A technique for the generation of three dimensional isometric glow curves from conventional glow curve records.

I.K. Kaul, S. SenGupta, and Tuhina Sanyal
Department of Geology and Geophysics, Indian Institute of Technology, Kharagpur 721302, India.

A technique of generating three dimensional glow curves from conventional glow curve records by computer graphics is described. The software also allows these glow curves to be viewed from any direction. A typical 3-D glow curve for blue-coloured fluorite from Amba Dunger, India as viewed from different directions is presented. It has been possible to obtain such 3-D glow curves for various minerals by this technique. The present approach should be useful to the investigators who may not be in a position to equip their laboratories with multiplexing systems.

Levy and his co-workers (Levy et al, 1971) were the first to develop an apparatus for the simultaneous determination of TL intensity and spectral distribution. Their work on TL analysis of minerals demonstrated the utility and elegance of 3-D glow curves, in which the TL intensity is displayed as a function of both temperature and emission wavelength (or photon energy) in isometric 3-D projection. Jenson and Prescott (1982) enumerated the advantages of such plots. Various TL spectrometers, which resolve the TL intensity as a function of wavelength and temperature, have since been described by different workers (Bailiff et al, 1977; McKeever et al, 1983; Jensen and Prescott, 1982; Walton, 1982; Riaz and Prescott, 1985). Although those instruments with multiplexing capability have the advantage of simultaneous recording of all wavelengths, this is frequently at the cost of either resolution or sensitivity. Bailiff et al (1977) improved the optical transmission of their scanning instrument by the use of an extended source (ie by using slit-less optics). They recorded the spectrum by rapid scanning of the TL emission with a series of narrow band filters by repeated insertion of these filters in the optical path. Set against the signal losses incurred by scanning and the finite spacing between the filters is the increase in optical throughput which may be gained using this technique. The method described in this paper is based on a similar principle, using optical filters passing between the photomultiplier (pm) tube and the TL sample. The use of two similar pm tubes (S20 response) permits one to be employed as a reference to eliminate blackbody radiation (Kaul et al, 1977).

Procedures

The sample under study was divided into 24 aliquots of 25 mg each. Each sample was irradiated with ^{60}Co γ rays to a total dose of 5.10^4 Gy, and the TL glow curve recorded immediately with a particular filter. In this way 24 "monochromatic" glow curves (digitised at 3°C intervals) were recorded for the sample under study, using 24 different interference filters (Oriel Corp, USA; with maximum transmission wavelengths between 254 and 659 nm).

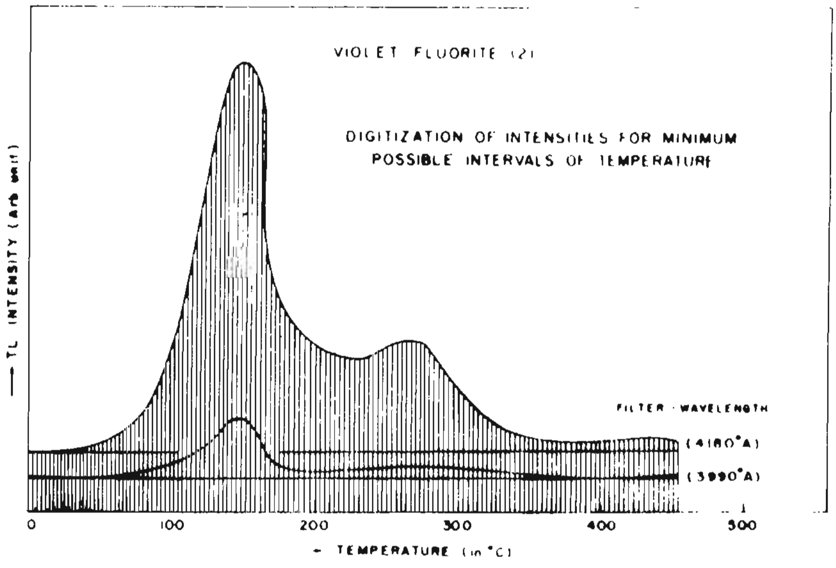

Figure 1. Digitization technique for normal TL glow curves.

This procedure is illustrated for two glow curves of violet-coloured fluorite in fig. 1. The digitized data (temp. vs TL intensity) for each sample measurement were stored in separate datafiles in a Hewlett Packard 9000 computer, and a program was developed to permit graphical display of these datafiles, the structure of which is given below. The intensities for the intermediate wavelengths were interpolated using spline-fitting techniques (Folley and Van Dam, 1984).
A portion size of 25 mg was found to give good reproducibility of the TL glow curves. The spectrometer is capable of detecting much lower "source strengths" (defined as sample weight x dose), and for the fluorite discussed here, 3-D glow curves were detected using a source strength of 10mg x 1Gy. It is to be noted that no differences between the spectra obtained for these two levels of "source strength" were detected. However, samples with lower "source strengths" showed distortions, due to a combination of poor signal-to-noise ratio and poor reproducibility of the TL glow curves.
Although the lack of multiplexing of this method presents some limitations, it may not be a significant disadvantage for those who have sufficient sample available, the time and the patience, and the necessary computing and plotting facilities. In reward, one may obtain a variety of isometric views of the 3-D TL glow curve, as demonstrated in fig. 2.

References

Bailiff, I.K., Morris, D.A., and Aitken, M.J. (1977) A rapid scanning interference spectrometer: application to low-level TL emission. *J. Phys.E: Sci.Instrum.*,**10**, 1156-1160.

Folley, J.D., and Van Dam, A. (1984) Fundamentals of interactive computer graphics. Addison Wesley Publishing Co., New York. pp503-536.

