Unusual Features of the Thermoluminescence Signal Profile for Sediments from beneath Lake George NSW

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The thermoluminescence signal as a function of depth has been measured on a core designated LG4 taken from the sediments beneath the northern end of the large, ephemeral fresh water lake, Lake George, New South Wales, which lies some 40 km to the north east of Canberra. The measurements were initially made using the inclusion method and the preliminary results reported by Mortlock and Price (1980). The TL signal at 375°C grew steadily with increasing depth and it was possible to make a provisional TL age determination at a depth of one metre (1.1×10^4 years) which compared well with a radiocarbon age of 0.9×10^4 years at the same depth. This age correspondence is important as it indicates that the TL signal is not spurious in its origin and that any surface residual signal must be negligible. These TL measurements were the first reported on sediments from within Australia. The annual radiation dose rates in all these cases were determined by XRF measurements of the contributing radioactive elements U, Th, K and Rb.

Since that time more measurements have been carried out on the same core, not only extending to greater depths but also looking at the depth variation of the TL signal in greater detail.

The results obtained using the inclusion method on 100 μm separated quartz grains are brought together in Figure 1. The error bars correspond to standard errors of the means of the several individual readings taken at each depth. The numbers of these individual observations which go to make up one plotted point varied, but the average was six.

Two unusual features in the profile are immediately evident. The first is the apparent break between 5.5 and 8.2 m with the TL signal at depths below 8.2 m seemingly being translated by a fixed amount to lower values than expected from an extrapolation of the earlier part of the profile. The second is an isolated high mean observation at a depth of 54 cm. These features cannot be explained by variations in annual radiation dose rate along the core. Such variations were relatively small, showing a standard deviation of 10% from the mean, and no correlation with the features themselves.

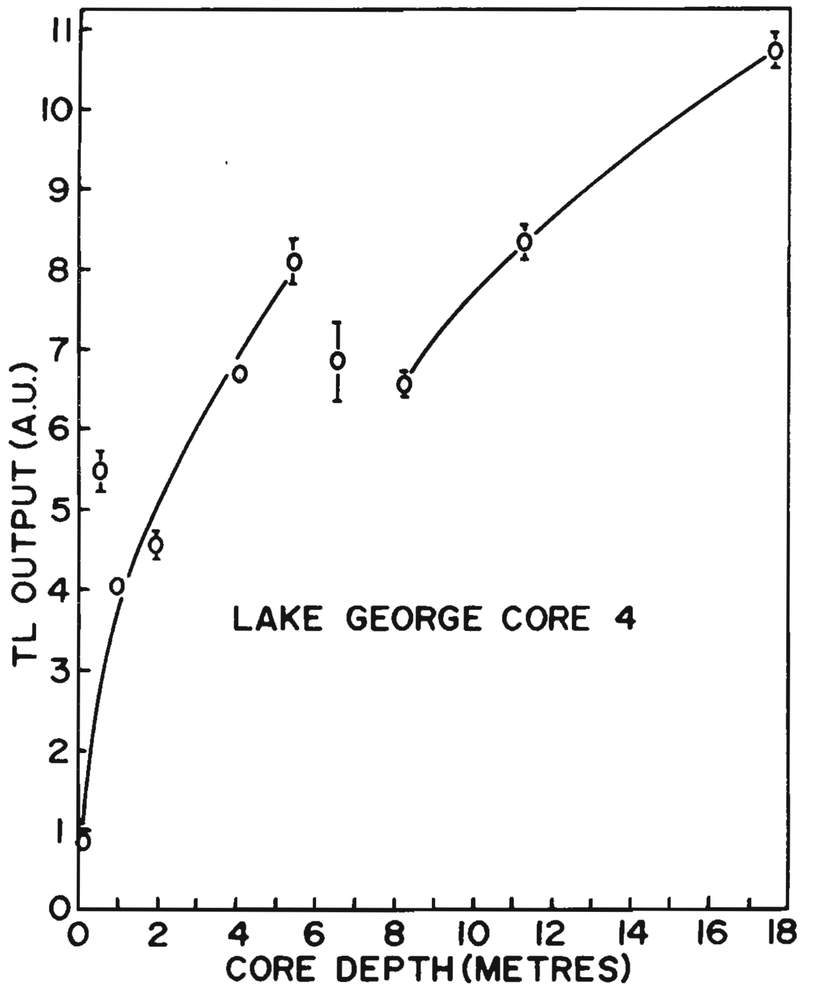

Figure I Variation of TL signal with depth beneath Lake George, N.S.W.

