DETERMINATION OF THE TRAP KINETIC PARAMETERS OF PEGMATITE USING DIFFERENT METHODS

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ABSTRTACT

Thermoluninscence (TL) measurements for the determination of the kinetic order and the trap parameters for pegmatite samples have been achieved. Different theoretical analysis were discussed. The average activation energy and frequency factors were found to be 0.751 eV and $7166x10^4 sec^{-1}$ which is small and insure that the used samples are not suitable for practical dosimetry.

INTRODUCTION

The first method for estimating activation energy from TL golw curves was proposed by (Urbach, 1930). The most convenient method for glow peak isolation is that proposed by (Hoogenstraaten, (1958), which consists of erasing all peaks preceding the one to be studied using suitable thermal treatments, so that each peak can be individually analysed and the values of the trap depth (E) and the frquency factors (s) determined. Booth, 1954

and Bohun, 1954 working independently have used different heating rates to evaluate E basing their experiments on the variation of the temperature at the maximum of the glow peak (T_m) with the heating rate.

The purpose of this work was to study the basic features of the natural glow cuves for pegmatite at different heating rates to evaluate its kinetic parameters for dosimetric and dating preposes.

EXPERIMENTAL TECHNIQUE

The samples under present consideration were extracted from pegmatite pre-Cambrian basement complex rock from Rod El-Liqah area (Eastern Desert of Egypt). The samples were prepared for TL studies in slices form (El-Fiki, 1993), washing in dilute hydrochloric acid and then in hydrogen peroxide (Aitken 1974). The optimum thickness for best glow curves was fround to be 1.275 mm. A reading system of type Harshaw 3000 was used where the TL yield was recorded in nanocoulombs.

THEORETICAL ASPECTS

The essential features of the thermolinescence phenomena are as follows. When a TL material is exposed to radiation many of free electron or holes become trapped at lattice of the solid. If the temperature is raised the probability of escape is increased and the electrons or hloles are released from the traps. subsequently retur-

ing to stable energy states with the emission of light. This is ther-
moluminescence. Part of the energy absorbed by insulating materi-
als is emitted durning the heating as light in the form of a glow
curve which may present several peaks. The positions, shapes and
intensities of the glow peaks are erlated to the various parameters
of the trapping states responsible for the TL. The most important
parameters to be determined are the trap depth (E), which is the
thermal energy required to liberate the trapped electrons or holes
and the frquency factor (s). There are various methods used for de-
termining trap parameters. The most important of which are as fol-
lows:

1-The Urbach method

It is the first method for estimating activation energy from the
glow curves. Using the emperical equation $E=T_m/500$ where T_m is
in °k.

2- The Booth Bohum method

This method based on different heating rates using the follow-
ing Randall-Wilkins equation:

$$I = n_o \, s \exp (-E / KT) \exp \left\{ - \left(\frac{s}{\beta} \right) \int_{T_o}^{T} \exp (-E/KT') dT' \right\} \quad (1)$$

Where I is the TL intensity, S is the frequency factor, n_o is the
initial concentraion of trapped electrons prior to heating, β is the
heating rate and T_o is the initial temperature. The position of the

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maximum can be obtained by dervative of this equation with repect to the temperature and equating it to zero, which yields

$$\frac{\beta E}{KT_m^2} = S \exp(-E/T_m) \qquad (2)$$

Solving this equation for two different heating rates, e.g., β_1 and β_2 gave

$$E = \frac{KT_{m1} \cdot KT_{m2}}{T_{m1} - T_{m2}} \ln \frac{\beta_1}{\beta_2} (T_{m2}/T_{m1})^2 \} \qquad (3)$$

The value of S can be calculated by substitution E in equation (2), then

$$S = E/K \exp\{ (T_{m2} \ln \frac{T_{m_2}^2}{\beta_2} - T_{m1} \ln \frac{T_{m_1}^2}{\beta_1} \} / (T_{m1} - T_{m2}) \} \qquad (4)$$

3- The Hoogenstraaten method

This method uses equation (2) and several heating rates to obtain a linear relation between $\ln(T_m/\beta)$ and $1/T_m$ as follows:

$$\ln(T_m^2/\beta) = E/K (1/T_m^2) + \ln(SK/E) \qquad (5)$$

Which represent a straight line. The value of E can be dtermined from the slope and the S value from the intercept.

