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Thermo luminescence Dating of Quartz Sediments Extracted from the Terraces of Thoubal River at Leirongthel, Manipur, India

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ABSTRACT

The annual dose level determination of an area is one of the most important parameters in calculating the geological and archaeological age of the sample using luminescence techniques. The luminescence properties of quartz extracted from the sediment deposits and landforms allow us to measure depositional ages for late Quaternary sediments. The present work reports the determination of age of quartz extracted from the terrace of Thoubal River, (one of the important rivers in Manipur), by additive dose method. The age of the quartz samples at a depth of 6 feet from the uppermost layer of the river is found to be (37,400±850) years. This terrace dating should contribute significantly to the study of land forms, climatic change and reconstruction of environmental change of Thoubal Valley of Manipur.

KEY WORDS: *Thermo luminescence, Quaternary, Fluvial, dose, sediments.*

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I. INTRODUCTION

Luminescence dating has been applied to fluvial deposits by many workers over the past decade [1-4]. It is based on a radiation - induced luminescence from non-conducting crystalline materials such as quartz or feldspar. These materials are capable of determining the period of time which has elapsed since the last time of exposure of sediment layer to sunlight prior to deposition [5].

Fluvial deposits, terraces and alluvial fans are important archives of tectonic activity [6]. In modern theories of terrace formation of rivers it is assumed that two separate ingredients are required: One being surface uplift, to provide the impetus for fluvial incision [7] 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 [8 – 11].

The dating information is carried in the form of trapped electrons. These electrons are produced by the interaction of the nuclear radiations originated mainly from radioactive impurities (eg. U, Th, K) present in sediments. The electrons released from the traps when applied thermal stimulation produced luminescence, used in geological dating and archaeological dating [12]. The amount of luminescence is proportional to the time that has elapsed since the geological clock of the material is set to zero , which is achieved in nature when the material is heated to above 500^0C or prolong exposure to sunlight [13].

Figure 1: A view of the Thoubal River at Leirongthel area.

This paper presents the determination of the age of the terrace of the Thoubal River, one of the important rivers of Thoubal Valley of Manipur, by additive dose method. In this method a range of doses is added to the natural samples being dated. Half of these are bleached by direct sunlight for 2 days, which is long enough to remove any rapidly-bleached TL components but not long enough to remove any significant amount of slowly-bleached TL. The samples are glowed out and the data are used to define a (natural + dose) growth curve and a (natural + dose + bleach) growth curve. The two curves are extrapolated to intersect at a point that defines the Equivalent Dose. The age of these terraces of this river can provide a framework for modelling the fluvial incision as a part of landscape evolution [7,14], soil profile development [15], clash weathering and Aeolian inflation [16].

Figure 2: Collection of samples from the terrace of Thoubal River.

Experiment

(a) **Sample Collection**:

A view of the Thoubal River at Leirongthel area is presented in Figure 1. Suitable terraces are traced in the field area of Thoubal River at Leirongthel, Thoubal District of Manipur(India), ranging in elevation from 6 feet to 20 feet above modern flood plain. Each terrace consists of ~ 1-4 feet thick gravel capping a strata surface eroded into sandstone bedrock. We have marked and labelled these strata from lowest to highest. Samples were collected from homogeneous sandy layer in metal pipes under dark room like conditions, at a depth of 6 ft from the top of the upper layer (Figure 2).

(b) **Sample Preparation :**

The preparation of samples took place under subdued red light conditions. Sand sized grains ~ 80 – 150 μm were extracted from the sample by washing with water and sieving. Then, the samples were treated with 30% H_2O_2 and 10% HCl to remove organic and carbonates materials. Finally they are treated with 40% HF for about 50 minutes to dissolve feldspar grains and to etch the alpha- exposed outer rim of

grains. This yields quartz extract for TL measurement. The raw sand samples and the quartz samples extracted from the samples are presented in Figure 3.

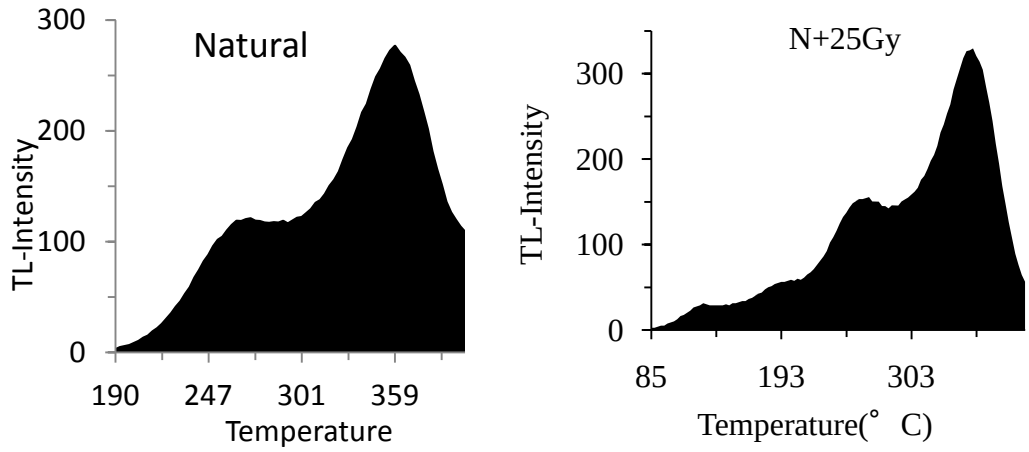
Figure 3: The raw sand samples collected from the terrace of Thoubal River at Leirongthen at depth 6 feet and the quartz extracted from it.

