CHAPTER - V

RESULTS

FIGURES 1 TO 3

Thermoluminescence glow curves exhibited by B.D.H. grade undoped sodium chloride specimens in three different physical conditions; as-obtained from aqueous solution, obtained after annealing at 500 and 750°C temperature for two hours (in air) and subsequently cooled rapidly to room temperature were recorded in present experiments. They are presented in figures 1, 2 and 3 respectively. It is clearly seen from Fig. 1 that NaCl specimen, as-obtained from aqueous solution, irradiated by a standard alpha dose 3800 rad, display three peaks at 90, 240 and 340°C during the first heating run. Among them the 90°C peak appears as a weak peak and other two appear as shoulders. The intensity of 340°C is significant. During second heating run, the intensed shoulder at 340°C disappears and a new well defined prominent peak is generated at 250°C. The 90°C glow peak remains there as a small peak with slightly higher intensity than that in the first run. They, then stabilized themselves in all the respects for further successive thermal cycles.

It is very interesting to note from Fig. 2 that specimens of NaCl air-quenched from 500°C results in a well defined dominant TL peak at 240°C alongwith a hump at 340°C and a small well defined peak at 90°C.

It is also observed that the intensity of 240 and 90°C slightly increases in the second heating run, while the peak at 340°C remains absent. They also stabilize themselves in further successive thermal cycles. Figures 3 exhibits the successive TL glow curves for 750°C air-quenched NaCl. It is clearly seen that the 340°C peak appears as a dominant peak with weaker peaks at 90 and 240°C. In further successive heating runs, the 340°C peak disappears and the peaks at 90 and 240°C stabilize themselves in all the respects.

FIGURES 4 TO 6

Figures 4 through 6 respectively represents the thermal glow curves exhibited by Ba^{++} doped sodium chloride (with Ba^{++} concentration 10^{-5}m.f.) in three different physical conditions, as-obtained and air-quenched to room temperature from 500 and 750°C.

The as-obtained NaCl:Ba (10^{-5}m.f.) specimen exposed to alpha radiation (3800 rad) exhibits, three broad and small peaks at 90, 230 and 340°C during the first heating run (Fig.4). The peak at 230° C comes out with significant intensity, while the peak at 340°C disappears during second cycle. No remarkable change is observed in the position and intensity of 90°C peak. The further thermal cycling does not show significant change.

It is significant to note that the specimens of NaCl:Ba (10^{-5}m.f.) after application of thermal treatment (Fig. 5 and 6) produce well resolved well defined, isolated and intensed peak at 230°C. The peaks at 90 and 340°C are very weak. There is a minor variation in the intensity of the 230°C glow peak with successive thermal cycles. The peak at 340°C disappears after the completion of the first cycle as usually found in other specimens. The overall intensity of TL is found more in these specimens compared to that of undoped sodium chloride.

FIGURES 7 TO 9

The specimens of NaCl:Ba with higher concentration are also examined for their TL behaviours in three different physical conditions namely; as-obtained from aqueous solution and quenched to room temperature from 500 to 750°C in open air.

It is clearly seen from figures 7 through 9 that the three peaks at 90, 220 and 340°C appear in all the three physical conditions of the material of

NaCl:Ba (10^{-2}m.f.). The peak at 220°C is observed to be isolated, well defined and prominent one, while other two are found to be well defined and small. It is observed that the successive thermal cycling does not influence the TL glow curves remarably. However, it is seen that in each and every condition the specimen of NaCl:Ba (10^{-2}m.f.) the peak at 340°C does not remain present after the completion of first heating run.

It is also observed from the figures 7 to 9 that the intensity of 220°C peak has markedly enhanced with the thermal treatment. It is more or less identical for 500 and 750 air-quenched NaCl:Ba (10^{-2}m.f.) specimens.

FIGURES 10 TO 12

In order to investigate the effect of Ba^{++} concentration on the TL behaviour of NaCl:Ba, the thermal glow curves are also recorded for heavily doped NaCl:Ba specimen (10^{-1}m.f.). The figures 10 to 12 clearly indicate that the effects of thermal cycling and pre-heat treatments are more or less identical to that observed in the NaCl:Ba specimens with Ba^{++} concentration 10^{-2}m.f. and 10^{-5}m.f. The only difference observed is that the prominent peak appears at 220°C in heavily doped NaCl:Ba phosphors. Besides this, it is very interesting to note that the peak at 220°C shifts to 200°C and then to 180°C, respectively, in the 500 and 750°C air-quenched NaCl:Ba (10^{-1}m.f.) specimens. The overall intensity is also found to be reduced in these heavily activated NaCl:Ba (10^{-1}m.f.) specimens compared to that of other NaCl:Ba specimens with 10^{-5}m.f. and 10^{-2}m.f. content of Ba impurity.

FIGURES 13 TO 15

Figures 13, 14 and 15 respectively represent the thermal glow curves exhibited by pure sodium chloride in three different physical conditions; as-obtained and air-quenched to room temperature from 500 and 750°C. The figures 13A, 14A and 15A and 13B, 14B, 15B respectively exhibit TL glow curves obtained

after excitation with standard dose of beta and gamma radiations (800 rad). Comparision of these curves with the TL glow curves of respective specimens with one minute alpha dose (3800 rad); figures 1, 2, 3 first curves clearly brings out the fact that as-obtained NaCl specimens exposed to alpha and beta radiations, display two peaks at 90 and 240°C (Fig. 13A). Whereas the excitation of these specimens with gamma radiation gives peak at 90, 180, 240 and a hump around 140°C (Fig. 13B). Further in both the cases 90°C peak is predominent one.

It is observed that the intensity of 90 and 240°C peaks in the case of the gamma-irradiated sample is significant is significant than that in case of beta-irradiated sample.

It is very interesting to note that the pure NaCl specimens irradiated with standard dose of alpha-, beta-, gamma- and UV radiations, after the application of the thermal treatments (Figs. 3, 14 and 15) produce a well defined, isolated and intensed peak at 240°C. The 90°C peak is very weak as compared to the 240°C peak.

It is important to note that the UV excitation produces a dominant peak at low temperature say 167°C (Fig. 15B), in contrast with other type of radiations.

It is also observed that the 180°C peak obtained in as-obtained sample remains absent in pre-heat treated sample. Comparison of TL glow curves exhibited by as-obtained and heat treated NaCl. Figs. 1, 2, 3, 13, 14 and 15 indicates that TL output is maximum with gamma excitation and minimum with alpha radiation.

