

# Physics for Cultural Heritage: TL Dating of the Kamakhya Temple, Assam, India

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**Abstract:** - The ancient bricks samples collected from the two distinct strata of the famous Kamakhya temple in Guwahati, Assam, India have been dated using thermo luminescence (TL) techniques. The studies show that part of the temple in all probability was reconstructed around 800 A.D. while the older layer was built around 500 A.D. The necessity of reconstruction probably arose due to either earthquake induced devastation or damage caused by outside invaders.

**Keyword:** - Archeometallurgical, Kamakhya, TL/OSL, Quartz, XRF/XRD

## I. INTRODUCTION

Bricks are collected from two different sites of the Kamakhya Temple. The one which was collected from the old (protected) site is named as the old brick and the other which was collected from the new site is named as new brick. Bricks are one of the oldest building materials known to man. The use of sub-soil materials in building was a large subject along eras. The brickwork has attracted considerable interest over the years, through using different types of bricks that have been divided according to different criteria depending on fabric, dimensions, regularity of shape and appearances. Fired or burned bricks have been used on a large scale in buildings from the very beginning of the third millennium B.C. [1-7].



Figure 1 The ruins of the Kamakhya Temple (Old), Assam (Source: The Author)

The problems of cultural heritage specially authenticity of art objects, ceramics as well as their age in general are addressed by techniques of

Physical Science, namely XRF/XRD, Raman Spectroscopy, radio-carbon dating and luminescence (TL/OSL) dating [8-12].

The XRF / XRD and Raman Spectroscopy are generally used for elemental /compositional analysis of archeometallurgical objects, ceramics and paintings while radio-carbon and TL/OSL techniques are used to date objects important to the cultural heritage. These may be potteries, bricks and ceramics for TL/OSL techniques.

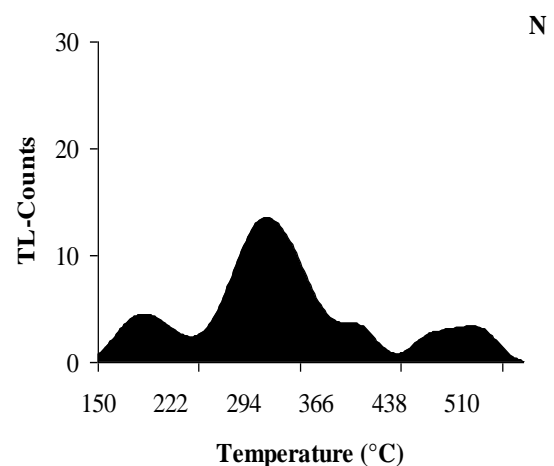
In this work, TL dates of two samples of bricks collected from two different horizons of Kamakhya Temple, Assam are provided. The samples were believed to be of different ages. It is to be noted that the temple is not only intricately linked to the people of Assam (known as Kamarupa in ancient Indian texts) but is the springboard and centerpiece of Tantric practices and Shakti worship of India (Fig. 1).

## II. EXPERIMENTAL

Measurement was made in well-known Risø TL/OSL-DA-15 reader using internal Sr/Y-90 beta source at the Luminescence Laboratory of Prof. R. K. Gartia in Manipur University [13]. Other experimental details are reported in earlier papers [14-15].

## III. RESULTS AND DISCUSSIONS

Two typical glow curves of the quartz extract of one of the samples are presented in figure 2.



The corresponding curve for determination of equivalent dose (ED) of the sample is shown in Fig. 3. The TL age corresponding to the ED is  $1500 \pm 150$

years. Another sample yielded an age of  $1200 \pm 125$  years. These two ages clearly show that some portion of the existing temple most probably was reconstructed around 800 A.D.

