International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 8
August 2017

Estimating the age of the Historic Imphal River Terraces by Physical Techniques

Md. Raheijuddin Sheikh[1], A. Nabachandra Singh[2], S. Bidyashwore Singh[3]
[1]D M Community College, D M College of Science, Imphal – 795001, Manipur, India
[2& 3] Thoubal College, Thoubal- 795148, Manipur, India

Abstract:
Luminescence dating has emerged as a physical technique to directly determine the age not only of ancient potteries, bricks and terracotta but also the burial age of the main mineral constituents in unheated Quaternary Sediments. Fluvial deposits and landforms may be considered as important archives of river response to climate, tectonics and base level change which are commonly associated with archaeological sites. Among other rivers in Manipur, Imphal River is an integral part of the history of Manipur which is famous for its beautiful terraces in itsupper course. Considering the application of luminescence dating to fluvial deposits,the age estimation of the four strata of the river in its upper course in Senapati District, Manipur(India)whose depth are ranging from 5 to 3 metresare found to be (55 ± 5), (42 ± 4), (18 ± 3) and (5 ± 1) ka respectively.

1. Introduction

Long terrestrial sedimentary records with an independent chronology are important to evaluate the influence of Quaternary climate change on continental landscape evolution. They also form an important tool for correlating continental environmental changes with variations in the continuous marine and ice-core records. Unfortunately, terrestrial sedimentary records are usually rather discontinuous in time and space. This work aims at reconstruction of the depositional environment, sediment provenance and landscape development in the Imphal River Valley during the Middle and Late Quaternary by means of sedimentary and palaeo-ecological research. The completeness of the record and the significance of depositional hiatuses for the interpretation of the sedimentary sequence are considered. The age of the deposits is determined by extensive quartz luminescence dating at three different sites. The multi-disciplinary approach provides detailed knowledge on the geomorphological processes and landscape evolution in Manipur under the influence of repeated Quaternary climate change.In the present study areas both paired and unpaired terraces are commonly found. Paired terraces are more common at the foot hills and flood plain areas while unpaired terraces are found at the upper reaches of the stream.

Figure -5. 1: A photograph showing the terraces of the Imphal River at Gopibung, Senapati District, Manipur (India)

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 8
August 2017

The levels of terraces at Gopibungin its upper course used for dating are shown in Figure 5.1. Older terraces are covered with thick vegetation. These terraces mark the position of former flood plain (stage of aggradations) and floor of valley flowing at that time. These terraces are composed of boulders, gravels, pebbles, sand slit and clay showing mixing of active channel as well as flood plain deposits.

2. Experimental

2.1. **The OSL:**Optically Stimulated Luminescence (OSL) dating technique is used to determine the age of the Imphal River at Gopibung. Study of the age of this river is of interest and helpful to date the age of the valley of Manipur as the river is flowing to the foot of the important Kaobru Hill, as this hill is believed to be the place for the first ancient human settlement of Manipur as quoted in the history of Manipur **"AwangKaobruAsuppaLaimanaiKhundaAhanba"** (Sharma, 1960).

2.2. The Sample Collection

Tracking and sighting of the places of interests are the first steps which were being used in the sample collections. After sighting the proper terrace the place was cleared and dug the terrace surface vertically inside for about a metre and marked the levels of the strata with white color which vary from about 30 ~ 60 cm thick gravel capping surface eroded into shale and sandstone bedrock. Then we make boring at the upper layer of each stratum at a depth in the range 3 – 5 metres from the top surface with GI pipe by hammering deep enough to collect enough samples for preparation. Then it was wrapped tightly with black covering to protect from sunlight.

2.3. Sample Preparation

Luminescence dating essentially is based on the fact that natural mineral such as quartz, feldspar and zircon serve as sensitive radiation dosimeters. Therefore, it is mandatory to extract these minerals either in more or less pure form or as poly-minerals from the material that is to be dated. Both fine grains (poly-minerals) as well as quartz grains were extracted following the standard techniques. Organic materials were removed by treating with H_2O_2 while carbonate with HCl. Etching of quartz grain with 40% HF for 40minutes at 20°C is done to remove the feldspar component as well etching the outer layer of the quartz grain, which eliminates the α-particle contribution to the palaeodose. All the procedures are performed in dark room.

