MOSSBAUER STUDIES OF THE UMBRIA ARCHEOLOGICAL CLAYS+

I. ORTALLI and A. VERA
Physics and C.N.R., Medicine Faculty, University of Parma, Italy

A. ANTONINI and L. BONOMI PONZI
Department of Physics, University of Perugia, Sovraintendenza Antichità Umbria, Italy

We report an analysis of two different clays from the region of Umbria (Italy): 1. potteries found one inside and the other outside the town of Todi, dating from the end of the IV century B.C., 2. bond clays of Bagnara (Nocera Umbra) and Colfiorito (Foligno) dating V century B.C..

INTRODUCTION

In the past few years, the Mössbauer spectroscopy has been applied to the characterization of archaeological potsherds and has been found to be able to provide information on the provenance and manufacture of ancient pottery.

We report some salient aspect of our 57Fe Mössbauer studies of archaeological potteries which were discovered in the Umbria Region in Italy. These are of two different types: 1) Todi potteries, found in the "Grotta Bella" and in "Pozzo Valle" localities dating from the end of the IV century B.C. to the end of the I century B.C. and 2) bond clays of Colfiorito (Foligno-Perugia) dating from the end of VI century to the second half of V century B.C..

The aim of this work is to establish the firing technique, which also means the provenance of the Todi potteries, and to establish if a given sample of voting offering from a tomb of Bagnara is a bond clay or if it is a special Angelica clay.

TODI POTTERIES

Black painted ceramics were the most commonly diffused type of ceramics found in Italy from the end of the IV century B.C. up to the end of the I century B.C.. A large number of these potteries come from the Italian areas of Todi, Bettona, and Perugia /1/.

The problem which still remains is that of clarifying whether these findings were manufactured locally or if they were imported.

It is well known /2/ that the color and the shinyness of the paint is closely related to annealing. For example, annealing down with an insufficient amount of air for complete combustion reduces the oxide present in the ochre of the paint from ferric to ferrous.

The pottery samples analyzed came from two different areas: (1) the P.V. sample came from the "Pozzo Valle" locality inside the town of Todi and (2) the G.B. sample came from the "Grotta Bella" locality outside the town. The Mössbauer spectra of the samples at LNT are reported in Fig.1 and Fig.2. They have been analyzed by a least-square fit and Table I reports isomer shifts (I.S.), quadrupole splittings (Q.S.) and effective magnetic fields (Heff). All isomer shifts are referred to that of the natural α-iron at R.T..

+ Work supported by GNSM (C.N.R.) and CISM (M.P.I.)

© J.C. Baltzer A.G., Scientific Publishing Company
These results can be interpreted as the superimposition of two quadrupole doublets, due to \( \text{Fe}^{3+} \) and \( \text{Fe}^{2+} \) high spin ions, respectively, and the superimposition of two Zeeman sextets.

The broadening of the Mössbauer lines found at R.T. and the increase of the quadrupole splitting of the non magnetic component at L.N.T. indicate the presence of vacancies in the structure and a lattice distortion. The dependence of this distortion from the firing temperature was shown by JANOT /3/ and one can infer, from the Q.S. values, the temperature at which the pottery was fired.

Potteries fired in a reduced atmosphere contain a small, but definite, amount of \( \text{Fe}^{2+} \) that produces a quadrupole doublet. From the ratio of the intensities of the spectral components associated with \( \text{Fe}^{3+} \) and \( \text{Fe}^{2+} \) and from the values of Q.S. of \( \text{Fe}^{3+} \) doublets, information regarding the firing conditions and thus the manufacturing conditions can be deduced as reported by KOSTIKAS et al. /4/. We can deduce in accord with the data collected by EISSA et al. /5/ that

Table I

Mössbauer parameters at LNT. \( \text{Fe}^{2+}/\text{Fe}^{2+}+\text{Fe}^{3+} \)=ratio of the area of the \( \text{Fe}^{2+} \) subspectrum to the total spectrum. \( I_{M}/I_{TOT} \)=ratio of the area of the magnetic subspectrum to the total spectrum in %.

<table>
<thead>
<tr>
<th>Sample</th>
<th>G.B.</th>
<th>P.V.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NON MAGNETIC</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMPONENT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I.S.</td>
<td>0.32±0.01</td>
<td>1.26±0.03</td>
</tr>
<tr>
<td>Q.S.</td>
<td>0.98±0.1</td>
<td>2.47±0.02</td>
</tr>
<tr>
<td>I.S.</td>
<td>0.37±0.02</td>
<td>0.30±0.05</td>
</tr>
<tr>
<td>Q.S.</td>
<td>0.08±0.02</td>
<td>0.07±0.03</td>
</tr>
<tr>
<td><strong>MAGNETIC</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMPONENT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( H_{eff} )</td>
<td>528±1</td>
<td>502±2</td>
</tr>
</tbody>
</table>

\[
\frac{\text{Fe}^{2+}}{\text{Fe}^{2+}+\text{Fe}^{3+}} = 4.2 \\
I_{M}/I_{TOT} = 44.8
\]