FIGURES 16 TO 18

In order to find out the effect of different nature of radiations on TL

behaviours, the specimens of 750°C air-quenched NaCl:Ba with Ba concentration 10^{-5}, 10^{-2} and 10^{-1} molar fractions are also examined after excitation with standard beta and gamma doses (800 rad). The glow curves exhibited by them are shown in figures 16, 17 and 18 respectively. The comparison of these glow curves with those obtained after alpha irradiation (Figs. 4-12) reveals the fact that the glow curve is more intensed in the case where the specimens are exposed to gamma radiations. The gamma irradiation produces new peaks even at low dose.

FIGURES 19 TO 21

Thermoluminescence glow curves exhibited by undoped potassium chloride in three different physical conditions, as-obtained from aqueous solution and after annealing treatments at 500 and 750°C for two hours and subsequently cooled rapidly (air-quenched) to room temperature are represented in figures 19, 20 and 21 respectively.

It is clearly seen from figures 19 that KCl sample, as-obtained from aqueous solution, irradiated by a standard alpha dose (3800 rad) show two peaks at 50 and 340°C in the first heating run. During the second and third thermal cycles, specimen exhibits an additional peak at 100°C. It is worth to note that the peak at 340°C disappears after completion of first heating run. Minor variation in the intensity of 50 and 100°C peak is also observed with successive thermal cycling.

The examination of the TL glow curves exhibited by 500 and 750°C air-quenched pure KCl (Figures 20 and 21 respectively) clearly demonstrate that thermally treated KCl material displays more or less identical TL behaviours under excitation with standard alpha dose to that shown by untreated KCl.

FIGURES 22 TO 24

Figures 22 through 24 respectively represents the TL glow curves exhibited by as-obtained, 500 and 750°C air-quenched KCl:Ba specimens with Ba concentration 10^{-5} m.f.

Like pure KCl these specimens generate the peaks at 50 and 340°C during the first thermal cycle. In the second and other successive thermal cycles new peaks at 100 and 170°C come out very nicely and 340°C peak vanishes for ever. It is very interesting that the as-obtained specimen results 100°C peak as dominant one in the second cycle while 750°C air-quenched lightly doped material exhibits enhanced peak at 170°C. It is important to see that 500°C air-quenched material generates both the peaks (100 and 170°C) in well defined manner. Successive thermal cycling does not result remarkable changes in the TL glow pattern in general. The intensity of TL glow curves in all the three cases is not significantly different.

FIGURES 25 TO 27

An another batch of KCl:Ba specimens (10^{-2}m.f.) obtained by recrystallization from aqueous solution were annealed at two different elevated temperatures namely, 500 and 750°C for two hours in air and subsequently quenched rapidly to room temperature. The TL behaviours have been recorded for thermally treated and untreated KCl:Ba (10^{-2}m.f.) specimens which are presented in figures 25, 26 and 27.

It is observed that the untreated specimens display a strong peak around 340°C and a weaker one at 50°C, while thermally treated specimens give a weaker peak at 50°C, small but well defined peak at 170°C and a prominent peak at 340°C. After the completion of the first heating run the peak at 340°C

vanishes in all these specimens. The small but well defined peak at 100°C appears in the second and other successive thermal cycles in the case of as-obtained specimens. On the other hand thermally treated KCl:Ba (10^{-2}m.f.) specimens give rise to a well defined and well developed peak at 170°C alongwith a smaller one at 100°C. The TL intensity is significant in 500°C air-quenched KCl:Ba (10^{-2} m.f.) specimens as compared to that in 750°C air-quenched one. The thermal cycling effect in all the three specimens is identical. The sudden rise in intensity of TL glow curve is observed after the completion of first heating run. Thereafter, the glow curves stabilize themselves for all the further thermal cycles.

FIGURES 28 TO 30

The characteristic glow curves of KCl:Ba with Ba^{++} concentration 10^{-1}m.f. were recorded in three different physical conditions namely, as-obtained from aqueous solution and heat-treated from 500 and 750°C are represented in figures 28 to 30 respectively.

The specimens show small peaks at 50, 100 and 170°C and a strong one at 340°C during the first heating run. During second and onward thermal cycles they display well defined peaks at 100 and 170°C. It is important to see that the peak at 170°C is predominant one. The successive thermal cycles do not change the intensity of TL glow peaks. It is to be noted that 500°C air-quenched specimen of KCl:Ba (10^{-2}m.f.) gives the maximum TL output.

FIGURES 31 TO 34

The first thermal cycles obtained for pure and Ba doped NaCl with different concentrations, in as-obtained, 500 and 750°C air-quenched physical conditions, after a standard alpha dose are presented in figures 31 to 34. It is seen that the intensity of glow curve is high in pre-heated conditions. It is important

to note that the thermally treated specimen of NaCl:Ba with Ba concentration 10^{-2}m.f. exhibits a well defined peak at 220°C with optimum intensity. The intensity as well as position of the peak do not change with the increase in the quenching temperature from 500 to 750°C. The peak at 340°C also remains stable in all respects in this specimen. The peak around 340°C is present in all pure and Ba-doped specimens. The intensity of this peak does not vary systematically with increase in Ba concentration (Fig. 31 and 34). There is no significant difference in the intensity of this peak in pure and Ba-doped NaCl. The shift in the position of Ba induced peak is observed from 230 to 220°C and finally at 180°C with increase in contact of divalent cation impurity (Ba).

FIGURES 35A AND 35B

The thermoluminescence glow curves of 750°C air-quenched and pure Ba doped NaCl and KCl:Ba without any irradiation have also been examined. The three successive thermal cycles exhibited by 750°C air-quenched NaCl are presented in Fig. 35A. Identical results are obtained in the case of NaCl:Ba which are not presented in this thesis. The results of TL of 750°C air-quenched KCl:Ba (10^{-2}m.f.) without excitation are exhibited in Fig. 35B. It is very interesting to note that the 340°C peak appears in the present systems even without pre-excitation of the system. The peak disappears after the completion of the first thermal cycle.

FIGURE 36

The thermal glow curves and TL-emission spectra for 750°C air-quenched NaCl (dotted line) and NaCl:Ba (T) (Ba concentration 10^{-2}m.f. continuous line) are represented in figures 36A and 36B respectively. The TL emission spectra are recorded at temperatures 85, 120, 160, 200 and 230°C are respectively presented in Figure 36B. The examination of the experimental data reveals the following features

1. 750°C annealed and quenched NaCl specimens display measurable TL output with thermal glow peaks at 90 and 240°C (Fig. 36A). The recording of the TL-emission spectra is difficult due to poor output. In this case weak broad and diffused emission bands around 435 nm and 475 nm are discernible in the TL-emission spectrum recorded at 230°C.