2.4. Dose Rate Measurement

The annual dose rates were measured by gross alpha counting method using pairs' technique (Chougaonkar et al., 1999). Briefly, a thick source alpha counting set up consists of a photo-multiplier tube on the window of which a ZnS screen is placed in a Perspex cell. The scintillator screen is covered with the sample in a finely crushed form such that a total area corresponding to 42mm diameter circle of the screen is covered. After the sample is placed in the counter set up, the counts appearing in the first hour are discarded to make sure that no spurious counts are considered for calculations. Then, the counter is left on for counting for twenty-four hours or more depending on the counts produced by the sample. The scintillations produced due to the alpha particles emitted by pulses in the photomultiplier, are fed to a counter/timer through a preamplifier, pulse shape amplifier and discriminator. The triple scalar counter measures the counts produced, where gross alpha, pairs and fast pairs are separately measured. Th and U contents of the sample are then estimated using annual dose conversion factors (Chougaonkar et al., 1999). The typical errors involved in the measurements are 5%. The ^{40}K content in the sample is estimated by Atomic Absorption Spectrometry (AAS) method. The wetness in the sample was assumed to be 5% while the cosmic ray dose was assumed to be 0.15mGy/year.

2.5. Luminescence Measurements

Measurement was made in automatic RISØ TL/OSL-DA-15 (Botter-Jensen, 1997) readers using internal Sr/Y-90 beta source. For OSL stimulation, the Blue Diodes Array (Max. 50 mW, 470nm) is used at 90% as the source of optical excitation. Detection filters was the combination of Schott UG-11 and BG-39 filters. Signal integration of first few channels (1-7 channel corresponding to 1 sec) serves the OSL intensity while that of last but few channels (220-250 channels/4.8 corresponding to 1 sec) as background. All the signals are used after background subtraction and

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 8
August 2017

Table 1:OSL age estimation of river-terraces by SAR protocol

Terrace No.	Thorium (ppm)	Uranium (ppm)	Potassium (%)	Dose rate (mGy/a)	Equivalent dose, ED (Gy)	Age (ka)
T1	10.54	2.74	0.94	2.08	114±8	55±5
T2	7.97	3.59	0.95	2.10	89±8	42±4
T3	7.92	3.71	1.03	2.17	39±6	18±3
T4	5.62	4.72	1.20	2.36	13±3	5±1

in conformity with SAR protocol.

The natural OSL is measured after a heating at 240°C until the unwanted signal is effectively zero and then the same grains are put through several cycles of irradiation and heated up to 240°C. This provides a regenerated OSL response, with which the natural OSL can be compared and forms the basis of SAR protocol.

Thus, Sets of 5 or discs of each of 10mg sample were used and regenerative cycles of suitable doses like 0, 1, 2, 4, 8 and 16Gy for each disc, interleaved with the response to test dose (about 10% of paleodose) were measured. Then, 0 and a certain regenerative-dose say 4Gy points were repeated to verify the sensitivity corrections based on test-dose normalization.

OSL data were reduced by extracting net signal from the 1st 0-1sec of stimulation after subtraction of integrated signal from the last 35-40 s of measurement. Natural and regenerated signals were normalized to the subsequent test-dose response and equivalent dose is estimated by interpolation of the natural luminescence on to regenerated curve.

3. Result and Discussion

Blue Photon Stimulated natural OSL decay curves recorded at 125°C of 10mg of quartz extracted for terraces T1 to T4 of the Imphal River at Gopibung, Senapati District, Manipur (INDIA) are shown in Figures 5.1-5.6. This shows the fact that older the age of the sample, higher the OSL signal (Figure 5.7). Further, this shows the potentialities of luminescence dating of river terraces. The palaeodose of the terraces are estimated using SAR protocol (Figures 5.8). The details of the annual dose received by these terraces are presented in Table 1.

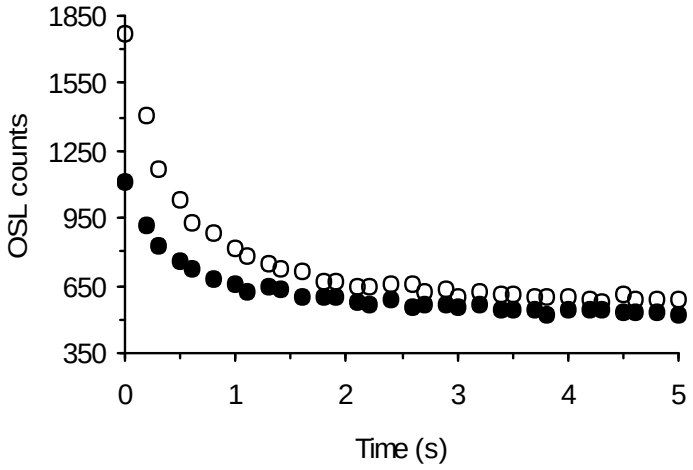

Figure 2: OSL decay curves of Quartz extracted from T1 (estimated age 55ka) and T4 (estimated age = 5 ka) of Imphal River at Gopibung.

