POLITECNICO DI TORINO
SECOND SCHOOL OF ARCHITECTURE
Master of Science in Architecture (Rehabilitation and Revaluation)
Honors theses

Safeguard and Valorisation of underwater archaeological sites - *Innovative methods for the in situ preservation of artifacts and the protected environment*
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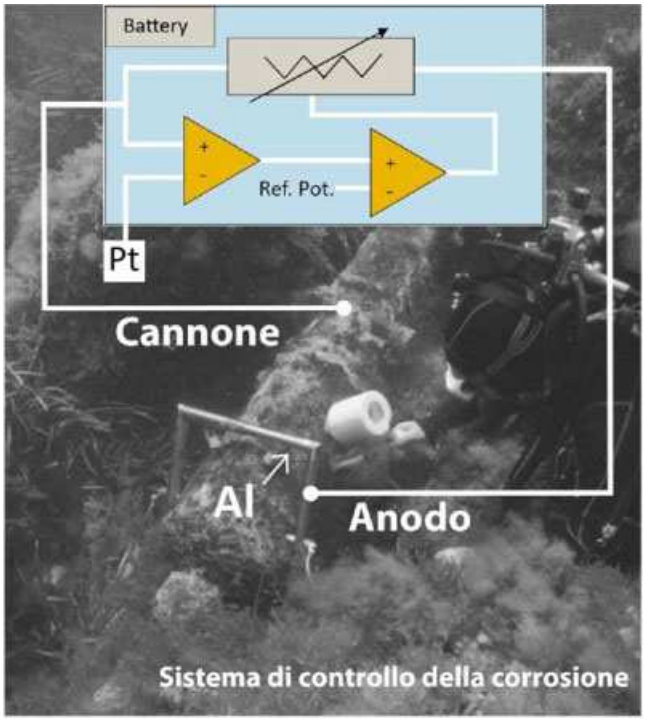
The thesis is the continuation of a work started with the opportunity given by the Alta Scuola Politecnica, through the project "TETI: *Integrated Technologies for the Sustainable Management of Underwater Cultural Heritage*". The project aimed to develop innovative technological systems for the sustainable management of the underwater archaeological site of Capo Graziano, in Filicudi (Sicily). The research has been improved with particular interest, thanks also to the personal passion for the underwater environment and the scuba diving.
The thesis has been characterized by an experimental part, regarding the development of techniques for the conservation of metal artifacts in aquatic environments. However, it was necessary to describe and analyze the archaeological conservation state of the art, focusing in particular on the protection through juridical instruments and on the need of science improvements for the development of more efficient techniques of intervention. The analysis involved the object scale, the site one and the landscape, too.

Amphorae situated in the archaeological site of Capo Graziano (courtesy of Soprintendenza del Mare per la Regione Sicilia)

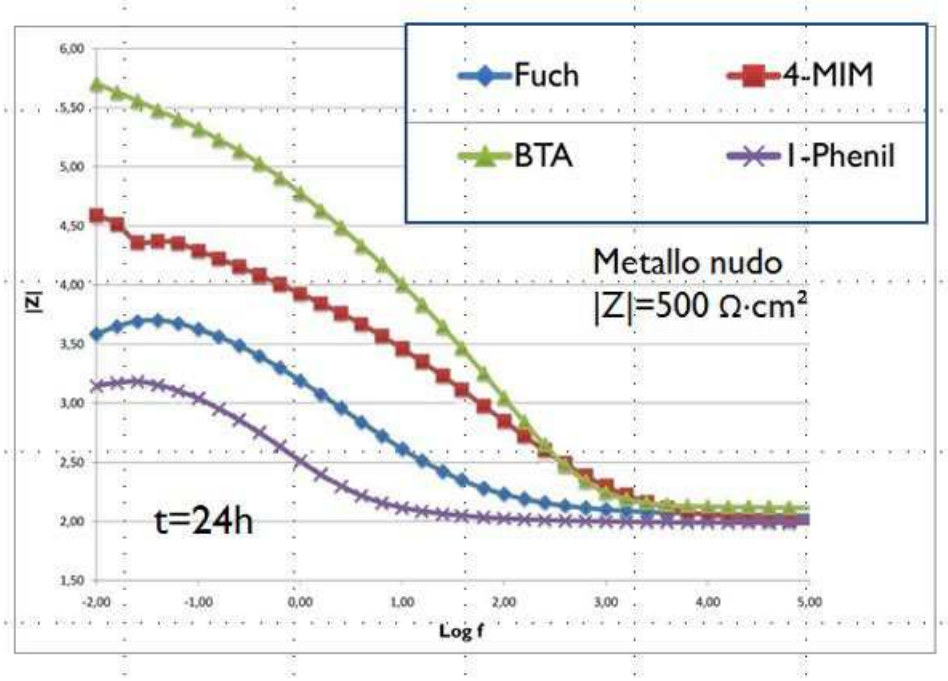
The research has emphasized the connections and the similarities between the protection of the underwater archaeology and the terrestrial one, and also the peculiarities that make the submerged artifacts' conservation an innovative and contemporary topic.
Some of the most important issues identified in the thesis are: the need of making adequate laws to safeguard the heritage and to professionally train some people, in a way to let them act for the conservation and the maintenance of such heritage.
Another important point developed in the thesis is the choice between the recovery offshore of the artifacts and the possibility of conserving them in their own environment; this second proposal is the best one at the moment, even if it implicates more difficulties in the interventions.
The modern methods for the underwater archaeological search, excavation, documentation and survey have been analyzed. Suddenly, the typologies of finds and the specific kind of disease affecting different material, such as ceramics, stone, wood and metal, have been identified and studied. In addition, the most recent techniques of intervention for the *in situ* conservation of the submerged objects have been researched and reported.

As the metal is the material most affected by deterioration in seawater, the experimental part of the thesis has focused on the research and development of innovative, sustainable and non invasive conservation techniques.
For iron objects, *in situ* conservation solutions have been proposed as an alternative to the use of zinc anodes for the passive cathodic protection, as this metal is toxic. The corrosion trends of the iron coupled with sacrificial magnesium and aluminum anodes have been studied. In addition, it has been proposed an integrated system for the monitoring of the conservation rates and the protection of the artifacts, during the time. Positive results were obtained through electrochemical laboratory measurements, which showed the feasibility of the system proposed for the conservation and the control in the long term of the metallic finds in seawater.



In situ monitoring system: measurements of the electrochemical potential of the couple Fe/Al using a Pt reference

Bronze archaeological objects are more precious than iron ones. For this reason, the best solution for their conservation has to follow the steps of recovery, desalinization, treatment and conservation in a humidity-controlled environment, in a way to avoid the dangerous “bronze disease”. The most efficient treatment is the use of protective chemicals drop on the surface of the metal, called inhibitors, which are often toxic. Therefore, another improvement of the thesis has been the search and the test of alternative green inhibitors performances. The analysis were carried through electrochemical impedance measurements and with the use of electronic microscope, and they lead to positive results, interesting for further improvements.



Bode diagram showing the effectiveness of the green inhibitors' protection: the more the curve is high, more the protection is ensured

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