2. Thermally treated NaCl:Ba (10^{-2}m.f.) specimens exhibit substantial TL output. The thermal glow curves show a prominent glow peak at 220°C alongwith two subsidiary peaks at 90 and 140°C.

3. TL-emission spectra of thermally treated NaCl:Ba (10^{-2}m.f.) specimens indicate TL-emission bands around 357, 435 and 495 nm. It is clearly seen that the TL-emission spectrum recorded at 85°C exhibits main TL-emission band at 495 nm emission band is suppressed and instead the band at 435 nm begins to be conspicuous. The 435 nm band becomes well defined dominant emission band when recording temperature is 200°C. With further increase in the recording temperature the overall TL-emission is considerably reduced. The TL emission spectra of KCl and KCl:Ba (T) have been found broad and weak. No informations regarding TL-emission centre could be drawn from them. Hence not presented in thesis.

FIGURES 37 TO 39

The measurements also included the examination of the thermal glow curves after exposure of the specimens to a range of alpha radiation. Because of their relatively better TL-output the 750°C air-quenched NaCl:Ba (10^{-2}m.f.) specimens were chosen for this purpose. Data presented in Fig. 37 represent the glow curves for NaCl:Ba (T) specimen subjected to varying alpha doses. The growth of 220°C glow peak as a function of dose plotted in Fig. 38. The results indicate that the peak position of the glow curve pattern remain unaltered in alpha dose.

The only change observed is the increase in the emission under the glow curve. The response is supralinear (Fig. 38).

The effect of different post irradiating intervals starting from few hours to twenty days on the TL-output at 220°C in NaCl:Ba (T) specimens was also studied. The plot of TL intensity at 220°C peak versus post irradiating interval is shown in Fig. 39. It brings out the fact that there is no significant variation in the intensity at 220°C glow peak with increase in the post irradiating time at room temperature.

FIGURES 40 AND 41

The TL behaviours of KCl:Ba (10^{-2}m.f.) air-quenched from 750°C with different alpha doses have also been examined and data are displayed in Fig. 40. It is clearly seen that the glow curve pattern does not change. The only change observed is the increase in the intensity of the glow curve. The growth of the intensity of 170°C glow peak with the increase in alpha dose is shown in Fig. 41. It is also observed that the dose response is linear.

FIGURE 1 : TL glow curves for pure NaCl as-received from the solution; exposure 1 min. alpha.

Curves 1 ———— Ist Thermal cycle.

2 ---------- IInd thermal cycle.

3 ..... IIIrd thermal cycle.

Sr. No.	Thermal Cycle Number.	TL glow peak intensities in units of 10^{-8} Amperes.		
		90°C	240-250°C	340°C
1.	I	0.5	1.2	6.5
2	II	1.2	3.95	-
3	III	1.3	4.5	-

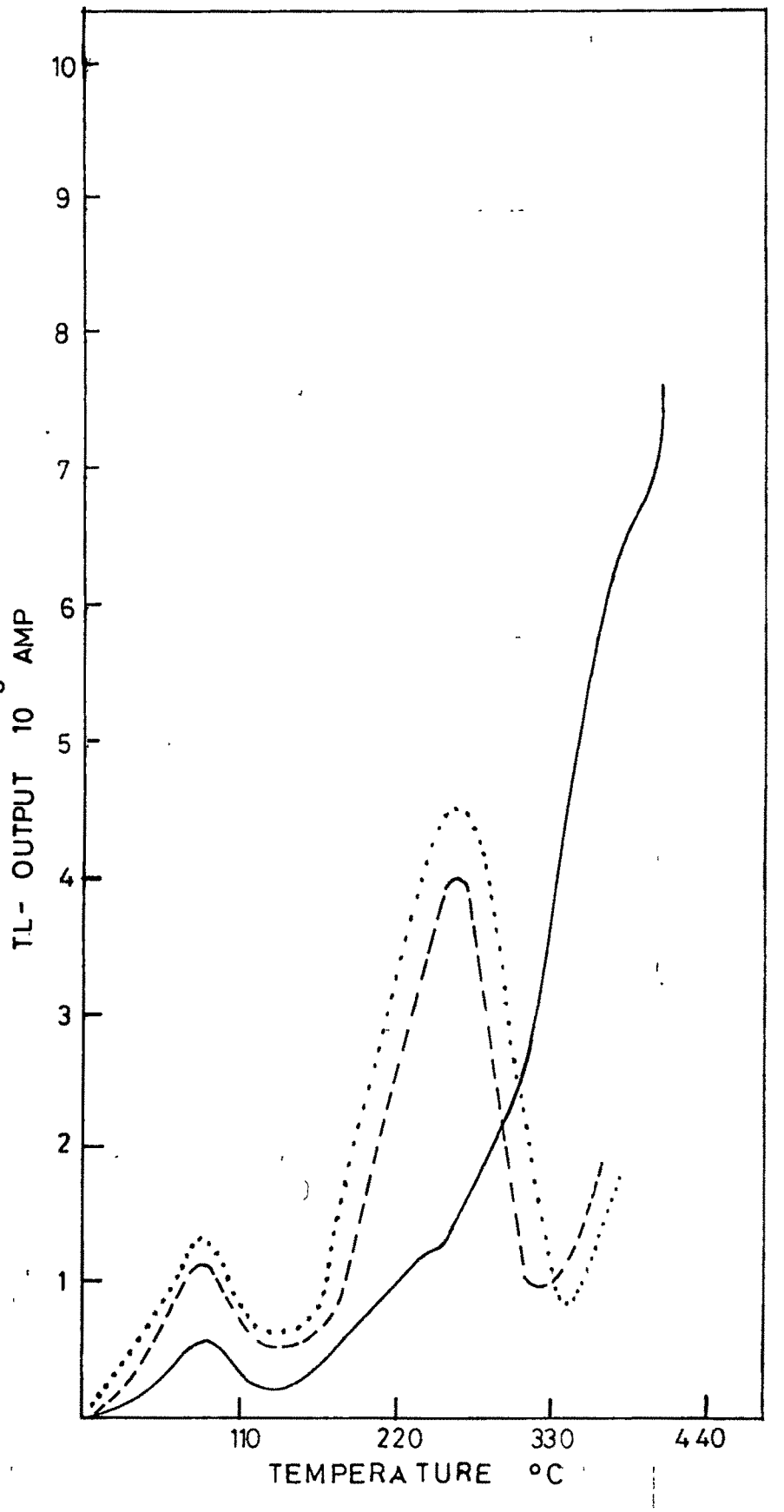


FIG. 1

FIGURE 2 : TL glow curves for pure NaCl, annealed and quenched from 500°C; exposure 1 min. alpha

Curves 1 ———————— Ist thermal cycle.
2 ---------- IInd thermal cycle.
3 ..... IIIrd thermal cycle.

