Washing and Cleaning of Ancient Coins, an Alternative Method Using Ultrasound and Chemometry

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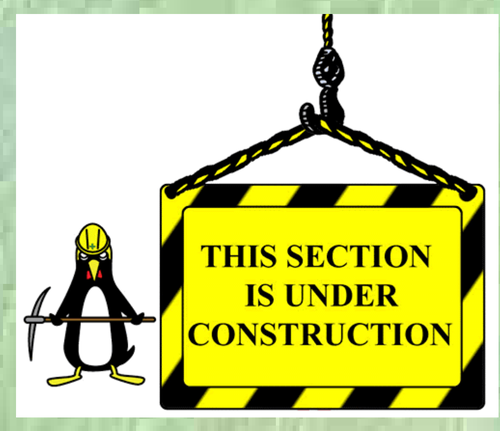
Alert!! Don't look for chemometry =>



Introduction

The removal of concretions and incrustations from the surface of metallic findings is one of the most critical procedure for restorers. Really soil particles and/or deposits of biological origin must be removed as well as any not cohesive corrosion layers originated by the oxidation process of the alloy. Contrarily the patina constituted by insoluble corrosion products should not be removed, or only slightly, because protective.

Depending also on the conservator's school and philosophical approach, lot of "receipts" are available for coins cleaning but, unfortunately, most of them base more on empirical concepts than on careful chemical-physical analyses and intend to satisfy primarily aesthetic criteria than conservation ones (...because in any case a protective layer will be applied...).

Here we present a preliminary study aiming to propose a scientifically based methodological approach that could ensure a better conservation of bronze small objects such as coins.

Experimental

5 ancient bronze coins, recently excavated, were chosen among a total population of 153 coins, all of the Roman Empire age, by simple random sampling without replacement and used without any preliminary treatment excluding a soft brushing (**Fig. 1**). Even if the heating function was excluded, the final temperature of the bath reached 30-35 °C.

The procedure was repeated for at least seven times. The labelled tubes containing the washing solutions were closed hermetically and stored at 4°C for the successive analyses. Conductivity (Λ), redox potential (ORP), pH and anions (by Ionic Chromatography) were measured

Drying
60 °C; 30 mins
recirculating air
↓
Cooling
30 mins
in a desiccator
↓
Ultrasonic bath
20 mins; 45 mL
deionised water
sweep function
↓
Weighting and
OM observation

Fig.1- Cleaning procedure

Aim

We look for the simplest index, coming from simple but reliable measures, that can be used by restorers to stop a cleaning procedure at "the right moment".

To attain the aim, a simple but rigorously scientific procedure must be proposed that couples the cleaning and the analytical methods

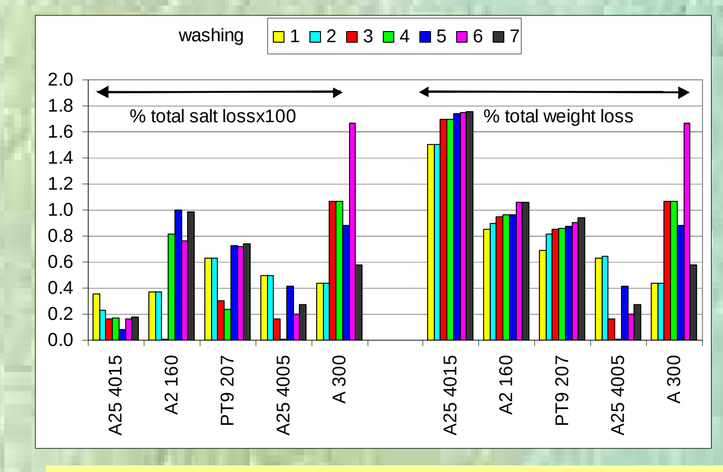


Fig. 2 - Trend of TL and TLS during the cleaning procedure

Results

As expected, data treatment resulted very complex and, at this preliminary stage, few information can be kept as no multivariata nor chemometric treatment was done uptoday.

Anyway it is evident (**fig. 2**) that the trends of the percentage total weight loss (TL) and of the total salts loss (TSL), as a function of the washing cycles, significatively differ. Really for all the coins the removal of incrustations resulted always increasing and reach more than 98% just after the first washing; on the contrary, the salts extraction trends are no regular and in most of the cases we have an inversion of the initial expected decreasing trend.

