Ancient TL

www.ancienttl.org · ISSN: 2693-0935

Issue 6(1) - December 1982: Legacy Issue
https://doi.org/10.26034/la.atl.vl6.i1

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Ancient TL

Editor: S. R. Sutton
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St. Louis, Mo. 63130

1982 Number 17

"A Clear and Green Stone, (a kind of Smaragdus) which being heated red hot, shineth in the Dark for a considerable time, sc about 1/16th of an Hour... I tried the experiment myself also. And at the same time observ'd That as it grew hot in the fire its Green colour was changed into a Sky-blew; which it likewise retained so long as it continu'd to shine: But after that, recover'd its native green again."

Nathaniel Grew in Museum Regalis (1681)

IN THIS ISSUE . . .

THIRD SPECIALIST SEMINAR ON TL AND ESR DATING

The title of the 1982 Seminar has been changed to the "Third Specialist Seminar on TL and ESR Dating" to indicate explicitly that contributions on ESR are welcome. The Seminar will be held 26-31 July, 1982, in Helsingør (Elsinore), Denmark. Abstracts are due by 15 April, 1982. For more information, see Ancient TL number 16 or contact Vagn Mejdahl, Risø National Laboratory, DK-4000, Roskilde, Denmark.

AN OPEN LETTER TO ANCIENT TL READERS

Dear Friends: After nearly eight months in prison, in custody, I have been released on the first court trial on the 15th January. The trial will continue in absentia. During these most difficult months I have really appreciated the letters of support I have received from you. I hope to see you all in future sometime in our conferences.

Best Wishes, Yeter Göksu Ögelman

A MICRO-COMPUTERISED TL SYSTEM

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Introduction.

An existing TL reader has been modified by rebuilding the detector system and incorporating a dedicated microcomputer to extend its capabilities for recovery and processing of TL signals. Specific objectives were to improve the dynamic range over which luminescence could be detected (particularly at high light levels) and to use a microcomputer to simplify measurement control and to give access to digital records of glow curves. The apparatus is also suitable for isothermal decay studies and trap depth experiments both of which are current areas of interest in our laboratory. Other areas of interest include establishing the feasibility of inclusion dating, particularly for Post Roman and medieval samples, in these laboratories and in investigating the TL properties of man made glasses with a view to assessing the dating and characterisation potential for this material.

The Apparatus.

Figure 1. shows a schematic diagram of the apparatus. A conventional glow oven based on the Oxford design is viewed by a linear focussed photomultiplier tube (EMI 9813B) used in photon counting mode. Pulses are fed through an emitter coupled logic (ECL) amplifier-discriminator (EMI C601) with a bandwidth of 100 MHz to a unit which translates from ECL to TTL logic levels and then to a multichannel scalar (Laben 511 ch. nim series). The MCS is controlled and read by an HP 85 microcomputer which also controls the heating cycle through a bi-directional BCD interface.

The HP 85 was chosen for this purpose because it provides a wide range of facilities in a compact and moderately priced unit. Overall dimensions are comparable with an electric typewriter and the facilities include a high resolution graphics CRT display (256 x 196 dots), integral thermal printer and fast tape cartridge data storage (200 kbytes per tape). There are four input/output ports for which a variety of 'intelligent' interfaces are available, and internal programmable timers operating on interrupts provide the basis for measurement control.

It was convenient for us to use an existing multichannel scalar as the signal integrator though this sets a limiting bandwidth of 12 MHz to the detection system. In practise this level is adequate for our present requirements though it could be enhanced by using an ECL counter-timer as the signal integrator.

Glow curves are recorded as a time series of integrated photon pulses over a linear heating cycle and can be corrected for thermal lag, multiphoton events and afterpulses from the tube and dead time effects once transferred to the computer. Dark counts and background signals from the glow oven are subtracted from the curves on the basis of a second glow giving equivalent signal recovery performance to that possible with digital lock-in techniques. Accurate background subtraction is of course essential for work at low light levels and can be achieved easily by this method.

