Thermoluminescence Dating of Fluvial Terraces Of Itok River, Chandrakhong, Manipur (India)

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ABSTRACT

The multi aliquot additive dose method is used in the determination of equivalent dose of the samples collected from a depth of 10ft from the top surface of the river terrace of Itok River, a tributary of Thoubal River of Manipur. The age of the sample is found to be about 1900 ± 340 years which indicate the formation of this terrace is at about 112 A.D. This study of the age of the river terrace will be helpful to reconstruct the climatic change due to deforestation of this region.

Keywords: Multi aliquot, equivalent dose, river terrace, itok river.

INTRODUCTION

Thermoluminescence (TL) produced by electrons released from traps by applying thermal stimulation, has been extensively used from archaeological dating to geological dating [1, 2]. In dating, the signals are related to determine the total ionizing dose to which the samples have been exposed in the past. It is the measure of the electron population accumulated in traps. Heating and sun bleaching can partially or totally eliminate these electrons. Hence the TL dating give the time since the sample was last heated or bleached before its burial.

Age of a buried sample can be assessed from the well-known equation [3]

$$Age\ (ka) = \frac{Equivalent\ Dose\ (Gy)}{Dose\ \ Rate\ (Gy/ka)} \ \ldots\ldots\ldots\ldots\ldots..\ldots\ldots\ldots(1)$$

To date a sample equation (1) is used in all the radiation damage (Luminescence) techniques and the only minor difference among the techniques is the process that sets the luminescence 'clock' to zero, related to the event that is being dated.

Among the established methods for determination of equivalent dose, the additive dose method has been employed for prolong. In this method, many aliquots of the sample are used because each aliquot is used only once. Luminescences from the aliquots to which various radiation doses have been added were measured. The radiation dose equivalent to the luminescence from the natural sample material is then determined by extrapolation from the data obtained from various radiation doses. But in this method aliquot to aliquot normalization is required because of different mass or unequal luminosity to radiation doses between the aliquots.

Froth terrace represent ancient floodplains of a river that is incising into bedrock. They are formed after remaining at the same elevation and widening its flood plain for a period of time. Accurate dating of strath terrace deposits can constrain the rate of incision of the stream system as well as the timing of the events that control incision rates. River terraces are excellent chronosequence sites for the study of soil profile development [4], clast weathering and Aeolian inflation, the rates of which may be constrained by dating the deposits [5].

There have been debates for many years about the theories to explain the formation of river terraces [6-10]. But recently it is assumed that two separate ingredients are required for the formation of river terrace systems, one being surface uplift, to provide the impetus for fluvial incision [11] and the other being cyclic climatic fluctuation of the sort that has experienced during the Quaternary, which has driven the fluvial activity that has led to the formation of river terrace [12-15]. With this background additive dose method is applied to calculate the equivalent dose of the froth terraces of Itok River, one of the important tributary of the Thoubal River in Manipur, India.

EXPERIMENT

a) The sample:

A number of terraces have been traced through the field area of Itok River at Chandrakhong, Thoubal district of Manipur (India), ranging in elevation from 5ft to 20ft above the modern flood plain. Each terrace consists of ~ 1-3 feet thick gravel capping a strata surface eroded into shale and sandstone bedrock. We have labeled these strata from lowest to highest and collected samples from the strata for analysis.

Figure 1: A view of the Itok river

b) Sample Preparation:

The samples collected from the terrace of Itok River were washed with water and subsequently treated with 30% H_2O_2 and 10% HCl to remove organic materials and carbonates. Finally the sample was etched in 40% HF for ~ 45 minutes to remove feldspars and provide a quartz rich extract. Then the samples are sieved to extract the grains of size in the range 90-180μm.

c) Measurement:

**Figure 2**. The terrace from where samples were collected.

All the glow curves were recorded using TL reader, Model 1009I (Nucleonix System Pvt. Ltd. Hyderabad, India) at Luminescence Dosimetry Laboratory, Thoubal College, Thoubal. The heating rate used was 5°Cs^{-1}

with the temperature set from room temperature to 500°C. A second readout was performed to record the background radiation, which includes the black body radiation. The data presented are all with the background subtraction. The samples were γ - irradiated at Life Sciences Department, Manipur University, Canchipur. Both NTL as well as N+γ_i glow curves were recorded with a pre-heat of the sample up to 175°C to remove bleachable lower temperature glow peaks.