This is particularly warrying if we consider that the chloride content, i.e. the most dangerous anion for bronze, in some case is higher at the end of our last washing than after the first one (**fig. 3**) and is the most abundant salt found on the considered coins (**fig. 4**)

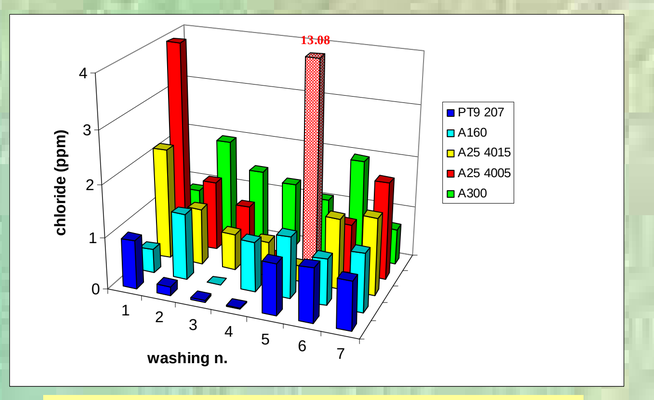


Fig. 3 - Content of chloride found in the solutions coming from the washing procedure

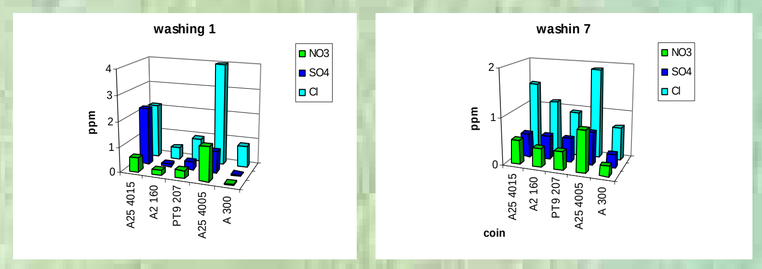


Fig. 4 - Content of salts found in the solutions coming from the washing procedure

Conclusions

Lot of work is needed to complete this study!!!

As above said simple measurements must be proposed as restorers will done them; so one or more robust and stable instruments have to be preferred (balance, pHmeter, conductivimeter, ORP electrode, optic microscope).
The next step of the present research will be surely the correct data treatment of the already enough huge dataset that we obtained.
Other measurements, at least cations analyses and X-ray diffraction could be performed, at level research, just to control at the best the procedure and many other coins must be considered in order to ensure that no damage will occur.

Fig. 6 - Coin PT9 207

At this stage we can assert that salts are yet present on the coin after 7 cleaning cycles and this is serious as they will remain under the protective layer, generally stratified on coin as final step of the restoration procedure. In **fig. 6** an example of the look change of one of the treated coin is shown.

Conductivity, pH and ORP measurements that in our opinion are the most suitable for our aim surely need a multivariate or chemometric treatment; just as an example in fig. 4

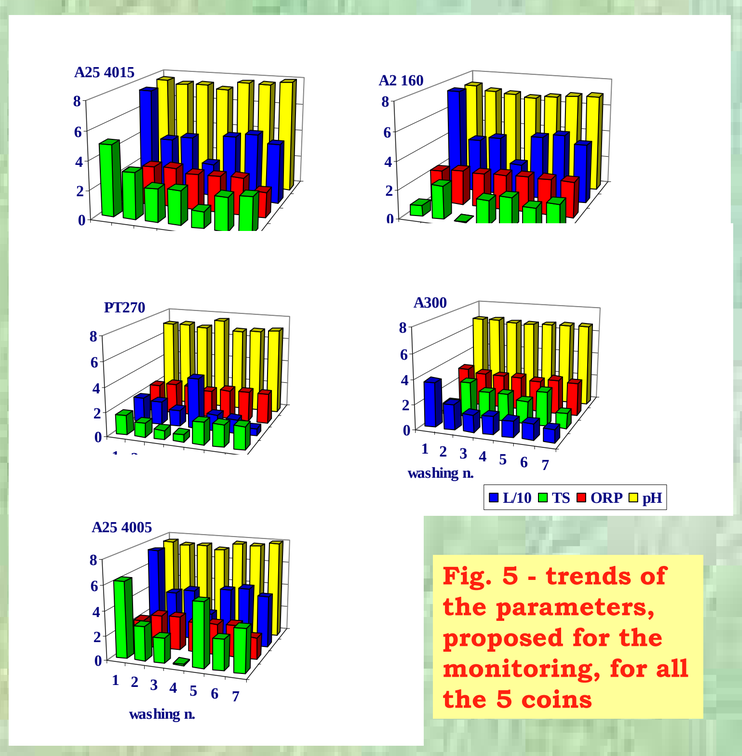


Fig. 5 - trends of the parameters, proposed for the monitoring, for all the 5 coins