SUMMARY AND CONCLUSION

Various spectroscopic techniques were applied on the archaeological samples collected from the recent excavations at Ariyalur, Kaniyampoondi, Melchittamur, Perur, Salamankuppam, Sankari Durg, Tandikkudi and Tittagudi to know the cultural sequence of a particular archaeological site.

The samples were collected on the site in participation with the technical know how of the excavations with the State Department of Archaeology, Chennai, Archaeological Survey of India (ASI), branch office, Salem and Chennai, Department of Ancient History and Archaeology, University of Madras, Chennai and Department of Epigraphy and Archaeology, Tamil University, Thanjavur, Tamilnadu. The samples were collected at 5 different depths.

First, using chemical analysis by Titration method, Quantitative analysis has been carried out on all the samples of interest to identify the clay composition in percentage experimentally and from that useful information about the nature of clay minerals, whether Calcareous or Non- calcareous and high or low refractory were identified and the method of firing (Oxidizing/Reducing) was predicted.

The FT-IR spectra were recorded in the mid infrared region. The different kinds of clay minerals (primary, secondary and accessory minerals) present in the pottery samples were identified by estimating the relative intensity and thereby from tentative vibrational assignments by referring the reported data available in the literature.
Using XRD method, Crystallographic phases of mineral compositions of the specimens were identified. The minerals were identified by search method on matching the observed peaks in the respective diffractogram with the recent JCPDS data file. The clay minerals identified from FT-IR spectra and XRD patterns played a vital role in estimating the firing temperature of potteries at the time of manufacture.

And also, the samples were refired to temperature upto 850°C in steps of 100°C starting from 550°C. At each and every temperature the infrared spectra were recorded including the samples at their received state. From the thermal behavior of the hydroxyl and other related absorption bands the lower limit of firing temperature was estimated individually to all the specimens. Half band width of main silicate band was also calculated and correlated with the firing temperature estimation.

The porosity values were also determined for all the samples by water absorption method. The nature of the clay whether coarse or fine is identified with the help of porosity value attained and the higher limit of firing temperature of all the specimens were estimated. The utility of the pottery by the people lived in ancient times was also identified.

The lower and higher limit of temperature attained by the artisans was estimated by using FT-IR spectroscopy and porosimetry methods respectively. The range of firing temperature was also attempted by using microscopic method such as Scanning Electron Microscope (SEM) along with EDS attachment. The
elemental analyses were carried out for all the samples and weight in percentage of different clay compositions present in each specimen was reported. From the nature of clay minerals (Calcareous/Non—Calcareous), firing atmosphere (Oxidizing/reducing), clay composition and from the percentage of fluxes, vitrification stage was identified and from that to which temperature the potteries may be fired was estimated.

Archaeological study will not be completed unless and otherwise we date the samples. Finally, an attempt has been made with ESR spectroscopy, a relevant, scientific technique and age of bones and teeth collected from the archaeological sites Melchittamur; Sankari Durg and Perur by irradiating the samples with $^{60}$Co source. The estimated age was in good agreement with the dates provided by the archaeologists and it has an accuracy of ±50 years.

From the above discussions it is clear that the artisans belonging to Ariyalur, Perur and Salamankuppam only knew the skill of adapting both the type of atmospheric condition to fire the artifacts. The artisans of remaining sites were not aware of reducing atmosphere. The FT-IR spectra of Sankari durg contains more source of accessory minerals and that of Kaniyampoonidi site samples contain minimum number of minerals. This due to the nature of the place from which the samples have been excavated. The artisans of Tandikkudi only have achieved maximum firing temperature which is due to the nature of particles present in the samples, the firing atmosphere adopted, the vitrification stage attained and foremost the clay mineral constituents. Hence it is concluded that the
various type of clay minerals present in the specimens and the method of firing adopted has greater influence on firing temperature.
FT-IR Spectroscopic method and chemical analysis to determine the atmospheric condition adopted by the ancient artisans at the time of manufacturing the potteries recently excavated in Tamilnadu, India

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ABSTRACT

An attempt has been made in the present work to determine the atmosphere prevailed at the time of manufacture of potteries belonging to the archaeological sites Sankagiri and Perur in Tamilnadu using Fourier Transform Infrared Spectroscopy (FT-IR) and Chemical analysis.

Keywords: Archaeological pottery, FT-IR, Chemical analysis, Atmosphere prevailed

INTRODUCTION

Archaeology is a method by which the remains of ancient man can be methodically and systematically studied to obtain a complete picture of his ancient culture and society to a possible extent. In short, archaeology is essentially a method of reconstructing the past from the surviving traces of former societies (Raman, 1986). The growth of science had a direct impact on the growth of archaeology. The path breaking inventions made in different disciplines of science from time to time indirectly helped to the development of archaeology (Rajan, 2002). Spectroscopic techniques now play an important role to examine antiquities. Among the physical remains, artifacts (portable man made object) occupy a primary position. Potteries have been made of baked clay minerals. The pottery artifacts were selected for the present study owing to their resistance to time and their maintenance of aesthetic characteristics with respect to time. These types of artifacts can be considered as a very specific trace of every civilization. For the present study, samples collected at different depths from the archaeological sites Sankagiri and Perur have been analyzed using spectroscopic technique such as Fourier Transform Infra Red (FT-IR) and Chemical analysis methods.