The dwell time of the multichannel scalar can be software controlled depending on the heating rate used and the amount of detail required in the glow curve. We normally heat at 4.2°C s^{-1} and collect the glow curve from room temperature to 550°C in 127 channels. Transfer of this amount of data to the computer takes about 3 seconds, and about 200 such curves can be stored on one data cartridge.

Software.

The HP 85 has a 32K rom interpreter which provides system commands and extended BASIC language though Assembler is also available. Prime considerations in developing a suite of programs for the TL system were to preserve user control over the measurement and processing cycles and to maintain flexibility for incorporating new routines if required at a later date. For these reasons the programs have been structured around a series of subroutines which control various system operations and written in BASIC to be run through the interpreter.

Two main programs have been written so far one of which provides manual access to the subroutines using a series of programmable function keys on the computer console, the other of which steers the user through a cycle of six glows for routine dating work, and provides full graphical and tabular output for equivalent dose determination.

Subroutines written so far include measurement control, transfer of the curve to the computer, storage and retrieval on data cartridges, smoothing, background subtraction, scaling, plotting, integration and printout. Hard copies are available at every stage if required. Times taken for particular jobs depend on the parameters selected, but as an indication a cycle of entry of two curves, smoothing, background subtraction, plotting and integration takes about a minute.

Performance and Applications

The modifications to the detector have improved the dynamic range over which signals can be measured; the previous pulse pile up rate of about 200 kHz on our old system has been extended to beyond 3MHz and could probably be taken further with some more work. Similarly performance at low light levels has been improved by the use of digital signal recovery techniques. Examples of strong and weak TL signals which are well within system capabilities are shown in figure 2. One advantage of the digital system in this respect is that it is not necessary to select a scale for the glow curve before measurement as is the case in some analogue recording systems. Also advantageous is the complete freedom from noise once the signals have passed through the discriminator thus giving performance which depends mainly on the quality of the photomultiplier and the light level itself.

For routine work we have been able to make considerable savings in time spent both in the lab, and in data reduction. A six glow routine incorporating both pre-dose and high temperature readings for a single disc now takes just over half an hour including full processing and output of the curves and a plateau test. This makes a six disc run possible in half a day. The natural, artificial and plateau curves from a Roman tile from York (ED approx. 650 rads) are shown in fig. 3.

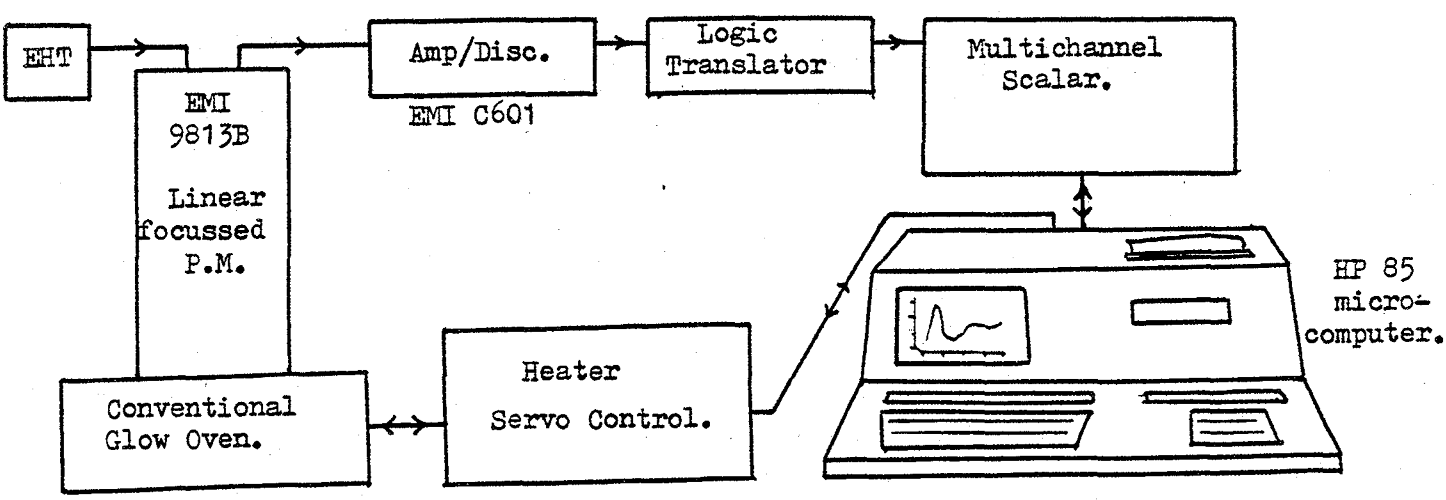
Work is in progress to implement a series of programs for kinetic studies related to TL and in statistical analysis of parameters extracted from long term records of raw data.

