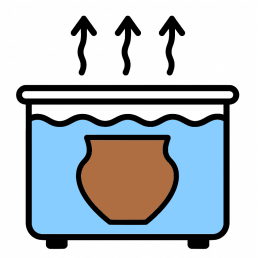
Nov 21, 2025

Ultrasound-Assisted Cleaning of Archaeological Pottery



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Cèlia Rodríguez-Pérez[1], Vanessa Forte[2]

[1]Autonomous University of Barcelona; [2]Sapienza Università di Roma

Cèlia Rodríguez-Pérez
Autonomous University of Barcelona

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We use this protocol and it's working

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Disclaimer

This protocol is intended for research purposes and should be applied only to well-preserved ceramic fragments. The use of ultrasonic cleaning may cause damage to fragile or underfired materials. Users are responsible for evaluating the suitability of this method for their specific samples and context.

Abstract

This protocol describes a method for cleaning archaeological pottery fragments using ultrasonic technology, with the primary objective of enabling the observation and analysis of use-wear and/or technological traces. Unlike aesthetic cleaning, this procedure focuses on the selective removal of surface deposits that hinder macroscopic and microscopic examination, while minimizing physical and chemical alterations of the ceramic surface.

Ultrasonic cleaning uses high-frequency sound waves to generate cavitation in a liquid medium, effectively dislodging dirt and encrustations. The advantages of this method include deep cleaning and a reduction in the destruction of use-wear caused by manual cleaning. However, it also presents significant risks: the energy generated can damage fragile ceramics, erase subtle use-wear traces, and cause surface abrasion, especially in porous or underfired pieces.

To mitigate these risks, the protocol recommends short exposure cycles, careful selection of fragments, and thorough microscopic and macroscopic photographic documentation before and after cleaning using a digital camera and either a digital or stereoscopic microscope. This procedure is particularly suitable for well-preserved fragments with non-consolidated surface deposits. Ultimately, the protocol aims to balance cleaning efficiency and conservation principles, preserving essential archaeological information for functional analysis.

Image Attribution

All images are original and produced by the author.

Guidelines

Ultrasonic technology uses high-frequency sound waves to generate a process known as cavitation. The formation and collapse of microscopic bubbles that produce shock waves and dislodge dirt. This can be a highly effective technique, but also potentially destructive, and should be used with caution when applied to archaeological heritage.
Always perform a test on a non-diagnostic fragment before applying the treatment to the entire archaeological collection.

Materials

Equipment
Digital camera
Photographic scale
Digital or stereoscopic microscope (recommended magnification range: 50× to 100×)
Ultrasonic cleaning tank
Syringe
Glass container
Stirring rod
Lab coat

Consumables
Paper towel

Reagents
Distilled water, preferably of low conductivity (0.1 µS/cm)
Non-ionic detergent with neutral pH (DERQUIM LM 02 without phosphates)

Safety warnings

- **Never use this method on cracked, friable, or underfired fragments.** The energy generated by the ultrasonic waves can lead to the complete disintegration of fragile pieces.
- **This process may erase or alter the most subtle use-wear**. Ultrasonic energy can be very powerful. Cavitation can produce temperatures of thousands of degrees at the microscopic level, potentially causing surface abrasion. Begin with very short exposure times and increase them gradually if necessary.
- **Record all the information about the piece and the process it undergoes.** Some public administrations require detailed reports on restoration, conservation, and analysis procedures for archaeological heritage. This is also important because ultrasonic cleaning can remove the information present in the inventory codes marked on the piece.

Neutral soap (Liquid DERQUIM LM 02 without phosphates)
Danger
Hazard Statements:
- H315: Causes skin irritation.
- H318: Causes serious eye damage.

Precautionary Measures:
- P264: Wash thoroughly after handling.
- P280: Wear protective gloves, protective clothing, eye protection, and face protection.
- P302+P352: If on skin: Wash with plenty of water.
- P305+P351+P338: If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do. Continue rinsing.
- P310: Immediately call a poison center or doctor.
- P362+P364: Take off contaminated clothing and wash before reuse.
- P332+P313: If skin irritation occurs: Get medical advice/attention.

Hazard Pictogram: !GHS05: Corrosive *(Corrosive – indicates serious eye damage and skin irritation)*

Ethics statement

All interventions are carried out in accordance with conservation ethics and heritage protection standards.

Before start

Any cleaning method is an irreversible process that can alter the surface of the object and lead to the loss of valuable information. Cleaning may destroy microscopic evidence such as organic residues, proteins, ancient DNA, etc. The goal is not aesthetic cleaning, but the selective removal of surface deposits that hinder analysis, while minimizing damage to the original surface.

This method has proven to be much more respectful of archaeological materials, especially ceramics, and is recommended for large volumes of pottery to reduce working time and lower costs (Colonna-Preti, 2017; Gheorghe, 2008; Iglesias Campos, 2015; Spier, 1961).

Phase 1: Preliminary Analysis and Documentation of Ceramic Fragments

1 **Record the general information** of the sherd (archaeological site, archaeological unit, and inventory number), as ultrasonic cleaning may erase the labeled codes on the ceramic piece.