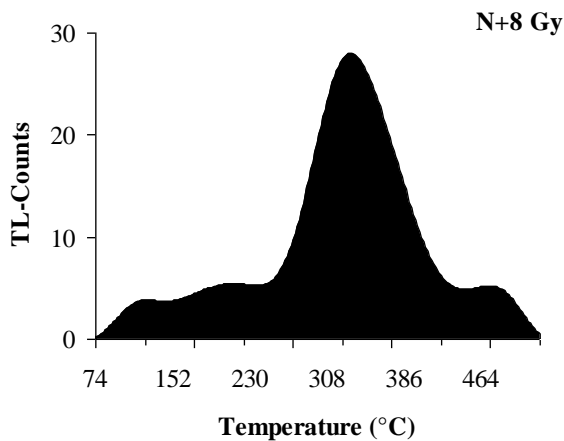


Fig. 2. Typical glow curves of quartz extracts of ancient brick of the Kamakhya Temple, Assam

while the older strata was built during 500 A.D. Radio Carbon dating of the temple reports that the bottom layer of the temple is 2200 years old and the second layer is 1500 years old [8], that agrees with one of the TL ages.

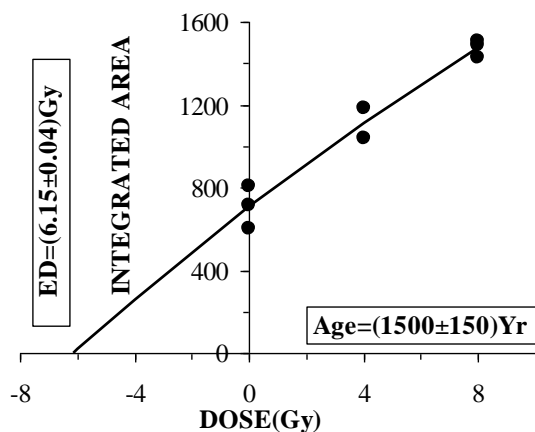


Figure 3 Determination of equivalent dose (ED)

Most probably the temple was either devastated by some ancient earthquake or damaged by outside invader during 500 A.D. Incidentally the temple lies in one of the most seismic prone zone of India. Our work gives the first scientific input to the application of luminescence dating to the history of the Kamakhya Temple, a rich heritage site of India.

Similarly, the bricks obtained from the Kamakhya Temple, both new and old sites, were analyzed by XRD, FTIR and TL techniques. XRD pattern of the old brick shows the presence of  $\alpha$ -quartz as the major constituents with minor amount of Calcium Aluminum silicate phases; whereas the new brick shows the presence of other minor phases of Calcium

Aluminum silicate and Iron phosphate hydrates. The presence of Iron phosphates in the new brick shows the advancement of brick manufacturing skills in response to the deterioration caused by natural hazards like earthquakes and any other impacts.

The FTIR spectra of the brick from the protected (old) and new sites were recorded in a Nicolet Impact 410 (Perkin-Elmer Corporation, Norwalk, Connecticut, USA), with Nichrome as the reference and KBr pallet as the sample [17].

Theoretically, Calcium Aluminum silicate phases in the bricks of the Kamakhya temple sites could be helpful in establishing linkages among bricks and raw materials, because they are metamorphic minerals formed at high temperature-pressure conditions resisting brick baking without undergoing mineral transformation, and Kamakhya Temple surrounding regional rocks contains phases inferred from the data. The large amount of quartz in the sample can belong to detritus sands coming from the Brahmaputra Valley rocks. It is known that calcite and dolomite phases play an important role during firing due to the development of neo-formed phases such as gehlenite and diopside. Bricks and ceramics can be considered as artificial rocks fired in kilns, which bring their research routines close to those followed for metamorphic rocks [18-20]. In this way, modern methods of mineralogy, petrology and geochemistry are very useful for the study of archaeological ceramic materials [21-23]. Bricks in ancient buildings retain complex physico-chemical histories from the clay stone geological formation to the finished product ready to be used in construction. From this point of view, a late history of changes, due to new pollution, different organic deposits and climatic variations, modifies the brick in dynamic equilibrium with its shifting environment. The presence of Boron in the form of oxides as revealed by FTIR of the Kamakhya New Bricks suggests that the ancient people used Boron Oxides for polishing and smoothing of the brick surface.

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