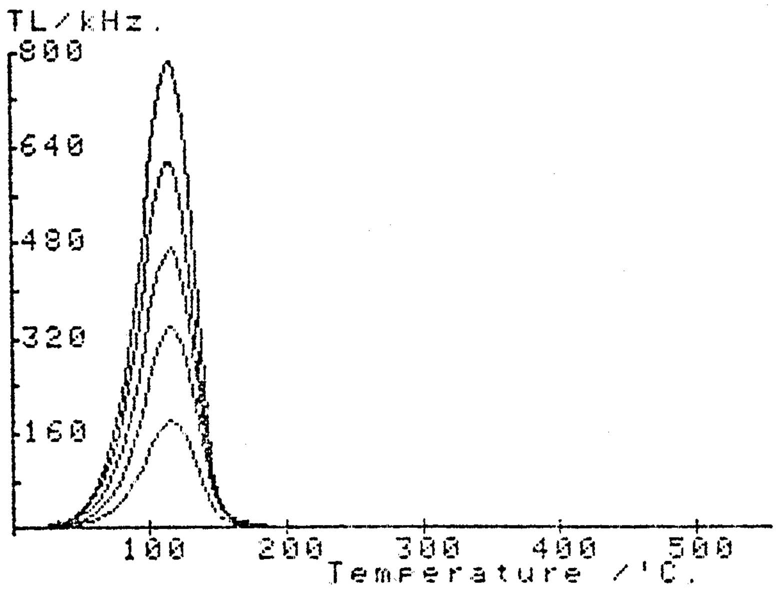
Concluding remarks.

The system described has greatly enhanced the TL facilities in Bradford and has been relatively easy to set up. The use of a completely digital measurement technique has benefits in terms of signal/noise ratio, is relatively immune to electrical problems related to d.c. stability and is well suited to interfacing to a computer for instrument control and data handling. The overall cost of such a system is roughly comparable with that of an analogue system and in our case could have been reduced if starting from scratch by using a fast counter timer instead of the multi-channel scalar, and by generating the temperature ramp in the computer.

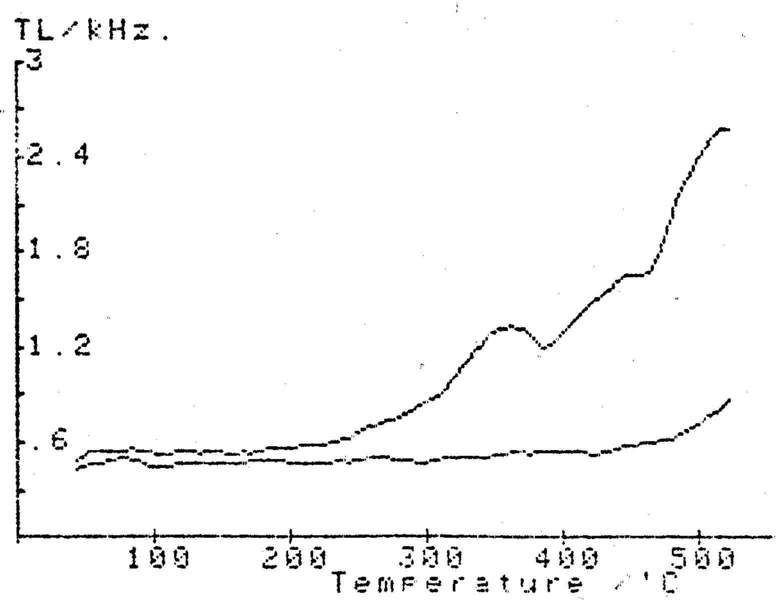
Further information on software and interfacing is available, and the School of Archaeological Sciences is considering the possibility of supplying complete systems along these lines should there be any interest.

