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Spectroscopic and porosimetry studies to estimate the firing temperature of some archaeological pottery shreds from India

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ABSTRACT

The present study aims to estimate the firing temperature of archaeological pottery shreds collected from the three archaeological sites namely Maligaimedu, Thiruverkadu and Palur in Tamilnadu state, India. The spectroscopic method Fourier Transform Infrared Spectroscopy (FT-IR) has been employed to find the lower limit of firing temperature of the archaeological pottery shreds by refiring the samples to four different temperatures from 200 °C to 800 °C. From the observation of the hydroxyl band and appearance/disappearance of octahedral sheet structure the firing temperature of the shreds has been estimated. The samples from Maligaimedu site named as MM1, MM3 and MM5, Thiruverkadu and Palur samples were fired to a temperature above 800 °C and the samples of Maligaimedu MM2, MM4 and MM6 were fired below 800 °C. Additionally, porosimetry measurements such as water absorption and mercury intrusion (MIP) were also carried out. The samples MM1, MM3, TK2–TK6, PL3 and PL5 were fired to a temperature less than 900 °C and the other samples to less than 1000 °C.

1. Introduction

Archaeological artifacts like potteries, bricks and tiles are the source of information about the ancient civilization, their technological skills and cultural trade links between continents. These potteries, which are the first innovation of mankind, were used to store food grains, water and for keeping dead bodies (Ramasamy and Dheenathayalu, 1989).

Many of the objects left behind by human societies are not present in archaeological records because they have been disintegrated over time. The material remains that still exist after hundreds or thousands of years have survived because of favorable preservation conditions in the soil or atmosphere. The pottery shreds are the only things that survive over the period of centuries inspite of the variation of time and atmospheric condition (Bahn, 1989).

Earlier unfired potteries are manufactured by artisans using local clays. After the development of firing technology, the artisans used to make good quality potteries by using proper clay materials and subjected to different firing techniques (Tite, 1969).

To study the materials used for firing, the technology of firing (either controlled firing or open firing) and art of controlling the firing, spectroscopic techniques are widely used. Infrared and porosimetry techniques have been applied in the present study to estimate the firing temperature of archaeological potteries recently excavated at three different sites in Tamilnadu.

Thermal transformations in clay materials during firing provide a means to estimate the firing temperature of the artifacts (Ramasamy and Dheenathayalu, 1989).

As an attempt, colour and porosity have been correlated (Palanivel and Velraj, 2003) to the firing temperature and the nature of the clay minerals present in the samples.

2. Sites location and significance

In India, Tamilnadu is known for its cultural heritage and civilization for the past 1400 years. The archaeological excavation sites, where the pottery artifacts collected are Maligaimedu, Thiruverkadu and Palur. The archaeological excavation sites of the samples studied are shown in Site Map 1.

Maligaimedu (lat. 11°48′N; long. 79°35′E) is the location identified by the State Department of Archaeology, Government of Tamilnadu. The word Maligaimedu refers to a place of mound. The archaeologist predicted that the potteries were belonging to the 13th and 14th century AD (Dhamotharan, 2000). The place may be Indo–Roman trading place on the coromandel coast of India.

The sites Thiruverkadu (lat. 13°48′N; long. 80°10′E) and Palur (lat. 12°58′N; long. 79°12′E) in Tamilnadu are identified archaeological sites by the Department of Ancient History and Archaeology, University of Madras, Tamilnadu. The pottery shreds of Thiruverkadu belong to the