MATERIALS AND METHODS

FT-IR spectra were recorded for the pottery shreds excavated from the archaeological sites Sankagiri, Salem district and Perur, Coimbatore district in Tamilnadu state, India.
Firing temperature determination of Maligaimedu pottery shreds excavated in Tamil Nadu, India

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ABSTRACT

The aim of the present paper is to bring out the full efficiency of spectroscopic techniques to estimate the firing temperature of the archaeological pottery shreds excavated from the archaeological site namely Maligaimedu in the state of Tamilnadu in INDIA. The lower limit of firing temperature of the Archaeological pottery shreds were estimated using Fourier Transform Infrared Spectroscopy (FT-IR) and also by determining the apparent porosity of the samples.

Keywords: FT-IR, Porosity, Firing temperature, Pottery shreds.

INTRODUCTION

The Physical characteristics of the potteries like the color, texture, style and size of the clay particles composing them can reveal the civilization, technology of manufacture and method of firing adopted to bake them and the technical skill evolved by the ancient artisans lived at that time. The estimation of the firing temperature of the potteries used by them throws light to identify the purposes for which they had used them in the daily routines of their living at that time (Ramasamy et al., 1987; Sankaran and Ramasamy, 2000). From the knowledge of firing temperature value achieved and method of firing one may able to conclude how the process navigated and tempered the raw clay used to model a vessel. Here, FT-IR and Porosity are the two techniques employed to estimate the firing temperatures achieved by the artisans of ancient times and the firing techniques adopted for the pottery shreds collected at different depths from the archeological site Maligaimedu, Cuddalore district in Tamilnadu.

MATERIALS AND METHODS

The samples collected at different depths from the Archaeological site Maligaimedu were refired to temperatures 200, 400, 600 and 800°C. The FT-IR spectra were recorded in explored range of frequencies 4000 - 400 cm⁻¹ for the sample at received state and the refi samples using Nicolet Avatar 360 FT-IR spectrometer (Russell, 1987). The porosity value
Characterization of potteries from Melchittamur by a combined FT-IR and chemical analysis

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ABSTRACT
As ceramics is a quite stable material, pottery is abundant in the archaeological context. For archaeological purposes, primary, secondary and accessory minerals are good enough to characterize the pottery material and to determine the clay and its sources. From this knowledge, information about the skill of the artisans in ancient societies can be established. Clay minerals, Chemical composition of potteries and the atmosphere prevailed by the artisans belonging to the archaeological site Melchittamur were identified in the present study using Fourier Transform Infrared Spectroscopy (FT-IR) and Chemical analysis.

Keywords: FT-IR, Chemical analysis, Clay minerals, Firing atmosphere, Archaeological potteries.

INTRODUCTION
During the last two decades, architectural heritage preservation has reached a rising interest for Scientists, Architects, Engineers and Archaeologists. This subject being an interdisciplinary research area (Paula Lopez-Arce et al., (2003)). The study of mineralogical phases of archaeological ceramics may be very helpful in unraveling the history of an ancient shred, particularly by means that investigate the process of its production. Phase analysis can potentially provide much information on the technology of the production of ceramics, which possess apart from provenance and dating, a very relevant and important archaeological question that need to be solved. Revealing the technical skill of ancient potters has been the subject of much research, since it is one of the most important issues for gaining a deep insight of bygone culture (Angela Zoppi et al., (2000)). In the present work, an attempt has been made to identify the clay minerals composition and atmosphere prevailed to the archaeological potteries collected from the recently excavated site Melchittamur using Fourier Transform Infrared spectroscopy (FT-IR) and Chemical analysis. This site was excavated by State Department of Archaeology, Chennai.

MATERIALS AND METHODS
The Infrared spectra of the pottery samples were recorded in the mid region 4000-450 cm\(^{-1}\) using Avatar 360 FT-IR spectrophotometer with 1 cm\(^{-1}\) resolution in its 100 scan
Estimation of firing temperature of Archaeological pottery shreds recently excavated in Salamankuppam, Tamil Nadu, India

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ABSTRACT

Clays and related raw materials have been used by mankind since earliest times. The different thermal reactions of clay minerals on temperatures ranging from 500-1100°C are important for formation of potteries as well as for reconstruction of their production conditions. Clay minerals as main raw material for production of potteries show some characteristic transformation effects in the course of their thermal decomposition. The property of thermal transformation in clay minerals during firing and process of firing provide a means to estimate the firing temperatures of the artifacts. Hence an attempt has been made in the present work to estimate the firing temperature of the archaeological potteries that have been collected at five different depths from the archaeologically important site Salamankuppam, near famous Mahabalipuram in Chennai using Fourier Transform Infrared (FT-IR) spectroscopic technique.

