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ATTEMPTS TO CIRCUMVENT ANOMALOUS FADING

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Anomalous fading (the instability of the stored TL at high glow-curve temperature) prevents the reliable dating of most minerals other than quartz. We have attempted to circumvent anomalous fading using three different approaches; spectral resolution, thermal annealing, and slow glow-curve heating rate. These experiments were based on the hypothesis that the stored high-temperature TL immediately after irradiation consists of two parts; an "unstable" part which will anomalously fade, and a "stable" part which is the same part as in the natural TL. Unfortunately, all three approaches were unsuccessful.

In the first experiment the emission spectra of various minerals exhibiting anomalous fading were measured immediately after beta irradiation and, using a second aliquot, one day later. If the "stable" and "unstable" TL were emitted at different wavelengths, anomalous fading could be avoided, or at least reduced, by doing the TL measurements using a filter that would transmit only the wavelengths that faded the least. The measurements were made with an optical multichannel analyzer (OMA) attached to the TL oven instead of the regular photomultiplier tube. The OMA consists of a polychromator and a 500 element vidicon tube with an image intensifier. The polychromator disperses the incident light across the face of the vidicon tube so that each element receives a different range of wavelengths between 400 and 600 nm. The signal into each element is integrated over a present length of time (> 30 msec), then read out and stored in a computer memory. In this experiment, four materials were measured (zircon, apatite, orthoclase, and pumice), the TL spectra being integrated between 300 and 450^{o}C in the glow curve. The anomalous fading was easily measurable in all four materials, being from 35 to 50% in one day, but was found to occur to the same degree at all wavelengths in all four materials. Fig. 1 shows the results for the feldspar sample.

In the second experiment, we tried to accelerate the fading of the "unstable" TL in the pumice by holding samples at elevated temperatures after irradiation in hopes of having rapid fading to a stable level. Fig. 2 shows the isothermal decay curves. Although the fading rate is increased at high storage temperatures, at 120^{o} a stable level has still not been reached after 80 days. At 160^{o}C it looks as if a stable level might be reached after about 30 days. Unfortunately, the natural TL at 450^{o}C in the glow curve decreased by 20% after one week at 160^{o}C. Thus, this type of thermal treatment seems to be unable to separate "unstable" and "stable" components.

The third experiment determined the fading using a much slower heating rate on the TL oven (0.18^{o}C/sec instead of our usual 7^{o}C/sec). The motivation for this approach was two-fold: 1) a reference (Shulman, 1967) to unpublished data by Ginther that "slow-glows" eliminated anomalous fading in the dosimetry phosphor CaF_2:Mn (in recent conversation, Ginther could not confirm this observation); and 2) the "slow-glow" will better separate individual glow peaks, and in this respect make the annealing characteristics simpler. We found that the "slow-glow" nicely separates the peaks for LiF (Fig. 3), but produces essentially no separation for CaF_2:Mn (Fig.4), apatite, zircon, albite, orthoclase, and pumice. We compared the fading of the pumice and apatite high-temperature TL using the normal and slow heating rates and the results are shown in Table 1. The "slow-glows" produced no substantial reduction in the fading of these samples.

The failure of all three experiments contradicts the hypothesis that the stored high temperature TL consists of separate "stable" and "unstable" components.

REFERENCE

Schulman, J. H., 1967, Survey of Luminescence Dosimetry, in Luminescence Dosimetry, ed. F. H. Attix, CONF - 650637, NBS, Springfield, Va., 28.