(c) **Measurement :**

All TL glow curves of the quartz sample of Thoubal river were recorded using TL reader, Model 1009I (Nucleonix System Pvt. Ltd. Hyderabad, India). The heating rate used was $5^{o}Cs^{-1}$ with the temperature set from room temperature to $500^{o}C$. 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 at different doses. Both natural TL (NTL) as well as N $+\gamma_i$ glow curves were recorded with a pre - heat of the sample up to $175^{o}C$ to remove bleachable lower temperature glow peaks.

Results and Discussions

The natural TL glow curve of the clean quartz sample of the terrace of Thoubal River is shown in Figure 4. In the same figure TL glow curves of Natural (N) + 25Gy, N + 50 Gy and N+75Gy are also presented. The dose response curve (DRC) of the sample is shown in Figure 5 along with DRC of the sample calculated after the sample is exposed to sunlight for two days that caused bleaching of the geological TL of the sample to a residual value Go [17] . The equivalent dose (ED) is calculated by extrapolation up to the horizontal line through residual value G_o (Figure 5) and found to be about (92.27 ± 2.10) Gy. Using the dose rate 2.47 Gy/Ka [18] of the region the age of the sample is determined by the equation



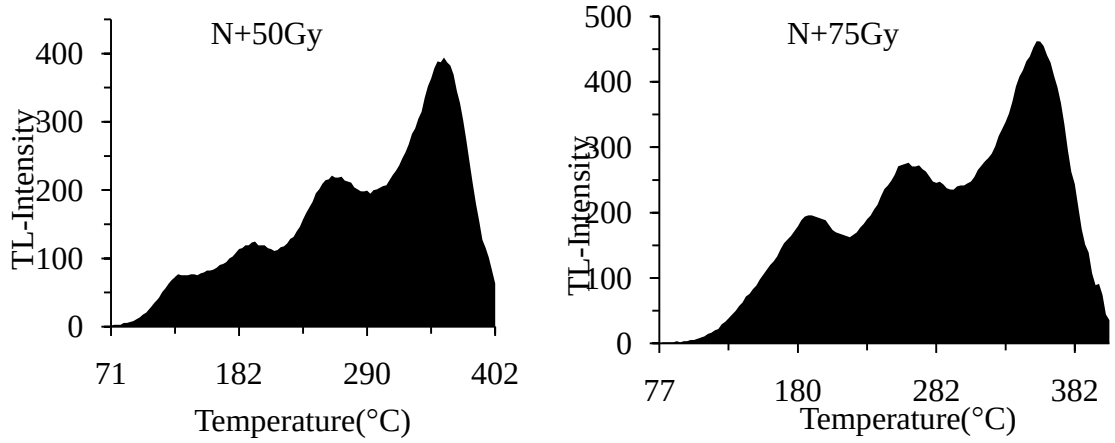


Figure 4: Natural TL (NTL), N+25Gy , N+50Gy and N+75Gy, γ-irradiated glow curves of quartz extracted from the samples of the terrace of Thoubal River at a depth 6ft.

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

The age of the sample is found to be about (37,350 $\pm$ 850) years indicating that the sample was belong to a period of about 35,335 B.C.

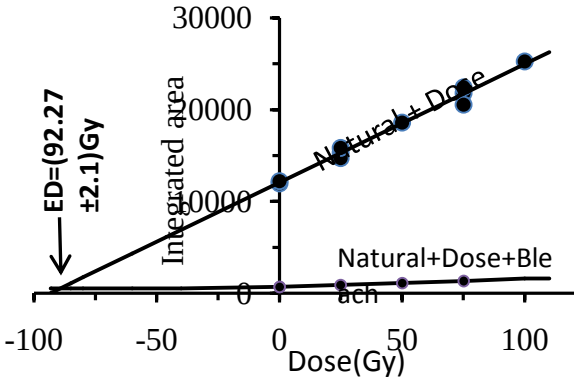


Figure 5: Dose Response Curve for the samples collected from the terrace of Thoubal River at a depth of 6 ft.

CONCLUSION

The age of the sample collected from the terrace at a depth of 6 feet from the top surface of the Thoubal River, determined by TL technique using additive dose method were found to be about (37,350 $\pm$ 850) years. The study of this terrace dating of the river will be helpful in understanding the site formation processes of the sedimentary deposits and to reconstruct the environmental and the climatic change of the region.

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