Sr. No.	Thermal Cycle Number	TL glow peak intensities in units of 10^{-8} Amperes.		
		90°C	240°C	340°C
1.	I	0.8	1.7	3.0
2	II	0.7	2.15	-
3.	III	0.75	2.3	-

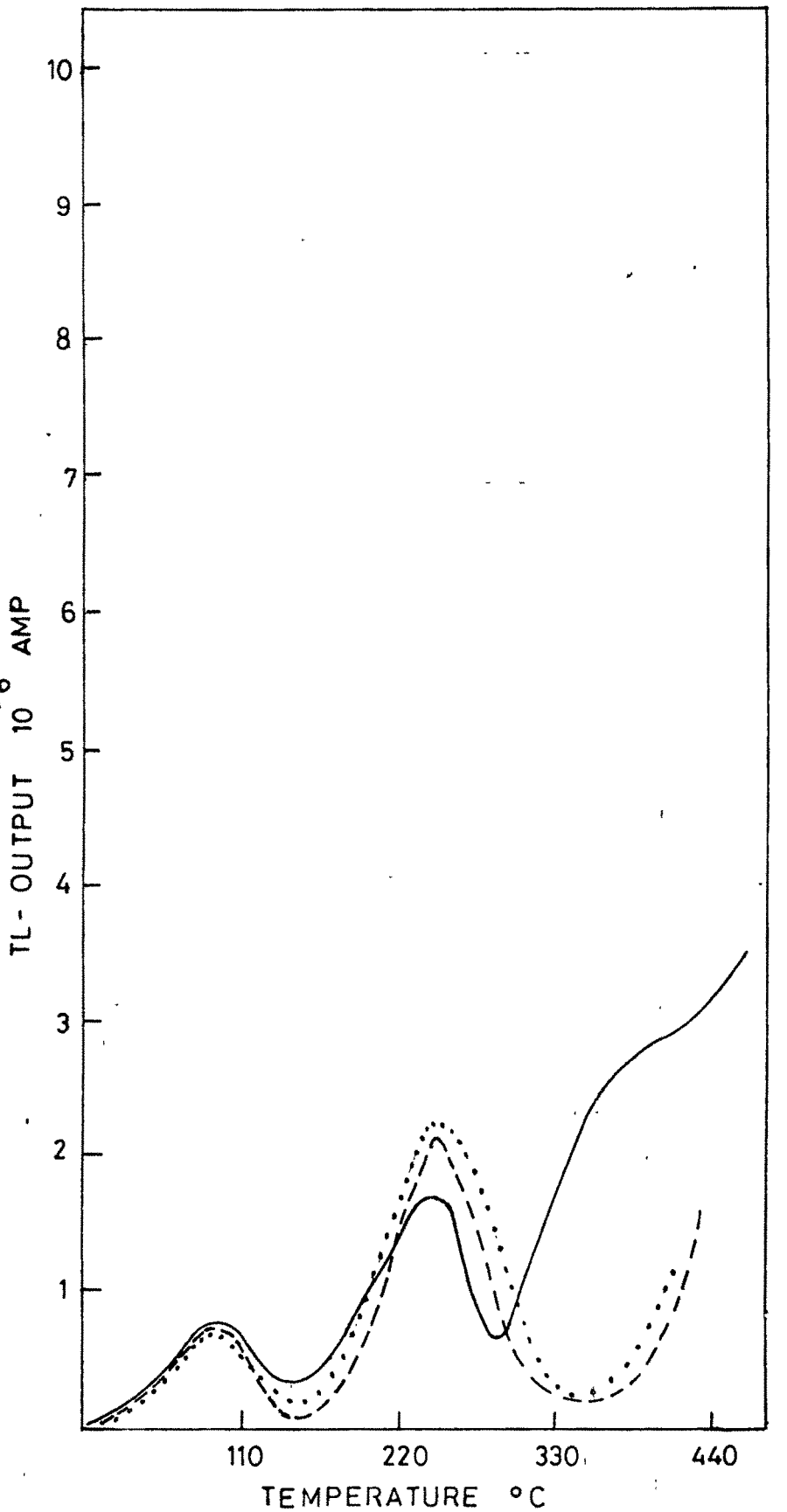


FIG. 2

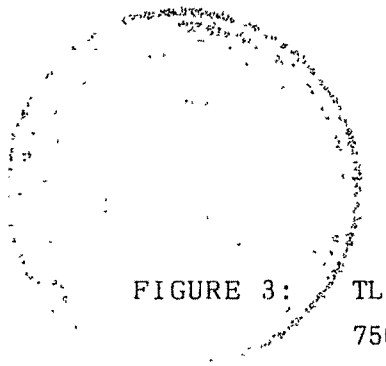


FIGURE 3: TL glow curves for pure NaCl, annealed and quenched from 750°C; exposure 1 min. alpha.

Curves 1 ——————Ist thermal cycle.
2 ----------IInd thermal cycle.
3 ..... IIIrd thermal cycle.

Sr. No.	Thermal Cycle Number	TL glow peak intensities in units of 10^{-8} Amperes.		
		90°C	240°C	340°C
1.	I	0.4	2.1	17.0
2.	II	0.4	2.7	-
3.	III	0.4	2.6	-