Figure 1. Schematic diagram of the apparatus.





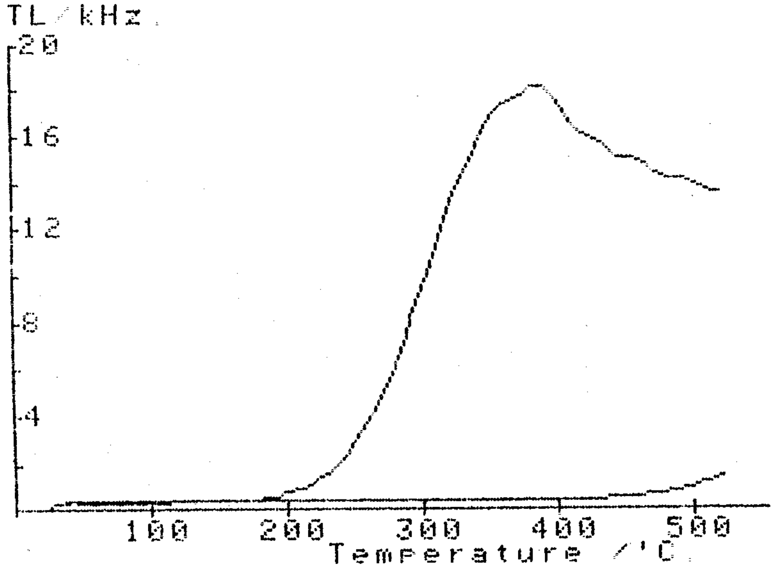
2a. Growth of the 110°C signal of a geological quartz sample with an activated pre-dose of 20 krad. Successive heatings to 200°C with incremented test doses of about 200 rad.



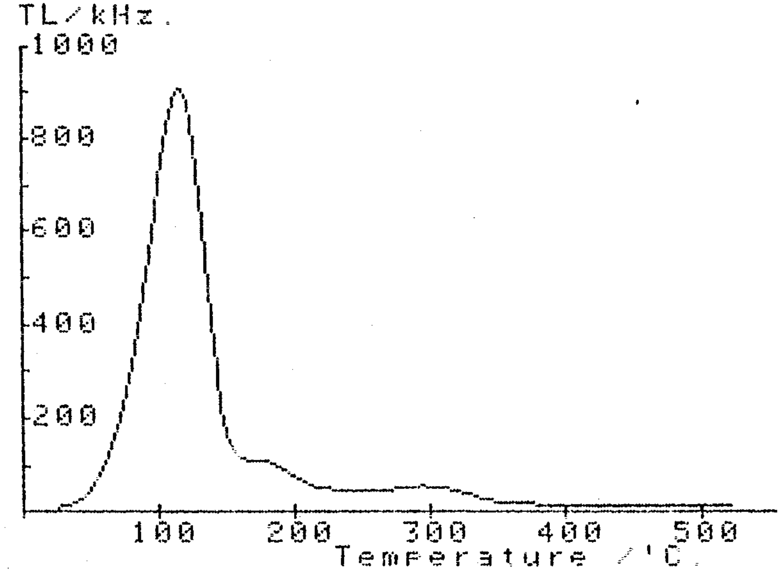
2b. The natural TL from a 3mg. inclusion sample extracted from a 16th. century Tile from Brill. The sample has mixed mineralogy.