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 8
August 2017

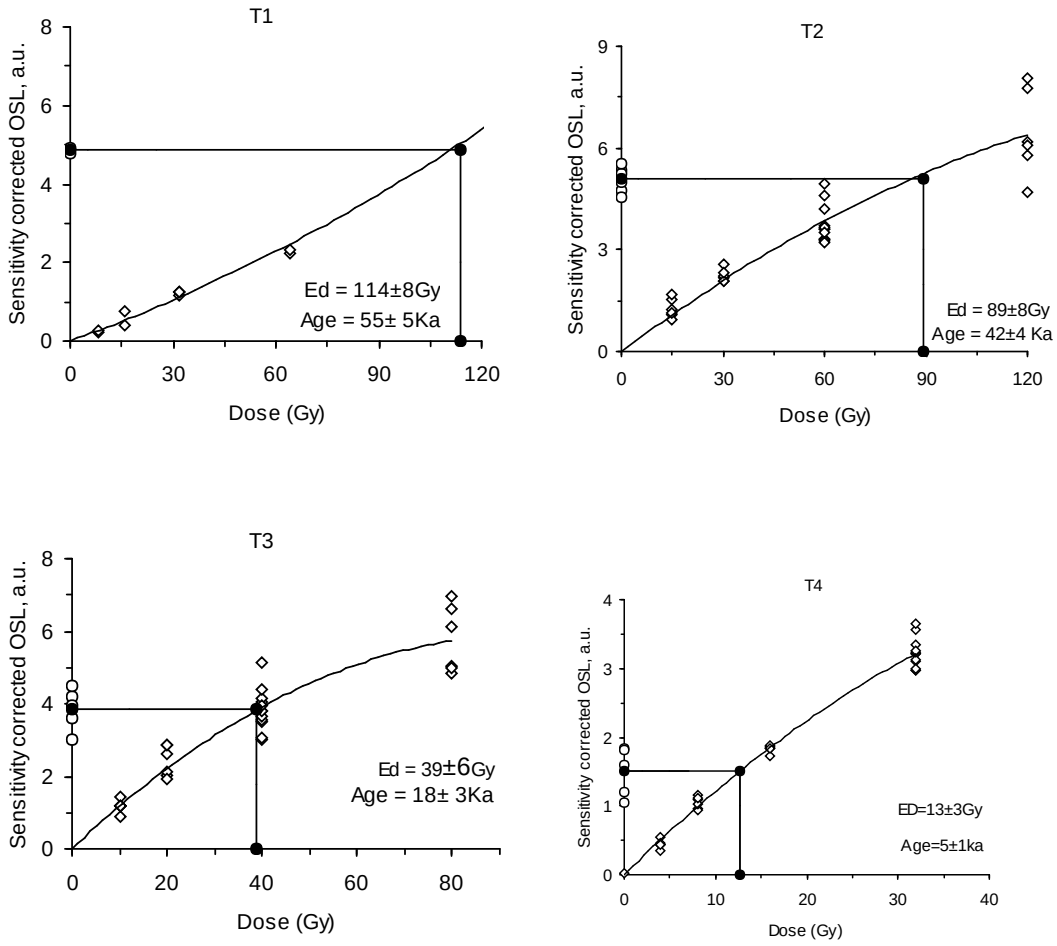

Figure 3(a) to (d): Ages estimation by using SAR protocol of samples collected from terrace of Imphal River at Gopibung

The OSL ages of the terraces are calculated using the age equation

$$Age(a) = \frac{Equivalent\ \ Dose\ \ (Gy)}{Dose\ \ rate\ \ (Gy\ \ per\ \ year)}$$

The ages are found to be (55 ± 5), (42 ± 4), (18 ± 3) and (5 ± 1) ka for the terraces T1, T2, T3 and T4 ranging the depth from 5 – 3 metres respectively. Table 1 shows the dose rates as well as evaluated ages of the terraces in a chronological order.

