arba*, 4. Stanje keramičke amfore nakon provedenih konzervatorsko-restauratorskih radova, dio posude sa sačuvanim crvenkastim premazom

Plate 2. 1. Ceramic amphora after conservation and restoration work, view of side inscribed with *Felix*, 2. Ceramic amphora after conservation and restoration work, view of handle with missing part, 3. Ceramic amphora after conservation and restoration work, view of side inscribed with *Arba*, 4. Ceramic amphora after conservation and restoration work, part with preserved reddish coating

foto / photo: I. Čondić

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