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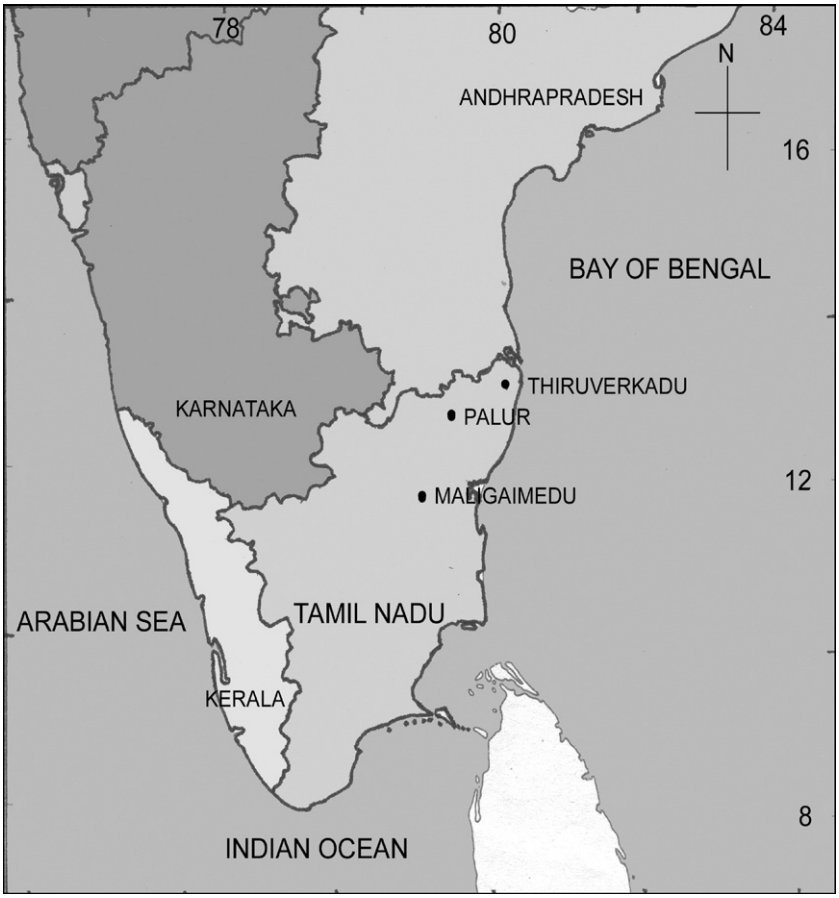

Site Map 1. Archaeological sites of recent excavation (●) in Tamilnadu (South India).

first century AD to 200 AD. The rouletted wares identified from the Palur site indicated that the place have trade links between Roman and other trade countries. The potteries may belong to the period 900 AD, 600 AD and 1–2nd century AD.

3. Materials and methods

The samples from the Maligaimedu site are named as MM1, MM2, MM3, MM4, MM5,and MM6,the Thiruverkadu site are named as TK1, TK2, TK3, TK4, TK5 and TK6 and the Palur site are named as PL1, PL2, PL3, PL4, PL5 and PL6.

3.1. Ft-ir

The samples collected at different depths from the three Archaeological sites were refired at 200, 400,600 and 800 °C. The FT-IR spectra were recorded from 4000–400 cm^{-1} for the refired samples after cooling to room temperature (Nicolet Avatars FT-IR spectrometer).

3.2. Porosity measurements

The porosity was estimated from water absorption (Palanivel and Velraj, 2003) and mercury intrusion (MIP) (Neelamegam et al., 2002).

Table 1
Estimated firing temperature of the pottery shreds excavated at Maligaimedu, Thiruverkadu and Palur using FT-IR spectrum

Sample	Colour	K575/K535	Atmosphere	Dehydroxylation	Octahedral sheet structure	Estimated firing temperature(°C)
MM1	Red slipped ware	–	Oxidizing	Complete	Disappeared	>800 °C
MM2	Red slipped ware	0.1291	Oxidizing	Incomplete	Disappeared	<800 °C
MM3	Red slipped ware	–	Oxidizing	Complete	Disappeared	>800 °C
MM4	Red slipped ware	–	Oxidizing	Incomplete	Disappeared	<800 °C
MM5	Red slipped ware	–	Oxidizing	Complete	Disappeared	>800 °C
MM6	Red ware	1.6104	Oxidizing	Incomplete	Disappeared	<800 °C
TK1	Red slipped ware	0.5545	Oxidizing	Completed	Disappeared	>800 °C
TK2	Black and Red ware	1.0710	Oxidizing	Completed	Disappeared	>800 °C
TK 3	Red Ware	–	Oxidizing	Completed	Disappeared	>800 °C
TK 4	Red ware	–	Oxidizing	Completed	Disappeared	>800 °C
TK 5	Black and Red ware	7.1195	Reducing	Completed	Disappeared	>800 °C
TK 6	Black ware	–	Oxidizing	Completed	Disappeared	>800 °C
PL 1	Red ware	–	Oxidizing	Completed	Disappeared	>800 °C
PL 2	Red ware	–	Oxidizing	Completed	Disappeared	>800 °C
PL 3	Red Ware	–	Oxidizing	Completed	Disappeared	>800 °C
PL 4	Red slipped ware	–	Reducing	Completed	Disappeared	>800 °C
PL 5	Red slipped ware	–	Oxidizing	Completed	Disappeared	>800 °C
PL 6	Black & Red ware	–	Reducing	Completed	Disappeared	>800 °C