RESULT AND DISDCUSSION

we used the previous theoretical coecpts for the analysis and discussion of our experimental measurements. To detect the thermodynamic orders of the TL, natural sample was heated to a certain temperature called (T_{stop}) and then cooled. The sample was again heated overall the range from 25 to 400°c and the temperature corresponding to the TL peak (T_m) was determined. Fig. (1) illustrate this behaviour where T_m is shifted to higher values as (T_{stop}) increases, which can be represented by the second order expression.

$$I(T) = n_0^2 \, s' \exp(-E/KT) \left(1 + \frac{n_0 \, s'}{\beta} \int_{T_0}^{T} \exp(-E/KT') \, dT'\right)^{-2} \quad (6)$$

The temperature coordinate of the peak T_m can be determined from the condition

$$\left(\frac{dI}{dt}\right)_{T_m} = zero \quad (7)$$

where:

$$(n_0 \, s'/\beta) \int_{T_0}^{T} \exp(-E/KT) \, dT = (2KT_m^2 n_0 \, S'/\beta E) \exp(-E/KT_m) \quad (8)$$

It is clear from this expresion that T_m depends on n_0. This means that TL for pegmatite is the second order of thermodynamics (El- Desoky, (1989).
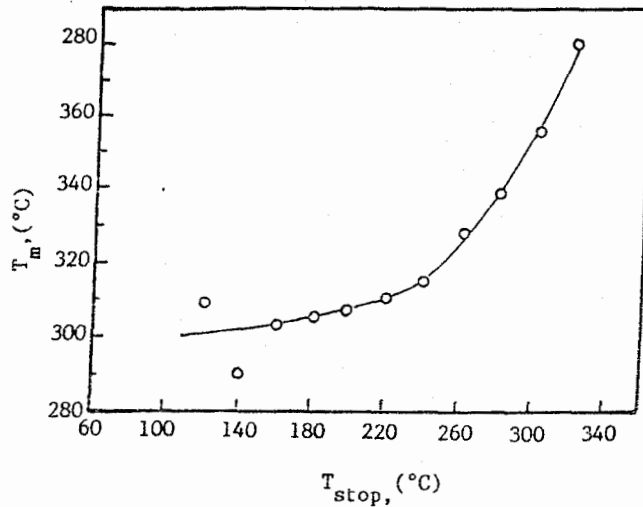
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Fig. (1) Variation of T_m with respect to T_{stop}.

Fig.(2) shows the glow cuves for natural pegmatite sample obtained at different heating rates. It is clear that pegmatite has two glow peaks, also the position of T_m varies with β.According to Urbach method, table (1) shows the average activation energies for the pegmatite glow peaks.This method did not come to be extensively used, it is just a kind of comparison. Fig. (3) represent the variation of T_m with repect to β which can be analysed using Booth-Bohum method. The resultant average values of (E) are found to be 0.66 eV, 0.821 eV and of (S) are 6776×10^4 sec^{-1}, 8549×10^4 sec^{-1} for the first and second peaks respectively using Ain Shams MV 6000 computer facilities. A least square fitted relation between ln (T^2/β) and $1/T_m$ is illustrated in Fig. (4) according to Hoogenstraaten method.
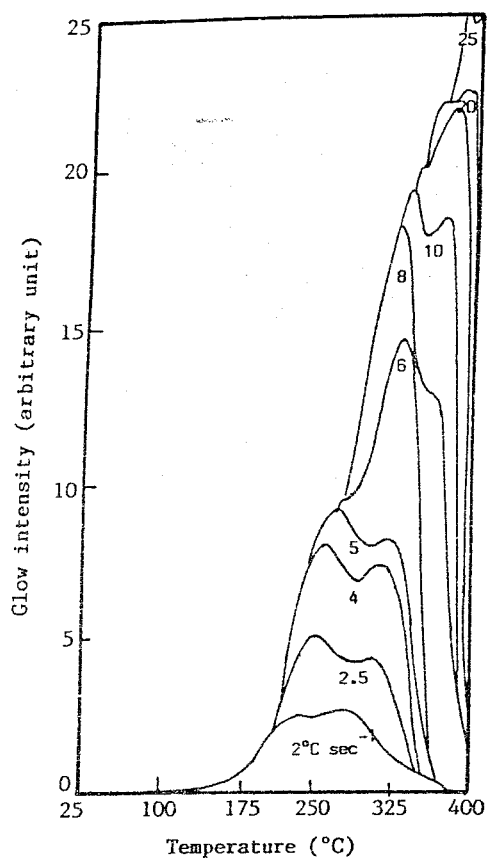
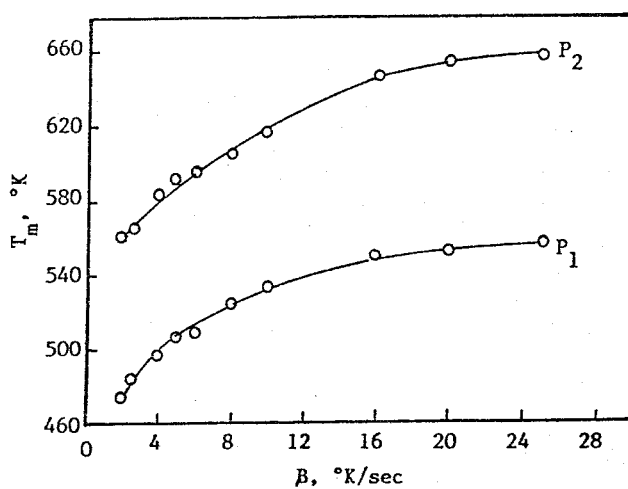Fig. (2): Natural glow curves for pegmatite obtaind at different heating rates.