2 **Record the technological features** of the ceramic piece (part of the vessel, manufacturing traces, surface treatments, decorations, temper type and size, firing...). These features may impact the performance of ultrasonic cleaning (Iglesias Campos, 2015).

3 **Previous photographic documentation**: Take detailed photographs of the initial condition of the whole fragment. As ultrasonic cleaning is irreversible, it is important to document the original state of the artefact before undergoing this procedure.

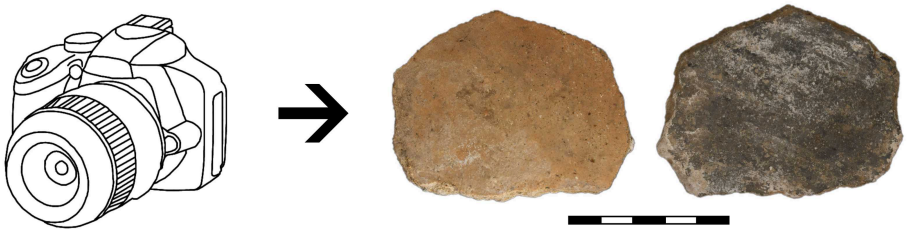

Fig.1 *Photographs of the front and back of the ceramic fragment before the cleaning, taken with a digital camera.*

4 **Previous microscopic documentation**: Use a digital or stereoscopic microscope (recommended magnification range: 50× to 100×) to preliminarily identify surface deposits (e.g., sediments, calcareous concretions, biological colonization) and assess existing surface damage. Take pictures to evaluate the effectiveness of the procedure once it's done.

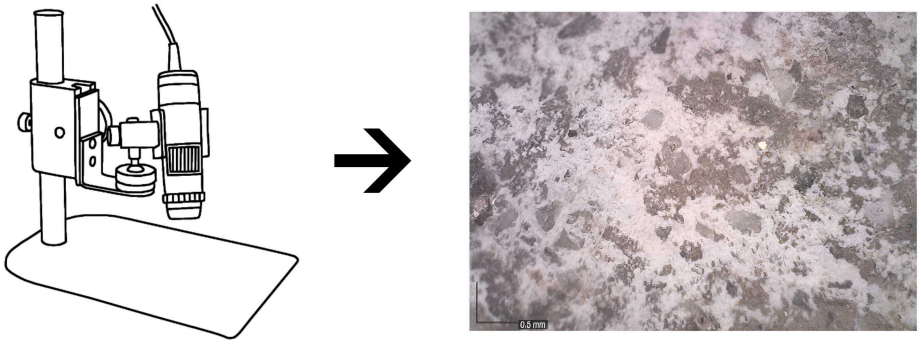

Fig.2 *Photographic documentation with a digital microscope of the calcareous concretions on the surface of the ceramic fragment (magnification: 71.8x).*

Phase 2: Cleaning by ultrasonic bath

1d 1h 16m

5 Prepare a cleaning solution with distilled water, preferably of low conductivity (0.1 µS/cm) and a neutral, non-ionic detergent (Liquid DERQUIM LM 02 without phosphates) (pH 7) at [M] 5 % (v/v) concentration inside the ultrasonic cleaning tank.

15m

Fig.3 *40 mL of a non-ionic detergent (Liquid DERQUIM LM 02 without phosphates) with a neutral pH* was *introduced into the ultrasonic bath, containing 750 mL of distilled water, using a syringe.*

6 Heat the solution to 40 °C

40m

7 Fully submerge the ceramic fragments in the ultrasonic tank using a glass container to prevent direct contact with the bottom surface, thereby minimizing the risk of impact-related damage or marking. For highly fragile ceramics, place the fragments inside a zip-lock bag filled with the water and soap solution to provide additional cushioning and protection during the cleaning process. Ensure that no air remains inside the zip-lock bag after it has been submerged in the tank. 1m

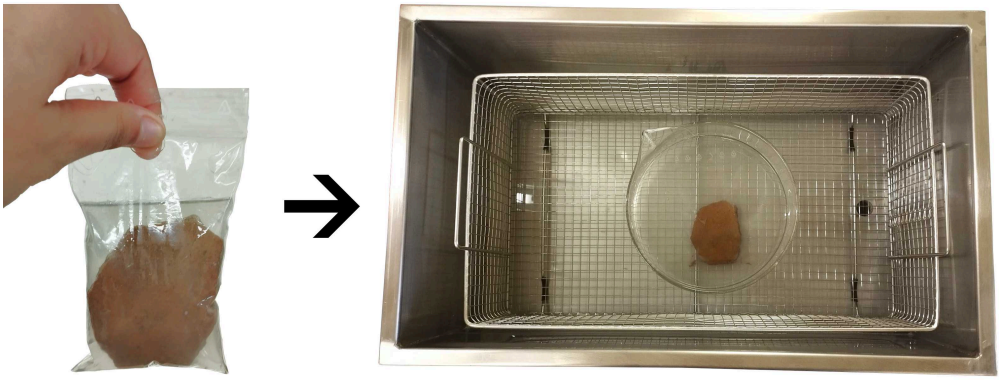

Fig.4 *Ceramic fragment placed inside a zip-lock bag filled with the solution of distilled water and neutral soap. The bag is left open, and no air has been trapped inside to ensure the ultrasound can operate without interference.*