RESULT AND DISCUSSIONS

A view of the Itok River is shown in figure 1. A number of terraces can be track through the field area with different range of heights. Figure 2 shows a part of the terrace from where samples were collected. Four different layers with different colours can be seen to the trenching site.

Natural TL glow curves were recorded from the clean quartz extracted from the collected samples is shown in figure 3. In the same figure one of the N+γ_i thermoluminescence glow curve (N + 25Gy) is also presented. Then the sample was exposed to sun light for two days that causes bleaching of the geological TL of the sample to a residual value G_o [16]. The dose response curve (DRC) of the sample is shown in Figure 4. The
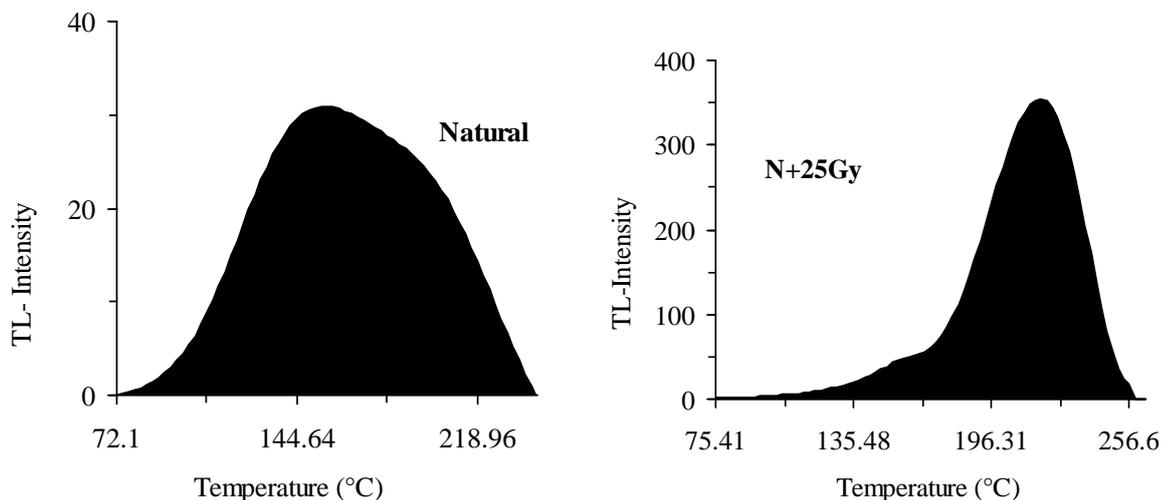
Figure 3. Natural TL (NTL), N+25Gy γ-irradiated glow curves of quartz extracted from the sample.

equivalent dose (ED) is calculated by extrapolation up to the horizontal line through residual value G_o as shown in Figure 4 and found to be 4.53 ± 0.83Gy. Using the dose rate 2.47Gy/ka [17] of the region, the age of the sample is determined by using the equation (1) and found to be 1900 ± 340 years in average indicating the sample belongs to a period of about 112 A.D.
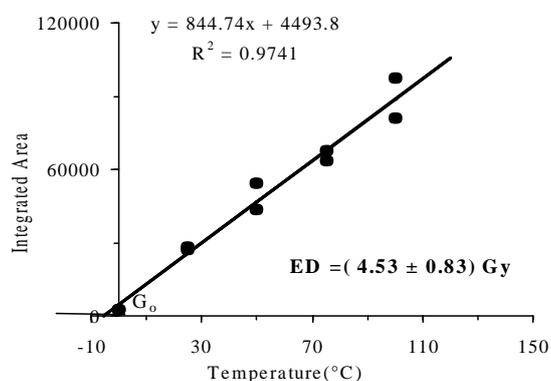
Figure 4. Dose Response Curve of the sample.

CONCLUSION

The age of the sample collected at a depth of 10ft from the top surface of the River terrace of Itok river, determined by TL technique using additive dose method were found to be 1190 ± 340 years. The study of the terrace of the river will be helpful to understand the site formation processes of these sedimentary deposits and to reconstruct the climatic change due to deforestation because of the human settlement in the region.

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