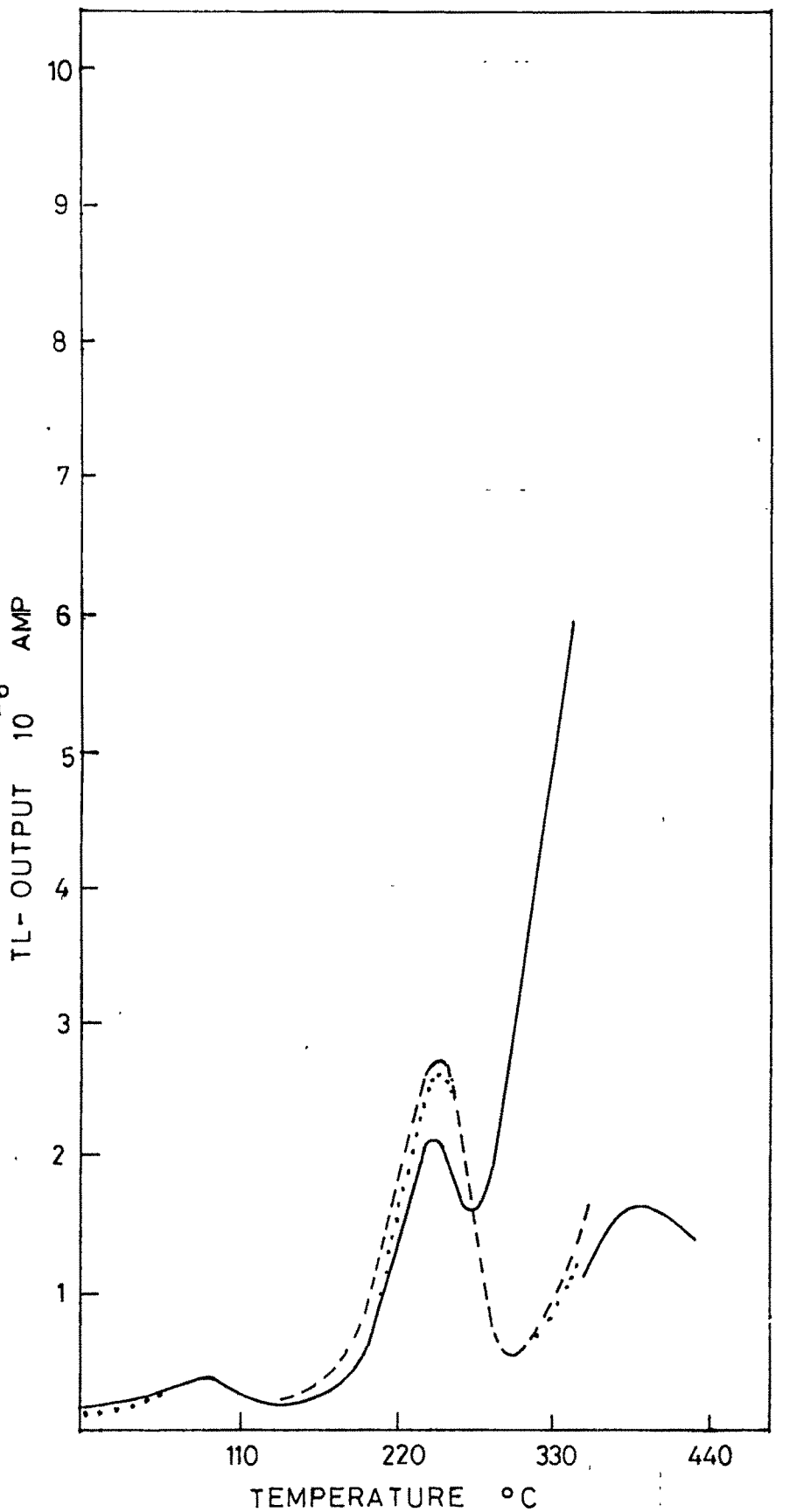


FIG. 3

FIGURE 4 : TL glow curves for NaCl:Ba 10^{-5} m.f. as-received from the solution; exposure 1 min. alpha.

Curves
1. ———— Ist thermal cycle.
2. ---------- IInd thermal cycle.
3. ..... IIIrd thermal cycle.

Sr. No.	Thermal Cycle Number	TL glow peak intensities in units of 10^{-7} Amperes.		
		90°C	240-230°C	340°C
1.	I	0.25	0.6	0.75
2.	II	0.3	1.9	-
3.	III	0.4	2.6	-