Figure 2. <u>Examples of strong and weak TL signals.</u>

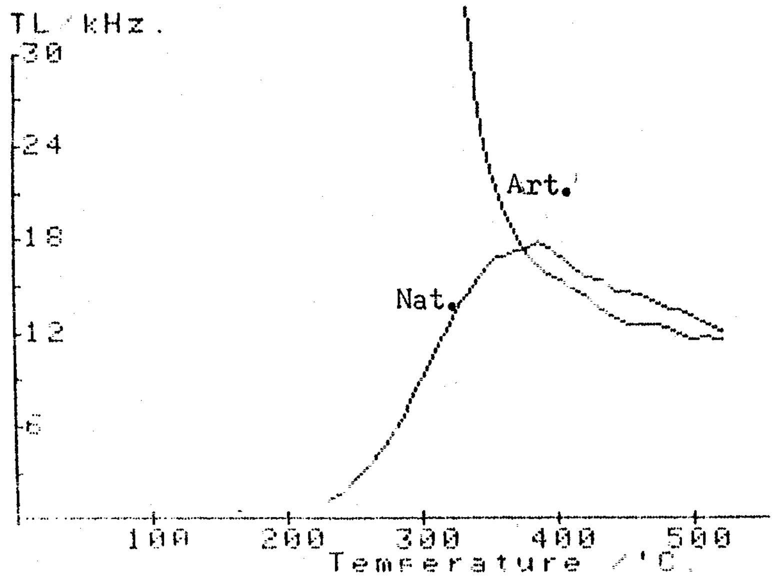
Figure 3. Some results from inclusions from a Roman Tile from York.



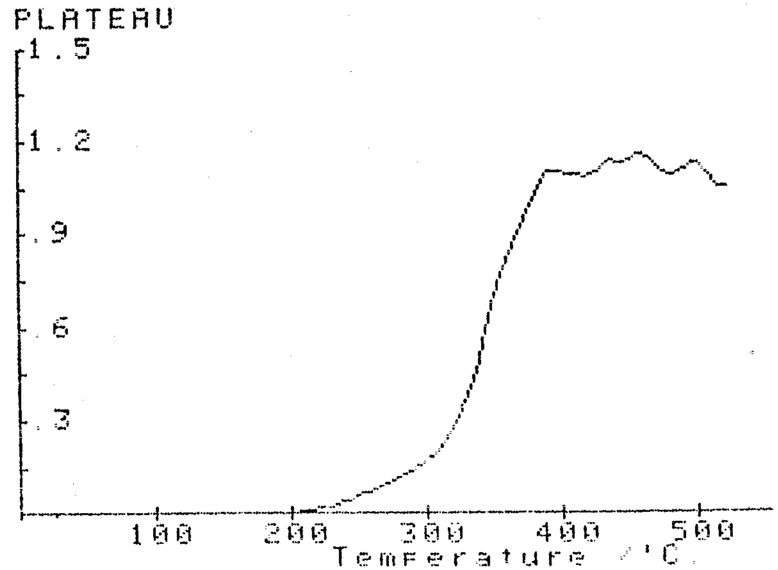
3a. Natural signal.



3b. Response to 570 rads.



3c. First and second glows matched.



3d. Output from the 'Plateau' routine; ratio of first to second glow curves after background subtrac ɔn.

TL DATING OF CALCRETE OVENSTONES

J. R. Prescott

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Although man-made ceramics probably still provide the bread-and-butter of TL dating, there has always been a small but sustained interest in non-ceramic materials. A review of this field has recently been put together by Wintle (1980). In Australia where prehistoric man never made pottery, dates must be based on hearths (Huxtable and Aitken, 1977; Bell, 1981) or oven stones (Prescott, et al. 1981), for which the zeroing mechanism is heat, or on the sediments in which artifacts are found, for which the zeroing mechanism is sunlight.

Over a large part of the valley of the River Murray, Australia's major river, prehistoric man used calcrete (kunkar) for oven stones in his fireplaces. This material can be picked up either as nodules or lumps in exposures throughout most of the valley. The purpose of the present note is to describe the treatment we have used successfully to date the material, since it may save others some time when faced with a similar problem.

The difficulty lies in the nature of the material, which is almost pure calcium carbonate. It is well-known that the presence of this material in TL samples frequently gives rise to spurious TL, although since calcite can be successfully dated (Wintle, 1978) it does not <u>necessarily</u> do so.

In the present case, the sort of procedures suggested for dating of calcite were all tried. No regimen of crushing and size sorting was successful in eliminating spurious TL. Treatment with weak acids such as EDTA and acetic acid and with Calgon, which are often successful with calcareous samples, did not work. Thin sections, polished or etched did not work either. In short, it was not possible to eliminate spurious TL from any preparation of the original material. Even digestion in cold dilute hydrochloric acid did not work.