Before attempting to give other tentative explanations of these features some particular physical characteristics of Lake George must be set down. A full description of the Lake, its stratigraphy, palaeomagnetic chronology and vegetational history has been given by Singh, Opdyke and Bowler (1981) and the reader is referred to this for information too extensive to be repeated here.

Of importance is the fact that the Lake is not always full. It can in fact be totally dry and the water level is certainly subject to great variations over quite short periods of time. In essence it is a large relatively shallow ($\lesssim$ 5m) pan which gains water from a number of sources and loses it by evaporation and seepage to depths below the floor.

Sediment is contributed to the Lake from four sources:

(i) bedload and suspended sediment carried by the numerous creeks that empty into it.

(ii) weathered material from the steep western escarpment accumulates as debris fans near the bottom edge of the slope near the Lake edge. Particularly during phases of high water such material is washed directly into the Lake.

(iii) shore-line material is eroded directly by wave action and redistributed within the water body.

(iv) a small component of aeolian dust is contributed especially during times of drought.

The core studied is located in the lake bed approximately 1.2 km from the rising edge of the western escarpment. It can be expected to contain material from all four of the above sources in varying proportions.

It is possible to envisage in particular a substantial amount of sediment coming into the area of the core from source (ii) over a short period of time due, for example, to strong wave action at a time of storm. All this material would have the same near-zero TL stored energy at the time of deposition and would tend to produce a plateau-like feature in the TL vs. depth profile obtained today.

Another mechanism which would lead to a reduction in the stored TL energy in the sediment of the Lake relative to expectation otherwise would be an extended period of strong soil formation. This would be anticipated to be associated with dry periods. However, it is difficult to see how this could influence a depth increment as large as 3m.

The feature at 54 cm could be explained by the presence in the core of a single piece of debris carried from the escarpment out onto the floor of the Lake. This is known to happen when the Lake is dry. This piece of debris could retain some stored TL energy over and above what is fully dispersed sediment would display. Another more extreme explanation of this particular observation is mentioned elsewhere, Mortlock and Price (1984).

It has to be remarked here that the description of a visual inspection of the core along its length given by Singh et al. does not draw attention to any particular anomalies that might be of value in this discussion.

In conclusion it can be stated that the present study has demonstrated that the TL vs. depth profiles for lakes such as Lake George can exhibit irregular features which are unlikely to be found with deep ocean sediments. It may be possible to use these features to throw further light on the geological development of the Lake. Other similar fresh water lakes can also be expected to exhibit irregular TL vs. depth profiles.

The authors are indebted to Dr. J. Bowler, Dr. G. Singh and Professor K. Campbell of this University for useful discussions. Also to Ms. W. Cobcroft of Osaka, Japan, who established contact for us with Dr. Miono of Osaka University.

References

G. Castagnoli, G. Bonino and S. Miono (1983) Thermoluminescence in Sediments and Historical Supernovae Explosions. Il Nuovo Cimento (in press).

A. J. Mortlock and D. M. Price (1980) Thermoluminescence Dating of Sedimentary Layers in Lake and Ocean Environments. Australian Physicist, 17, 190.

A. J. Mortlock and D. M. Price (1984) Thermoluminescence Dating and Outer Space, Australian Physicist (submitted for publication).

G. Singh, N. D. and Opdyke and J. M. Bowler (1981) Late Cainozoic stratigraphy, paleomagnetic chronology and vegetational history from Lake George, N.S.W. Journal of the Geological Society of Australia, 28, 435-452.

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