Fig . (3): The variation of T_m with respect to β for the two peaks.

Table:(1) The activation energies for the two peaks (Urbach method).

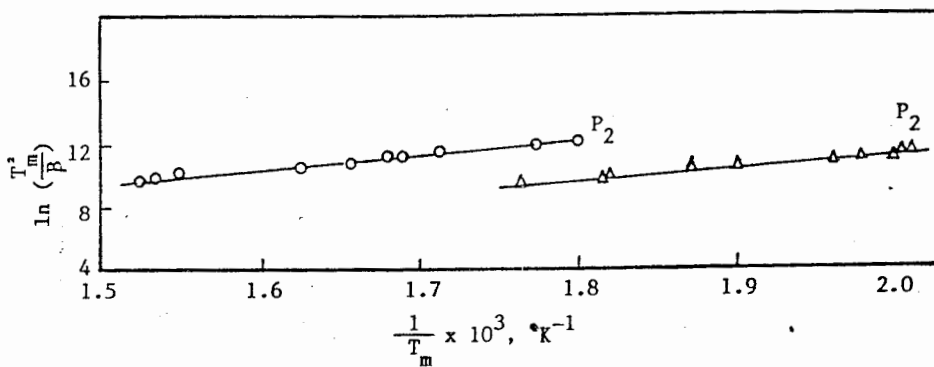| β, $^\circ$K sec^{-1}	E_1,e V	E_2,e V
2	0.948	1.124
2.5	0.968	1.128
4	0.992	1.167
4.5	–	–
5	1.012	1.184
6	1.019	1.189
8	1.051	1.208
10	1.067	1.231
16	1.099	1.293
20	1.101	1.305
25	1.112	1.313

Fig. (4): Least square fitted relation between $\ln \left(\dfrac{T_m^2}{\beta} \right)$ and $1/T_m$ for the two peaks.

The average activation energies are 0.718 eV, 0.805 eV and the freequency factors are 2044 x 10^4 sec^{-1}, 1129 10^4 sec^{-1}, for the first and seconed peaks repectively. the average activation energy and frequency factor for ther used pegamtite material were found to be 0.751 eV and 7166 x 10^4 sec^{-1} respectively using previous three methods, which is lower than 1.0 eV, and 10^{10} sec^{-1} (Horowitz, 1984). This means that the sample will not store energy well and depopulate in less than on day at room temperature. This insure that the used samples are not suitable for practical dosimetry.

ACKNOWLEDGEMENTS

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تحديد المعاملات الكينيكتيكية للمصايد لصخور البجماتيت بإستخدام طرق مختلفة

سعاد الفقى

كلية العلوم – قسم الطبيعة

جامعة عين شمس – مصر

تم فى هذا البحث تحديد المعاملات الكينيتيكية (طاقة التنشيط، معامل التردد، السلوك الحركى) لعينات من صخور البجاماتيت جمعت من شرق سيناء بمصر وذلك بإستخدام عدة طرق نظرية مختلفة مع قياسات عملية لمنحنى الوميض الحرارى بهدف إستخدامها كمقياس للأشعة بطاقاتها المختلفة . ولقد تبين من الدراسة أن العينات سلوك حركى من الدرجة الثانية. كما أثبت البحث أن طاقة التنشيط المستنتجة بواسطة نظريات مختلفة وقياسات معملية اقل من الواحد الكترون فولت، ومعامل التردد أقل من $10 \cdot 10$ ثانية$^{-1}$. وهذا يؤكد عدم صلاحية هذه العينات في مجال قياس الجرعات الإشعاعية.