The success treatment used digestion in hot 20% HCL for two hours. This treatment reduces the oven stone material to a sludge which, after thorough washing and further treatment with Calgon to remove calcium ions, can be used with standard procedures for either fine grain or coarse grain quartz dating. Two hundred grams of oven stone yields a gram or two of fine grain material and a hundred mg or so of quartz in all sizes up to about 250 microns. Actual dates have been obtained by both techniques and their significance is discussed elsewhere (e.g., Prescott, et al. 1981).

It should be added that if the ovenstone has not been heated to a sufficiently high temperature (as established for instance by measurements of thermo-remanent magnetism) the fine grain material may not be datable even after the rather extreme measures outlined above. This is because some mechanism, which is not yet clearly understood, transfers energy back into at least some of the traps that were emptied during first glow-out so that, on reheating, light is seen at low temperatures, to give a form of spurious TL different from that described earlier. The physics of this phenomenon is currently under study and will be reported elsewhere.

It is a pleasure to acknowledge the hospitality of the Research Laboratory for Archaeology and the History of Art, Oxford, where much of the developmental work was done during study leave.

REFERENCES

Bell, W. T. (1981) Thermoluminescent dates for the Lake Mungo aboriginal fireplaces and the consequences for radiocarbon dating, Antiquity (in press).

Huxtable, J. and Aitken, M. J. (1977) Thermoluminescent dating of Lake Mungo geomagnetic polarity excursion. Nature 265, pp. 40-41.

Prescott, J. R., Polach, H. A., Pretty, G. and Smith, B. W. (1981) Comparison of C-14 and thermoluminescent dates from Roonka, South Australia. Groningen C-14 Conference, PACT Journal (in press).

Wintle, A. G. (1978) A Thermoluminescence study of some Quaternary calcite: potential and problems. Can. J. Earth Sci. 15, pp. 1977-1986.

Wintle, A. G. (1980) Thermoluminescence dating: A review of recent applications to non-pottery materials. Archaeometry 22, pp. 113-122.