Keywords: FT-IR, Firing temperature, Archaeological potters.

INTRODUCTION

The transformation of clay into pottery was an important step in the development of artisans. The technology of production of archaeological materials reveals the level of the technical background of the people and can be used as an index of ancient civilization and their interactions (Maniatis et al. (1982); Venkatachalapathy et al. (2002)). Clays undergo several structural and compositional changes when exposed to increasing temperature. Up to 200°C adsorbed water evaporates. When the temperature increases to 450-600°C dehydroxylation and the loss of structurally water occur. The above transformation has been widely studied by Fourier-Transform infrared (FT-IR) spectroscopy for a range of temperature up to 1400°C. It is intended that these results will help in revealing the potential of FT-IR spectroscopy as a tool in analyzing earthenware pottery shreds and their methods of production in Tamilnadu (Francesco Berna et al. (2007)). To learn more about the technological conditions such as firing temperature under which potteries were produced, potteries collected from Salamankuppam site has been investigated by using FT-IR spectroscopy.

MATERIALS AND METHODS

The samples collected from Salamankuppam site was re-fired using the muffle furnace in the laboratory to temperatures 550, 650, 750 and 850°C. The re-fried samples...
Microscopic and porosimetry studies to estimate the firing temperature of Archaeological potteries of Perur site in Tamil Nadu, India

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ABSTRACT

Ceramics are amongst the artifacts that are most frequently unearthed by the archaeologist. These utilitarian goods are generally found in a fragmentary state. Such fragments of potteries collected from the archaeological site Perur in Coimbatore district was examined in the present work using Scanning Electron Microscopy (SEM with EDS) and porosimetry method. From these two measurements useful information regarding the artisans of Perur site and firing temperature achieved by the artisans at the time of manufacture has been obtained.

Keywords: SEM-EDS, Porosity, Firing temperature, Archaeological potteries.

INTRODUCTION

The examination of ancient pottery with an analytical Scanning Electron Microscope SEM is valuable for characterizing and distinguishing between the different traditions in ceramic technology in antiquity (because information is obtained on both the extent of vitrification and the firing temperature). The extent of vitrification provides a useful property for characterizing the quality of a pottery, since it influences several micro structural and physical properties which are relevant to its suitability for the various uses to which it might have been put (Sandrolino et al. (1993). The determination of apparent porosity of the archaeological potteries is another valuable method to estimate the firing temperature, to identity skills employed by the artisans to manufacture the potteries (Maniatis (1984); Palanivel and Velraj (2003)). In the present study an attempt has been made to identify the firing temperature achieved by the artisans belonging to Perur site in Coimbatore district at the time of manufacture. This site was excavated by the State department of archaeology, Chennai, Tamilnadu.

MATERIALS AND METHODS

The microphotographs of the samples were recorded using SEM JSM 5610LU JEOL make. The maximum magnification possible in the equipment is 3,00,000 times with a resolution of 3nm. The elemental analysis was done using the OXFORD INCA Energy dispersion X-
Electron spin resonance spectroscopic technique for dating of fossil bones

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ABSTRACT

Electron spin resonance (ESR) spectroscopic technique is applied to estimate the age of bones collected from the archaeological sites Melchittamur and Sankari Durg. The radicals or defects are produced artificially by irradiating with gamma rays from a $^{60}$Co source. With an external dose rate of 1.12 mGy/a and DPPH standard ‘g’ value the rough estimates of the site have been done. The results of the investigation are in good agreement with the historical period given by Archaeologists.

Keywords: ESR, Dating, Fossil bones.

INTRODUCTION

The study of the human past is to understand the human activity in a sequential order. The archaeological data has to be placed in chronological order to realize this sequential cultural process. For this, dating methods are being used in the archaeological investigations. Dating a site or artifact has always been one of the most important elements in archaeological research. Dating is the backbone of archaeology. There are many methods developed for dating the archaeological finds (Taylor and Martin, [1997]; Aitken Martin, [1990]).

Electron Spin Resonance (ESR) is one of the spectroscopic technique which deals with the interaction between electromagnetic radiation and magnetic moments (Paramagnetic centers) which are found in many materials either as intrinsic constituents or as impurities. In the field of cultural heritage the most important and better known ESR contribution is certainly dating, which has played a key role in developing our present knowledge of the origin and evolution of modern humans (Grun, [1990]; Ikeya, [1975]) and operates in a time range where other dating techniques can not be applied or unreliable. Hence an attempt has been made to date the fossil bones collected from Melchittamur in Villapuram district, Sankari durg in Salem district in Tamil Nadu, India. These two sites were excavated by the Department of Ancient History and Archaeology, University of Madras, Chennai and Archaeological survey of India (ASI), branch office, Salem respectively.