8 Activate the equipment for a cycle of 00:05:00 to 00:15:00 minutes at 40 kHz frequency. It is recommended to start with a 5-minute cycle to assess how the pottery reacts to the treatment. The cycle can be repeated if necessary. 15m

Parameter	Recommended Value
Duration	5–15 minutes
Temperature	40 °C
Ultrasound frequency	40 kHz
Solution	Distilled water with 5% neutral soap concentration

Fig.5 *Parameters and recommended values for the ultrasound tank configuration.*

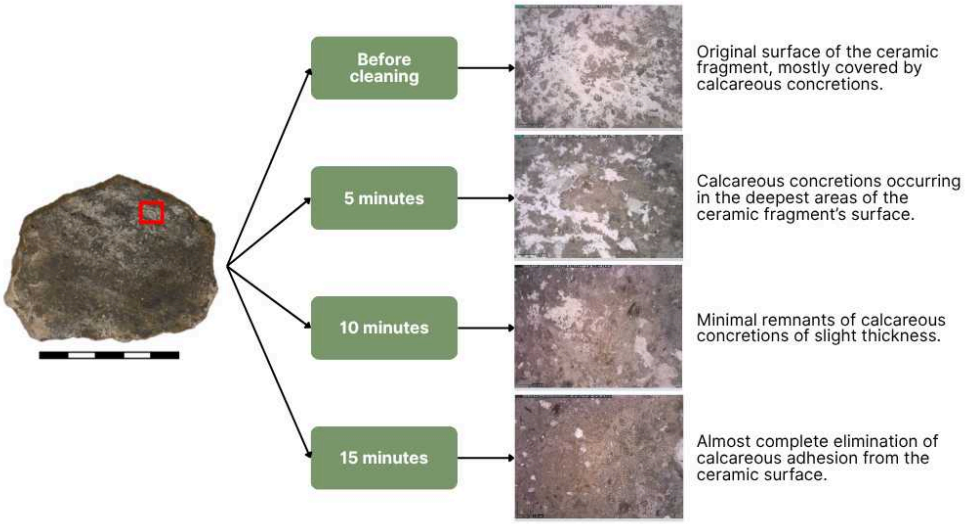

Fig.6 *Results of testing the procedure in 5-minute ultrasound cycles on a fragment with severe calcareous concretions on its surface (magnification 71.8x).*

9 Carefully remove the fragments from the tank. Avoid using tweezers or metal tools to prevent creating scratches or marks on the fragments.

5m

10 Rinse the fragments with clean distilled water, preferably of low conductivity (0.1 µS/cm).

Fig.7 *Ceramic sherd being rinsed with clean distilled water.*

11 Dry the ceramic fragments at Room temperature on an absorbent paper in a ventilated area Overnight

1d

Fig.8 *Drying of ceramic fragments on absorbent towel paper.*

Phase 3: Post-Cleaning Assessment

12 **Posterior photographic documentation**: Take detailed photographs of the final condition of the whole fragment.

Fig.9 *Photographs of the front and back of the ceramic fragment after the cleaning taken with a digital camera.*

13 **Posterior microscopic documentation**: Use a digital or stereoscopic microscope (recommended magnification range: 50× to 100×) to verify the degree of cleaning and inspect for any damage (e.g., material loss, color changes, new cracks) by comparing the images with those taken before cleaning.

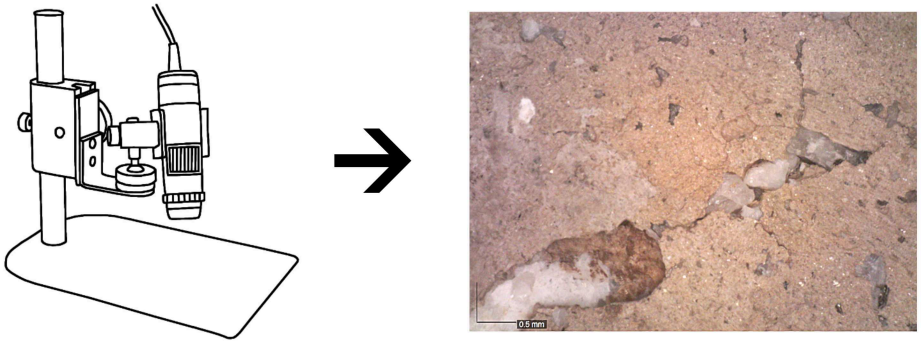

Fig.10 *Photographic documentation with a digital microscope of the cleaned surface of the ceramic fragment. A new crack has appeared where the temper is very superficial after 15 minutes of ultrasound cleaning (magnification* 69.5x*).*

14 **Cross-check documentation**: Record the cleaning method used, including all relevant parameters (products, concentrations, duration, temperature, etc.), as well as the results obtained. Some administrations require detailed reports documenting the restoration or cleaning processes applied to archaeological heritage.

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Exemple Form.pdf 853.1KB

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Acknowledgements

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