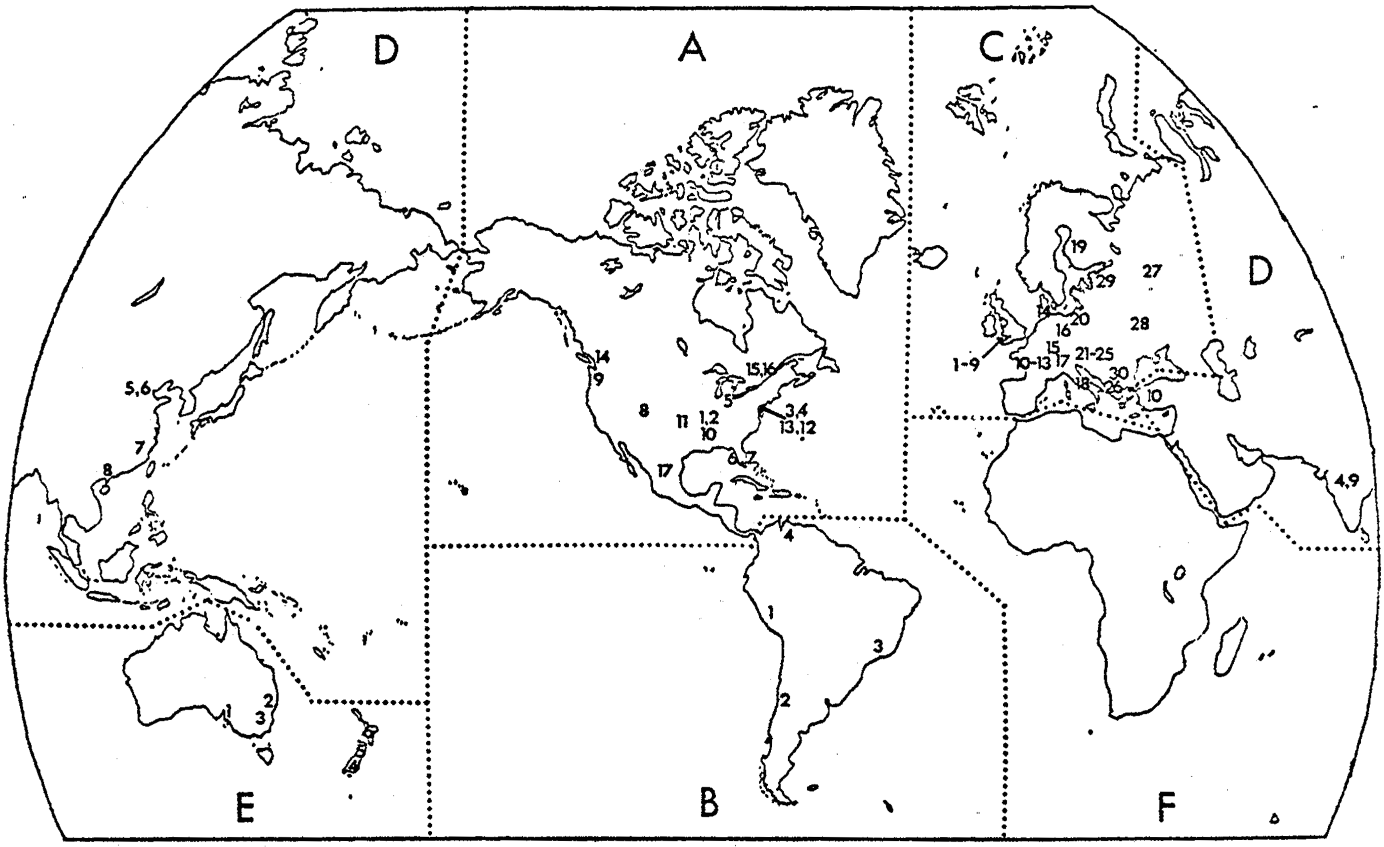
CORRECTIONS AND ADDITIONS TO THE TL LABORATORY LISTING

Since the printing of the TL laboratory listing and map in issue number 16, several errors have been pointed out by readers and some additional information has come to light. It has been drawn to the attention of the editor that the boundary between Europe and Asia on the map was in error. Although the map was subdivided merely to make it easier for readers to go from the listing to the appropriate map location, it is desirable to follow the continental boundaries as closely as possible. The main consequence of the incorrect boundary was to place several European laboratories in Asia. The following corrections to the laboratory listing should be noted:

1. Laboratories D1 (M. V. Lomonsov State University, Moscow), D2 (Institute of Geological Sciences, Kiev) and D3 (Institute of Geology, Tallinn) should be redesignated C27, C28 and C29, respectively.
2. Add C30 Physics Laboratory II, University of Patras, Patras, Greece (Dr. Y. Liritzis) Archaeological dating and geological applications; also U-series dating.
3. Address correction:
   C13 Centre de Recherche Interdisciplinaire d'archeologie analytique, CRIAA (associe au CNRS 584), Maison des Sciences de l'Homme, Domaine Universitaire 33405 Talence FRANCE (Prof. Max Schvoerer) Archaeological dating, geological applications (coral, basalt, nodules, obsidian), Radiation dosimetry, Physics studies.
4. Typographical corrections: C10 ESR; C27 Lomonsov; C28 Shelkoplyas; D5 Pei Jing-Xian; E3 A. J. Mortlock.

Shown in this issue is a reduced version of the revised map but the entire corrected listing is not included. The intention is to continually update the listing and to offer copies free of charge upon request. Those desiring the revised listing should send their requests to the editor at the letterhead address. With this in mind, the laboratories in the listing are encouraged to send brief descriptions of their interests to make the listing more complete. Laboratories which are not included at the present time may be added at any time.

THERMOLUMINESCENCE RESEARCH CENTERS



SOME RECENT BIBLIOGRAPHY

"Thermoluminescence dating of pottery from Springaverapura - Ramayana site", D. P. Agrawal, N. Bhandari, B. B. Lal and A. K. Singhvi, 1981, Proceedings of the Indian Academy of Science (Earth Planet. Sci.), 90, 161-172.

