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Archaeometallurgical Study for a Set of Ancient Coins Excavated from Mediterranean Sea North of Egypt using Synchrotron Radiation Based XRD.

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Introduction

Archaeometallurgy is an important field of study which allows us to assess the preservation state and value of ancient metal artifacts and better understand the ancient cultures that made them. Metallic artifacts, bronze in particular have specific characteristics that differs them to the other classes of materials. Electrochemical transformations that occurs to them mainly cause a process called corrosion to takes place that starting at the surface of the object changing the metals in to oxides, sulphates, carbonates or other compounds that cause a detectable physical degradation characterized by the presence of corrosion pits and cracks and result in substantial modifications in their morphology or the total mineralization. Therefore, scientific investigation of such ancient metal artifacts is necessary. One important requirement of analytical techniques is that they be non-destructive methods, since many of these artifacts are unique and irreplaceable. Thus, synchrotron radiation (SR) techniques highly recommended for such studies in last two decades. Therefore, We could achieve valuable information only using Synchrotron Radiation which is mandatory and it would guarantee the signal to noise ratio and the lateral resolution needed for such studies.

Abstract

The major goal of our research project was to study a set of 8 ancient bronze coins that excavated from the Egyptian Mediterranean Sea, Eastern Port of Alexandria in particular and are dated back to the Ptolemaic era. The study served to evaluate their recent conservation states as well as the effects of marine environment on their degree of alteration and helped to set the suitable strategy to preserve those coins using synchrotron based X- ray diffraction and X- ray fluorescence techniques. The measurements were performed in order to study their present chemical structure, corrosion phases and their respective crystallinity and grain size, in both the bulk metal and the surface/corrosion layers.

In addition, the ancient manufacturing methods in mining revealed too by examining the depth profile of the corrosion products and the metallic bulk core using the diffraction patterns behavior from the outer corrosion layers to the bulk metal where in cooling rates the diffraction phases changed along various depths. The effect of marine environment on the deterioration aspects of the coins have been studied too. Due to the manufacturing of ancient metallic coins in a quite primitive manner; they are inhomogeneous on a micrometer scale, containing remains of imperfect smelting and inclusions. Therefore, studying their elemental compositions and ratios (trace and minor element presence) could be used as a specific fingerprint to know the sources of the ore materials which have been used in manufacturing coins and could provide important clues about the metal provenance, leading to conclusions regarding the commercial, cultural and religious exchanges between the old populations and their way of life. Synchrotron radiation based X- ray fluorescence measurements have been carried out in order to verify this objective.

These measurements have been carried out at Elettra Synchrotron under ICTP - Elettra User Program

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