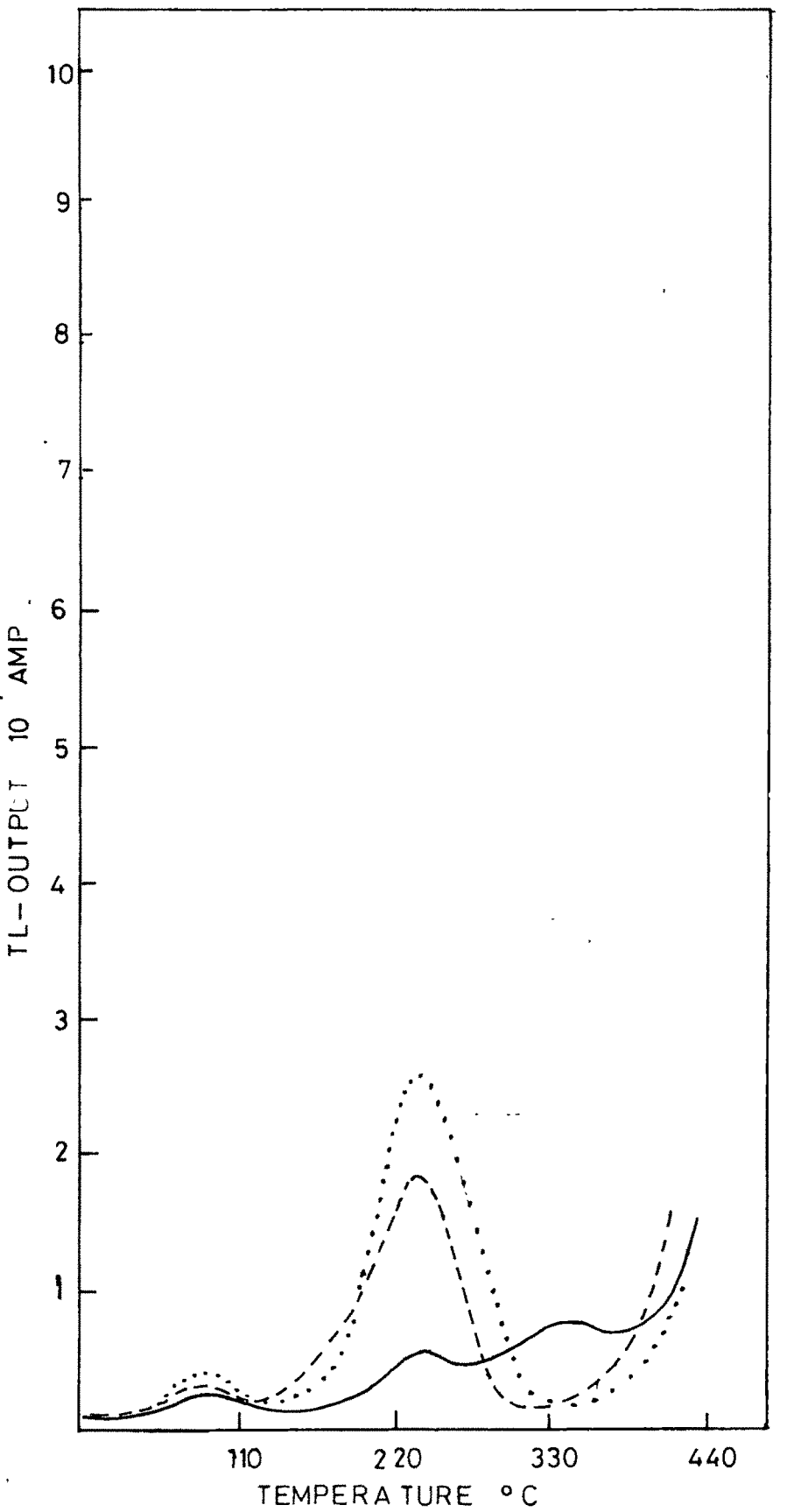


FIG. 4

FIGURE 5 : TL glow curves for NaCl:Ba (10^{-5} m.f.) annealed and quenched from 500°C; exposure 1 min. alpha.

Curves
1. ———— Ist thermal cycle.
2. ---------- IInd thermal cycle.
3. ..... IIIrd thermal cycle.

Sr. No.	Thermal Cycle Number	TL glow peak intensities in units of 10^{-7} Amperes		
		90°C	230°C	340° C
1.	I	0.2	5.4	0.6
2.	II	0.25	6.6	-
3.	III	0.35	7.7	-

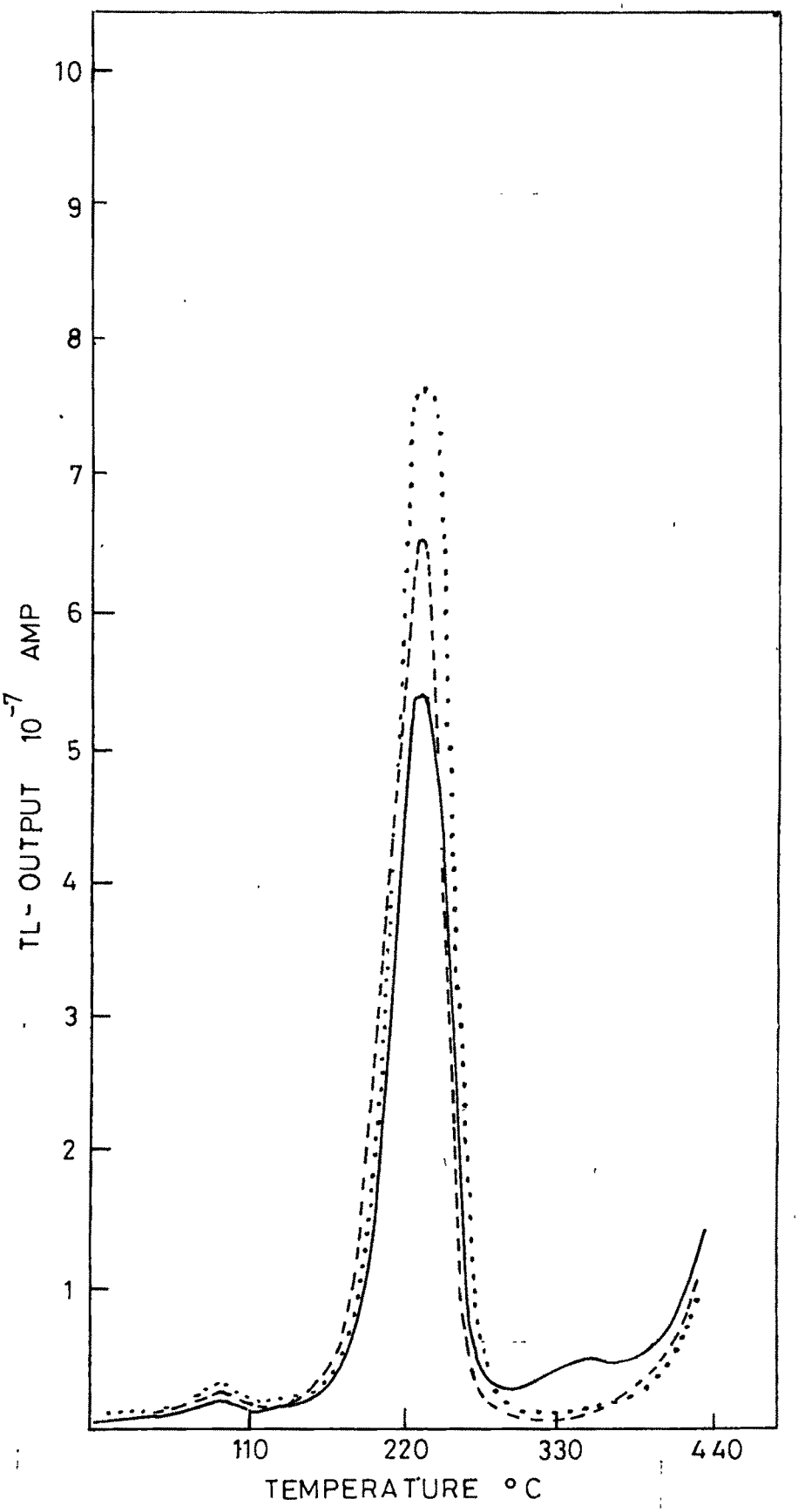


FIG. 5

FIGURE 6 : TL glow curves for NaCl:Ba (10^{-5} m.f.) annealed and quenched from 750°C; exposure 1 min. alpha.

Curves
1. ———— Ist thermal cycle.
2. ---------- IInd thermal cycle.
3. ..... IIIrd thermal cycle.