Since, Imphal River is intimately connected with the human settlement of the surrounding villages; the result will be helpful to study the early settlement of Manipur Valley. Physics has contributed to the estimation of the age of the river terraces of Imphal River, Manipur India which is in agreement with the dates cited in the Royal Chronicles of Manipur.

4. Acknowledgement:

The authors would like to thank Dr S Nabadweep Singh of the Oriental College, Imphal for providing facilities of his Dosimetry Lab and tremendous help extended by him towards making of this report.

5. References:

1. Adirovitch, E.I., (1956)(17)705, La formule de Becquerel et al Loielementaire du decline de la luminescence des phosphores crystalline, J.Phys. Rad.
2. Aitken, M.J., Zimmerman, D.W.Z. and Fleming, S.J. (1968)(219) 442, Thermoluminescence dating of ancient pottery, Nature.
3. Aitken M.J., (1984)(2) 2, Non-linear growth: allowance of alpha particle contribution, Ancient TL.
4. Aitken M.J., (1985), Thermoluminescence Dating. Academic Press Inc.(London)
5. Aitken, M.J., and Valladas, H., (1992)(337)139, Luminescence dating relevant to human origins Philosophical Transactions of the Royal Society of London Series B – Biological Science.
6. Aitken, M. J., (1998) 267, An Introduction to Optical Dating. Ed. Oxford University Press, Oxford.
7. Allen, J., (1989) (20) 149, When did humans first colonize Australia? Search.
8. Allen, J. and Holdaway, S. (1995) (69) 101, The contamination of Pleistocene radiocarbon determinations in Australia. Antiquity
9. Alexanderson, H., (2007)(26) 1, Residual OSL signal from modern Green – landic river sediments. Geochronometrea.
10. Ankovich, M.V., Sinitsyn, A.A., Hoffecker, J.F. Holliday, V.T., Popov, V.V., Lisitsyn, S.N., Forman, S.L., Levkovskaya, G.M., Pospelova, G.A., Kauz'mina, I.E. Burova, N.D., Goldberg, P., Macphail, R.I. Giaccio, B., and Praslov, N.D. (2007)(315) 223, Early upper Paleolithic in Eastern Europe and implications for the dispersal of modern humans. Science.
11. Anthony, I.M.C., Sanderson, D.C. W., Cook, G.T., Abernethy D. and Housley R.A., (2001)(20) 921, Dating a burnt mound from Kilmartin, Argyll, Scotland, Quaternary Sc. Rev.
12. Bailif I.K., (1985)(10)3226, Pre dose and inclusion dating: an attempted comparison using Iron Age pottery from North Britain, Nucl Tracks and Radiat Meas.,
13. Bailiff I K &Poolton N R J., (1991)(18)111, Studies of charge transfer mechanisms in feldspars, Nucl.Tracks. Meas.
14. Bailiff I K & Barnett S M., (1994)(23) 541, Characteristics of infrared-stimulated luminescence from feldspars at low temperatures, Radiat. Meas,
15. Bailey R M, Smith B W & Rhodes E J., (1997)(27) 123, Partial bleaching and the decay from characteristics of quartz OSL, Radiat. Meas.
16. Bailey, S.D., Wintle, A.G., Duller, G.A.T., and Bristow, C.S., (2001) (20), 701, Sand deposition during the last millennium at Abertfraw, Anglesey, North Wales as determined by OSL dating of quartz. Quarternary Science Reviews.
17. Bailey, R.M., (2001)(33)17, Towards a general kinetic model for optically and thermally stimulated luminescence of quartz. Radiat. Meas.
18. Bar-Yosef, O., (1998) 221, In: Early Human Behaviour in Global Context : The Rise and Diversity of the Lower Paleolithic Record (eds : Petraglia, M.D. and Korisettar R.), Routledge, London,.
19. Barnett, S.M., (2000a)(42) 431, Luminescence dating pottery from later prehistoric Braitain. Archaeometry.
20. Bateman, M.D., Singhvi, A.K. and Frederick, C.D., (2003)(22)1169, Investigations into the potential effects of pedoturbation on luminescence dating. Quaternary Science Rev.
21. Berger G.W., Pillans B.J. and Palmer A.S., (1992)(20) 403, Dating of loess upto 800 Ka by thermoluminescence, Geology.