



EDXRF study of Tupi-Guarani archaeological ceramics

C.R. Appoloni^{a,*}, F.R. Espinoza Quiñones^b, P.H.A. Aragão^a, A.O. dos Santos^a,
L.M. da Silva^a, P.F. Barbieri^a, V.F. do Nascimento Filho^c, M.M. Coimbra^a

^a *Physics Department, State University of Londrina (UE), Londrina, P.O. Box 6001, PR, CEP 86051-990, Brazil*

^b *Department of Chemical Engineer, State University of West Paraná, Av. da Faculdade 2550, CEP 85903-000, Toledo, PR, Brazil*

^c *Physics and Meteorology Department, ESALQ and Center of Nuclear Energy in the Agriculture (CENA), University of São Paulo, Piracicaba, SP, Brazil*

Abstract

A set of Indian Brazilian pottery fragments belonging to Tupi-Guarani tradition has been studied by EDXRF. The main objective was to characterize the ceramic paste, as well as the superficial layer of the ceramic fragments, in order to get qualitative information about the pigment composition of the plastic decoration. Energy Dispersive X-ray Fluorescence (EDXRF) methodology was employed to obtain the ceramic paste composition, as well as the superficial layer of the ceramic fragments. The experimental set-up consisted of ²³⁸Pu, ⁵⁵Fe and ¹⁰⁹Cd radioactive sources, a X-ray tube (at 15 kV, 40 mA, Mo target and Zr filter), a Si(Li) detector (30 mm², with a Be window) and a multichannel analyzer. X-ray spectra were analyzed using the AXIL program. A program based on the graphic polygonal representation method was developed and used to correlate the representative intensity data of each fragment. A low Ca content and a systematic presence of relatively high concentrations of Fe can characterize the ceramic pastes. Ti and Zr are also always present at high levels, and Ni, Cu and in some cases Zn at level of traces; Rb, Sr, Ba and Y are also present at low concentration. The black pigment in the pottery plastic decoration is due to the presence of Mn, the red pigment is due to the presence of Fe, while the white pigment is characterized by the presence of Ba. For the eleven fragments studied, the polygonal representation method points that the same materials were employed in the pottery production, and the pigments in the plastic decoration were obtained from different inorganic materials. © 2001 Elsevier Science Ltd. All rights reserved.

Keywords: EDXRF; Ceramic; Archaeological; Pigment

The investigated objects were eleven Indian Brazilian pottery fragments from the Santa Dalmacia farm archaeological site. Each one of these fragments came from a different ceramic object and all belong to the Tupi-Guarani tradition. The main objective of this work was to characterize the elemental composition of the plastic decoration and the ceramic.

Pigment which has survived buried in the ground characterizes the convex surface of each fragment and several different points were chosen. EDXRF spectra from several different surface areas of each pottery were obtained.

The EDXRF measurements of the pottery fragments were performed at the Radioisotopes Methodology Section, Center of Nuclear Energy in the Agriculture

of the São Paulo University, Piracicaba, SP, Brazil using a conventional XRF spectrometer.

The measurements were carried out using the following radioisotope sources: ²³⁸Pu, ⁵⁵Fe and ¹⁰⁹Cd and, in addition, a conventional spectroscopic the X-ray tube with molybdenum target and a zirconium filter, operating at an excitation energy of 15 kV and 40 mA. The X-rays were detected using a Si(Li) detector of 30 mm², with a Be window, and a multichannel analyzer. XRF spectra were stored on diskette and analyzed at the Physics Department, State University of Londrina, using a set of AXIL-QXAS programs by the International Atomic Energy Agency (Vienna).

For a given object, XRF spectra for each area showed the similarity in the main elements. Sixteen elements were identified by EDXRF within the measured fragments: Al, Si, K, Ca, Ti, Mn, Fe, Co, Ni, Cu, Zn, Ga,

*Corresponding author. Fax: + 55-43-371-4166.

E-mail address: appoloni@uel.br (C.R. Appoloni).

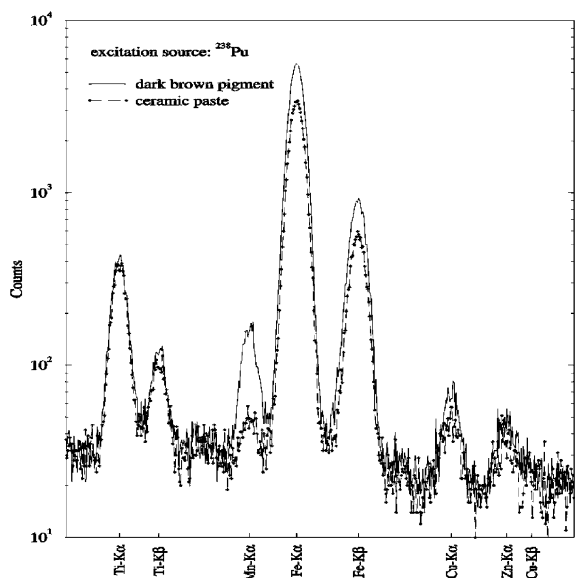


Fig. 1. EDXRF spectra for the dark brown pigment and the ceramic paste.

Rb, Sr, Y and Zr. For determination of the higher Z -elements, ^{109}Cd and ^{238}Pu sources were used. Using the ^{238}Pu source, the overlap of the X-ray lines of element such as Rb, Sr, Y and Zr and the elastic and inelastic scattering of Uranium L-X-rays was found to be unavoidable. However, using the ^{109}Cd source, compo-

sitional data were yielded for each part of a given fragment, showing high concentrations of Zr and Fe elements, but concentration of Ti an order of magnitude lower. In addition, trace amounts of Cu, Zn, Rb, Sr, and Y were detected in all the spectra. Results from use of the ^{238}Pu excitation source confirmed the presence of Fe at high concentration, being an order of magnitude larger than Ti, while relatively small amounts of K, Ca, Mn, Ni, Cu and Zn elements were also detected. The ^{55}Fe source was used for determination of low atomic number elements. With this low-energy excitation source, XRF intensities from elements such as Al, Si, K and Ca were enhanced. The presence of these elements was observed to be an order of magnitude weaker than that for Ti.

In the plastic decoration, dark coloration is used on the design motifs in the slip. The XRF spectrum for the dark coloration shows the level of manganese to be an order of magnitude greater than that of the paste. Dark brown pigment is also observed on other parts of the sample. Fig. 1 shows the spectra for the ceramic paste and the dark brown pigment. The ceramic paste and other pigments were shown to contain very low amounts of manganese, while white coloration in the pottery plastic decoration was associated with the presence of potassium.

For the eleven fragments, polygonal graphic representation has revealed a consistent picture of materials employed in the pottery production. In addition, the pigments in the plastic decoration were obtained from different inorganic materials.