Sr. No.	Thermal Cycle Number	TL glow peak intensities in units of 10^{-7} Amperes.		
		90°C	230°C	340°C
1.	I	0.2	1.8	0.9
2.	II	0.25	2.2	-
3.	III	0.3	2.3	-

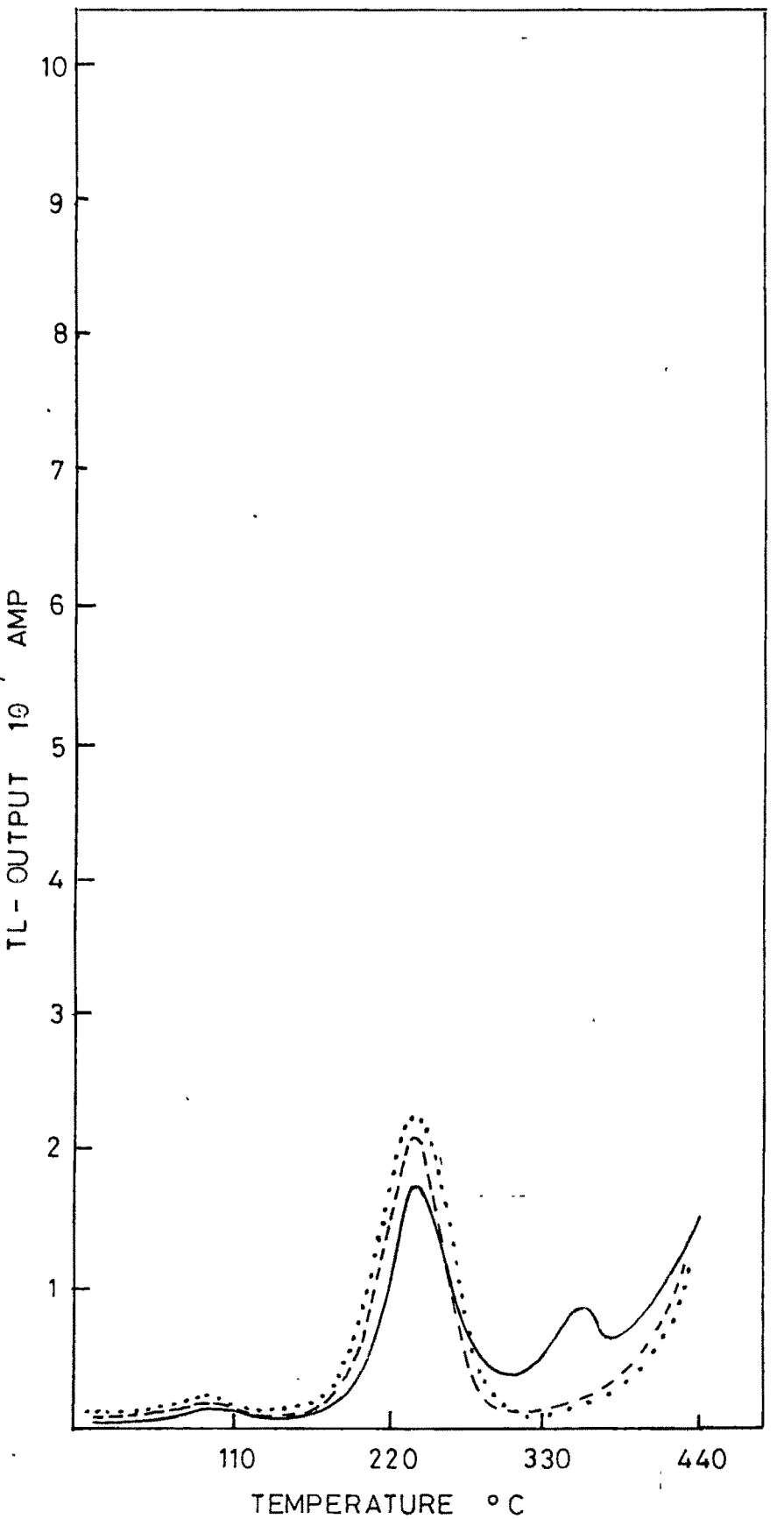


FIG. 6

FIGURE 7 : TL glow curves for NaCl:Ba (10^{-2} m.f.) as-received from solution; exposure 1 min. alpha.

Curves
1. ———— Ist thermal cycle.
2. ---------- IInd thermal cycle.
3. ..... IIIrd thermal cycle.

Sr. No.	Thermal Cycle Number	TL glow peak intensities in units of 10^{-7} Amperes.		
		90°C	220°C	370°C
1.	I	0.25	1.5	1.75
2.	II	0.4	2.4	-
3.	III	0.45	2.9	-