FIG. 1

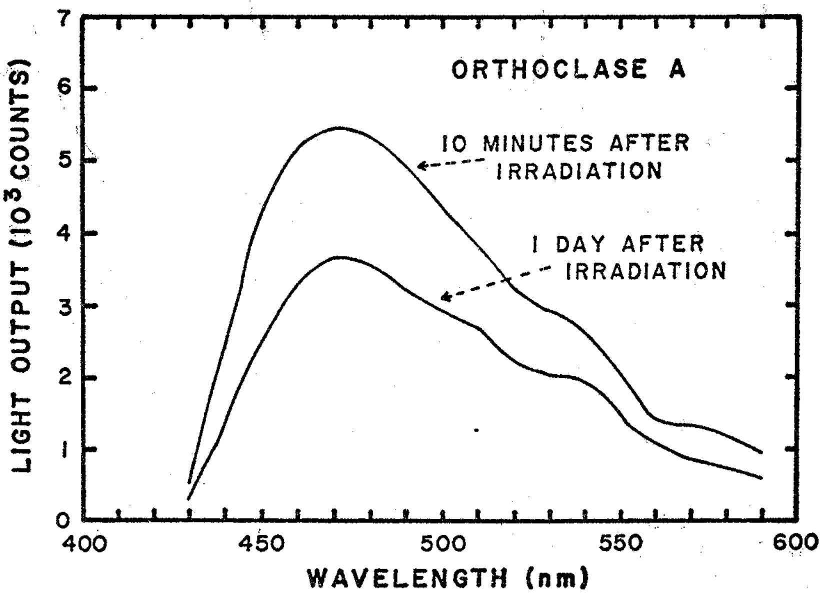

FIG. 2

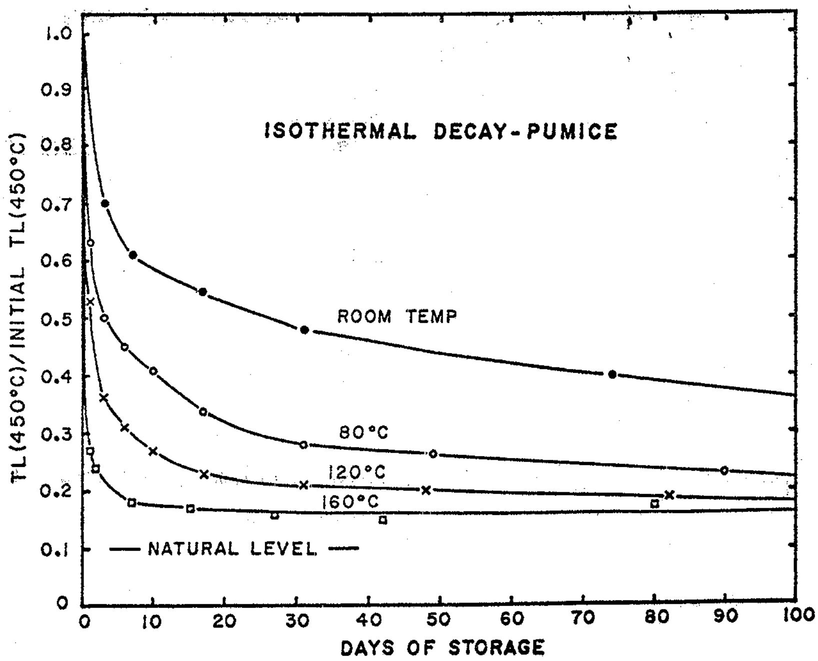

FIG. 3

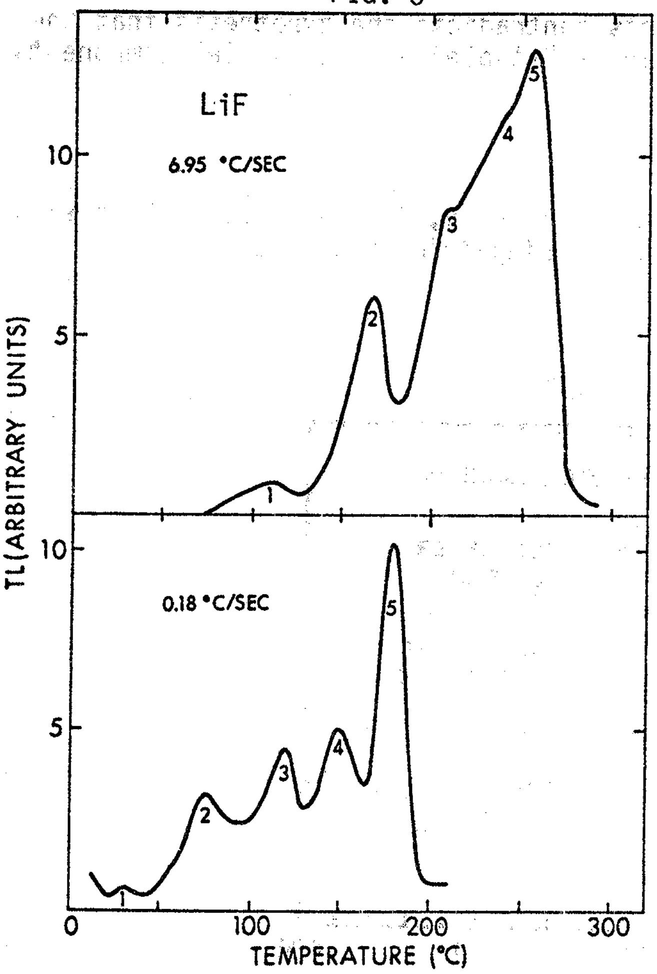

FIG. 4

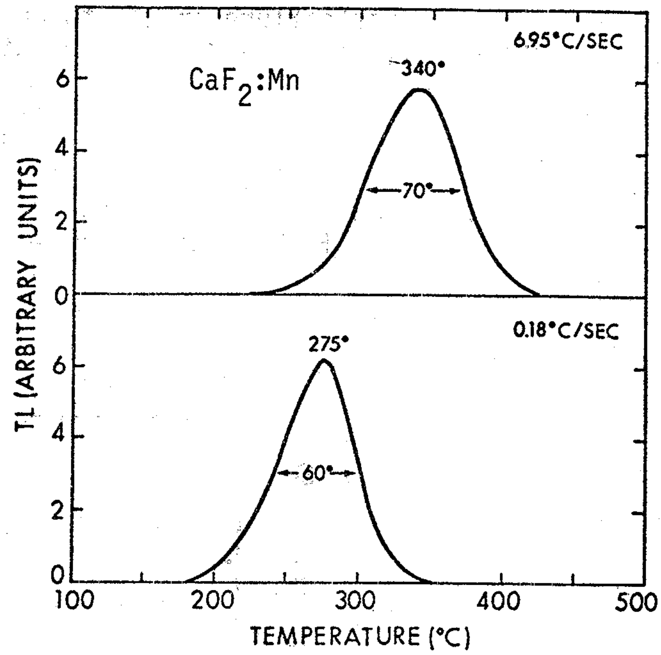

TABLE 1

EFFECT OF GLOW CURVE HEATING RATE ON ANOMALOUS FADING

Sample	Glow Curve Heating Rate (°C/sec)	TL Lost After 1 Day At Room Temperature* (%)
Apatite	7.35	41
	0.18	36
Pumice	7.35	24
	0.18	22

*Expressed as percent of the TL measured 30 minutes after irradiation.