"Relative age studies of lava flow samples from Deccan traps", V. N. Bapat, C. M. Sunta and A. V. Sankaran, 1980, Bulletin of Radiation Protection, 3, 51-55.

"Thermoluminescent dating of burned flint tools", Y. Göksu, 1981, Staringia, 6, 98-102.

"Pontnewydd Cave in Wales - a new Middle Pleistocene hominid site", H. S. Green, C. B. Stringer, S. N. Collcutt, A. P. Currant, J. Huxtable, H. P. Schwarcz, N. Debenham, C. Embleton, P. Bull, T. I. Molleson and R. E. Bevins, 1981, Nature, 294, 707-713.

"Low-Level Thorium and Uranium Determination for Thermoluminescent Dating: Better Dates for Archaeologists", J. R. Prescott and H. E. Jensen, Atomic Energy in Australia, 23, No. 4, Oct. 1980, 26-32.

"Thermoluminescence reveals weathering stages in basaltic rocks," Y. Göksu-Ögelman, 1981, Nature 296 pp. 231-232.

"TLD photon counting analyser:, D. W. Hanna and G. G. Simons, 1981, Nuclear Instruments and methods, 186, 569-578.

"Thermoluminescence dating of Quaternary sediments", M. Lamothe, A. Dreimanis, M. Morency and A. Raukas, 1981, presented at the 1981 Symposium on Quaternary dating methods held in 1981 and to be published in June 1982, ed. W. C. Mahaney.

"Thermoluminescence dating of sedimentary layers in lake and ocean environments", A. J. Mortlock and D. M. Price, 1980, The Australian Physicist.

"Terrestrial ages of meteorites", D. W. G. Sears, 1981, Nature, 293, 433.

Several papers dealing with TL and ESR dating, as well as other dating techniques were presented at a meeting at Tautavel in 1981. There were papers by Aitken, Debenham et al, Ohta, Valladas et al and by Walton and Debenham. They will be published in a volume entitled "Datations Absoluteset Analyses Isotopiques en Préhistoire. Méthodes et Limites" (eds. H. de Lumley and J. Labeyrie).

"Thermoluminescence Dating in Architectural History: Venetian Villas", 1981, C. Goedicke, K. Slusallek and M. Kubelik, Journal of the Society of Architectural Historians, Vol. XL, Number 3, p.203-217.

"The theoretical and microdosimetric basis of thermoluminescence and applications to dosimetry", Y. S. Horowitz, 1981, Physics in Medicine and Biology, 26, 763-824.

"Trapping parameters from isothermal decay of TL", S. V. Moharil, 1981, J. Phys. D, 14, 1677-1682.

"Mixed first and second order kinetics in thermally stimulated processes", R. Chen, N. Kristianpoller, Z. Davidson, and R. Visocekas, 1981, Journal of Luminescence, 23, 293-303.

"A new instrument for thermoluminescence research", D. B. Nuzzio, 1982, Thermochimica Acta, 52, 245-254.

"Thermoluminescence dating of sand dunes in Rajasthan, India", A. K. Singhvi, Y. P. Sharma, and D. P. Agrawal, 1982, Nature, 295, 313-315.

The first Australian Archaeometry Conference was held at the Australian Museum, Sydney, February 15-18, 1982. Two papers which were presented are:

"Advances in Thermoluminescence Dating and their Significance for Australia and Oceanic: Review," J. R. Prescott.

"Thermoluminescent Dating of Marine Sediments from Spencer Gulf," B. W. Smith, J. R. Prescott and H. Polach.

For more information, contact Hans Jensen, University of Adelaide, Australia.

"Datation-caractérisation des céramiques anciennes" - Compte- rendu de la IIème Ecole Européenne de Physique appliquée à l'Archéologie, Université de Bordeaux 6-18 avril 1981, M. Schvoerer, J. Marcadé, Archéologia, août 1981.

"La datation par thermoluminescence", M. Schvoerer, F. Bechtel, B. Gallois, L. Langouet, Dossiers de l'Archéologie, 39, novembre-décembre 1979, 68-77.