Jensen, H.E., and Prescott, J.R. (1982) A Fourier transform spectrometer for the measurement of thermoluminescence emission spectra. *PACT J.*, **6**, 542-549.

Kaul, I.K., Bhattacharya, A.K., Ganguli, D.K., and Hess, B.F.H. (1977) High sensitivity apparatus for low-level TL detection. *Mod. Geology*, **6**, 87-91.

Levy, P.W., Mattern, P.L., and Langweiler, K. (1971) Apparatus for the simultaneous determination of thermoluminescent intensity and spectral distribution. *Mod. Geology*, **2**, 293-294.

McKeever, S.W.S., Ahmed, K., Chandler, P.J., Strain, J.A., Rendell, H.M., and Townsend, P.D. (1983) Analysis of emission spectra of meteorites during thermoluminescence measurements. *PACT J.*, **9**, 187-204.

Riaz, A.A., and Prescott, R. (1985) Thermoluminescence in some feldspars: early results from studies of spectra. *Nucl. Tracks and Rad'n Measts.*, **10**, 575-580.

Walton, A.J. (1982) An image intensifier spectrograph for thermoluminescence studies. *PACT J.*, **6**, 524-532.

PR Accepted after revisions; reviewed by W.F. Hornyak.

Structure of isometric plotting program

Stage	Input
1	Number of rows and cols. in the input data matrix. Line spacing for plotting Input data file name Display options
2	Initialise plotting routines
3	Read data from file and rotate it to zero degree pos'n.
4	Transform the data by adding data points to grid. Scaling of data for display
5	Rotate the axes labels in accordance to the data rot'n
6	Plot the data by drawing lines parallel to y-axis first then to x-axis, while drawing mute the lines which are not visible.
7	Plot labels.
8	Read data from files and rotate data by 90° Rpt 4-7
9	As 8; rotate by 180°
10	As 8; rotate by 270°
11	Select view (0, 90, 180, 270°)
12	Plot (Y/N option)
13	Select plotter param's for hard copy plot
14	Plot all four views (Y/N option) Rpt 3-8
15	Stop

The computer program developed on the above lines can be obtained from the authors on request. An isometric 3-D glow curve for the blue-coloured fluorite from Amba Dunger, Gujarat, India, obtained using this program is shown in fig. 2.

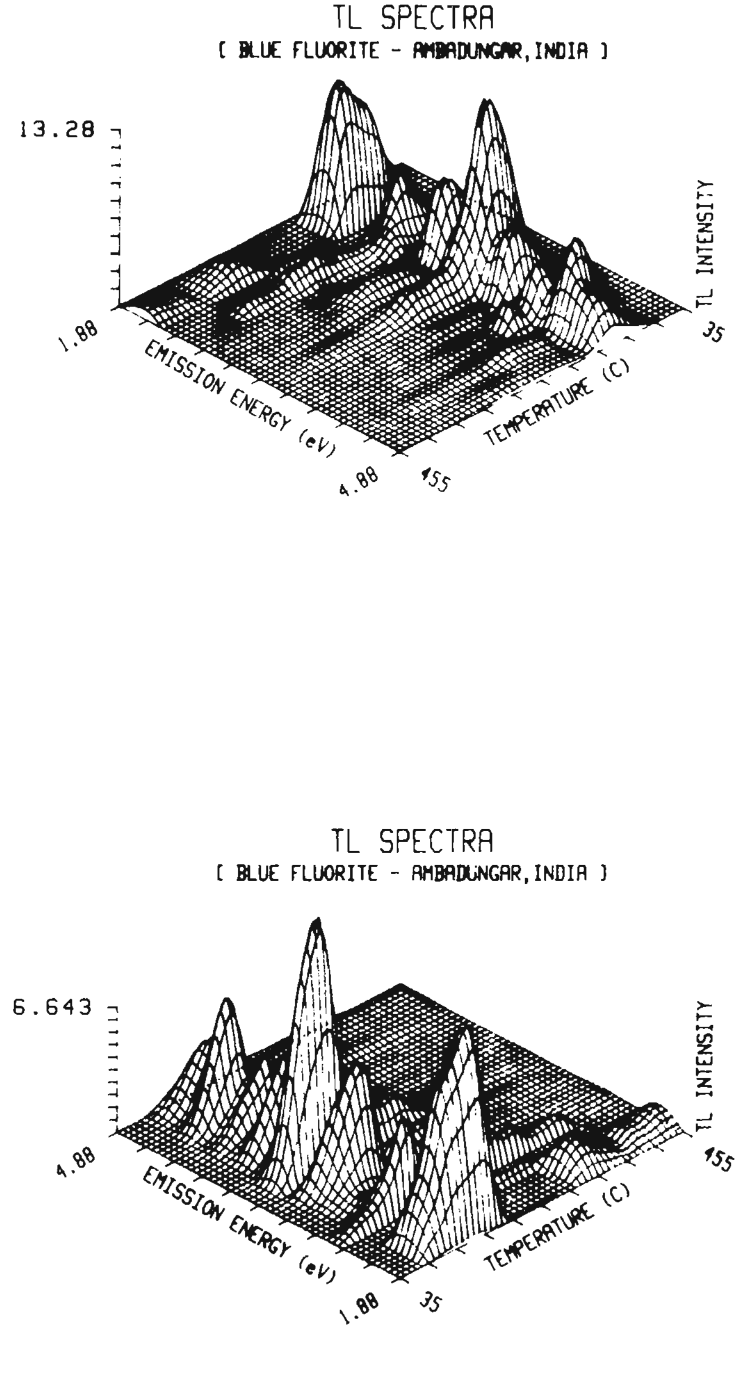

Figure 2. Isometric 3-D glow curves of blue-coloured fluorite from Amba Dungar, Gujarat, India, as viewed from different directions.