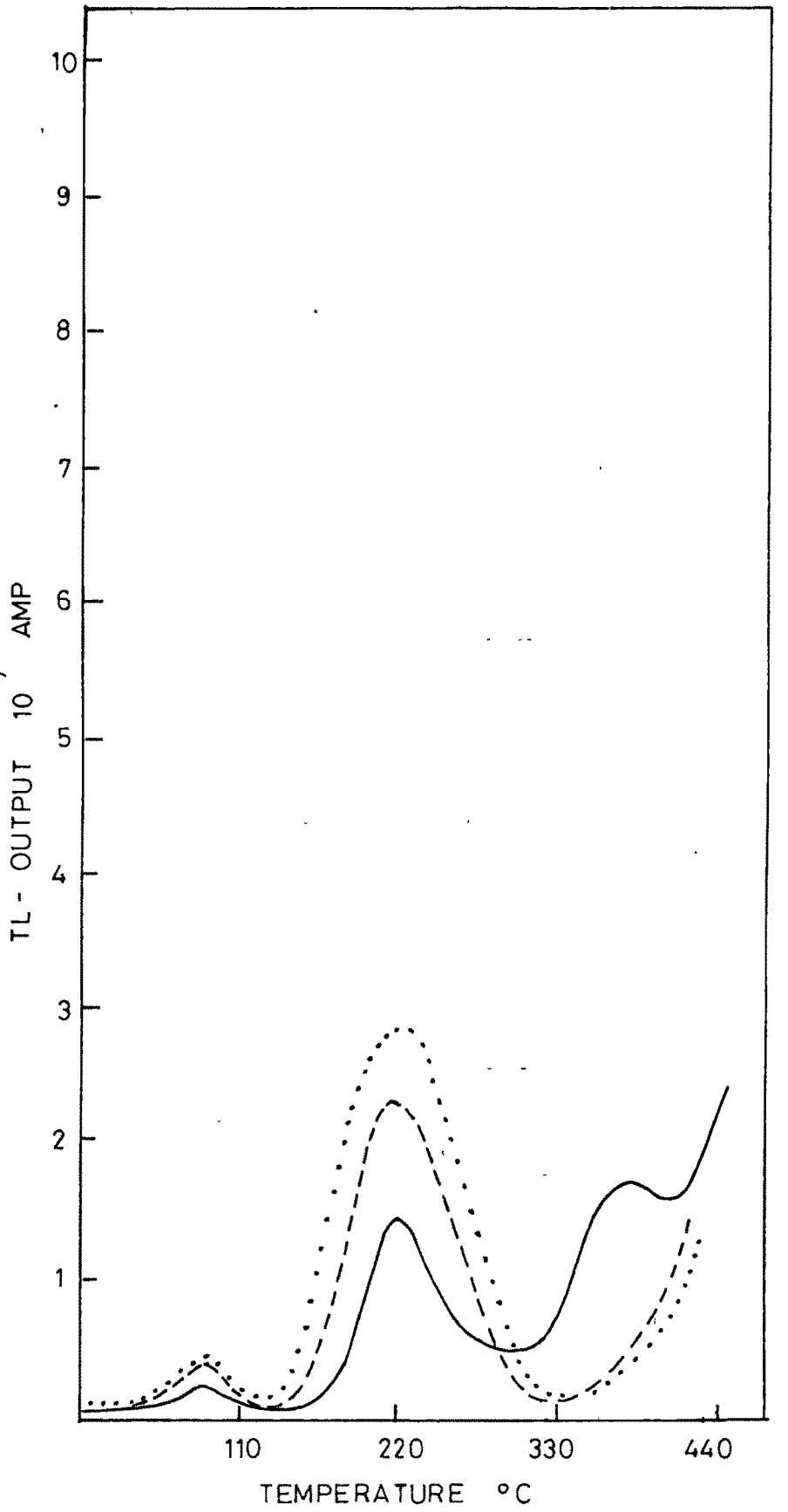


FIG. 7

FIGURE 8 : TL glow curves for NaCl:Ba (10^{-2}m.f.), annealed and quenched from 500°C; exposure 1 min. alpha.

Curves
1. ———— Ist thermal cycle.
2. ---------- IInd thermal cycle.
3. ..... IIIrd thermal cycle.

Sr. No.	Thermal Cycle Number	TL glow peak intensities in units of 10^{-7} Amperes.		
		90°C	220°C	370°C
1.	I	0.3	5.15	1.85
2.	II	0.3	5.3	-
3.	III	0.45	5.75	-

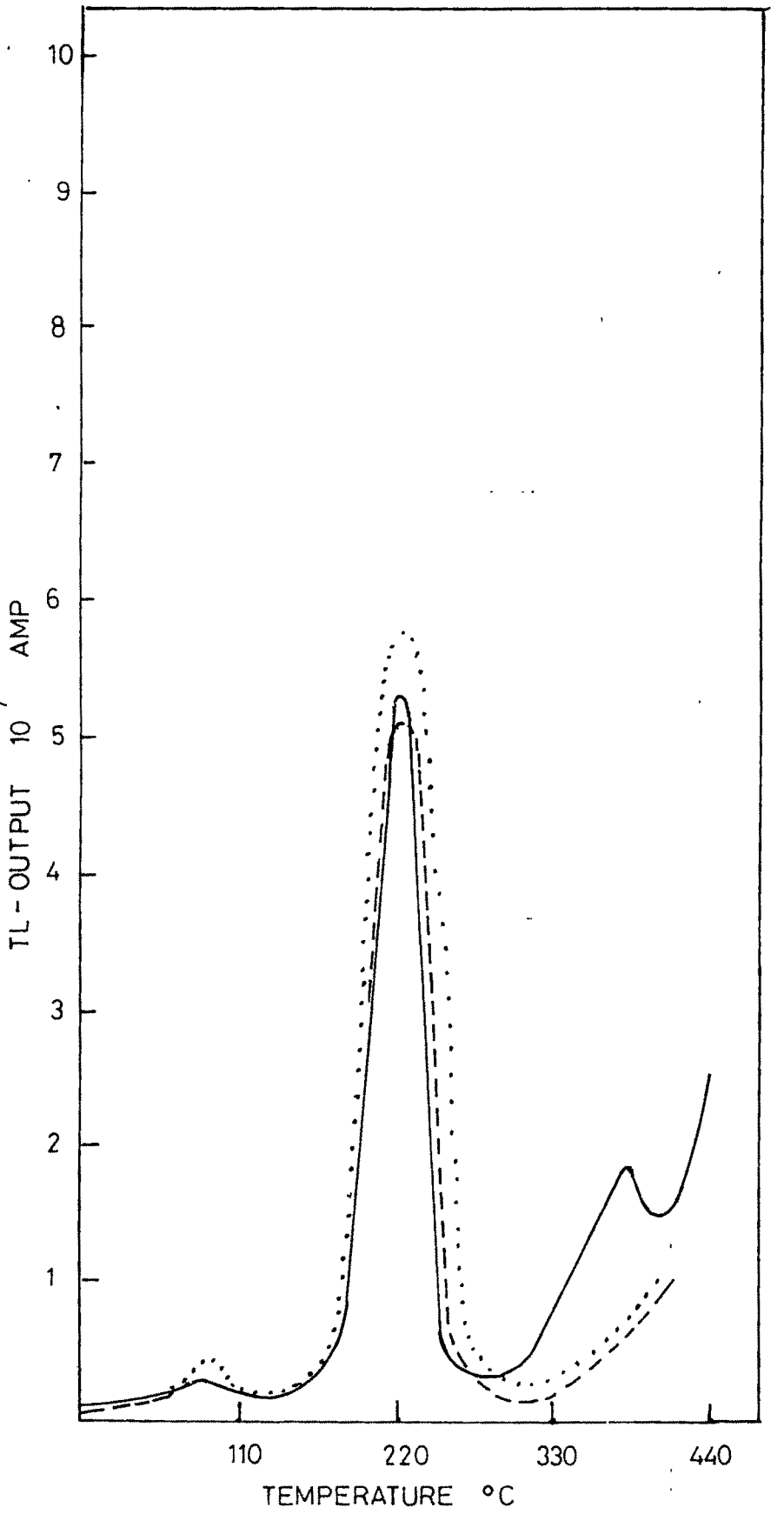


FIG. 8

FIGURE 9 : TL glow curves for NaCl:Ba (10^{-2} m.f.) annealed and quenched from 500°C, exposure 1 min. alpha.

Curves
1. ————Ist thermal cycle.
2. ---------- IInd thermal cycle.
3. ..... IIIrd thermal cycle.

Sr. No.	Thermal Cycle Number	TL glow peak intensities in units of 10^{-7} Amperes.		
		90°C	220°C	340°C
1.	I	0.25	5.3	1.8
2.	II	0.4	5.15	-
3.	III	0.45	5.8	-

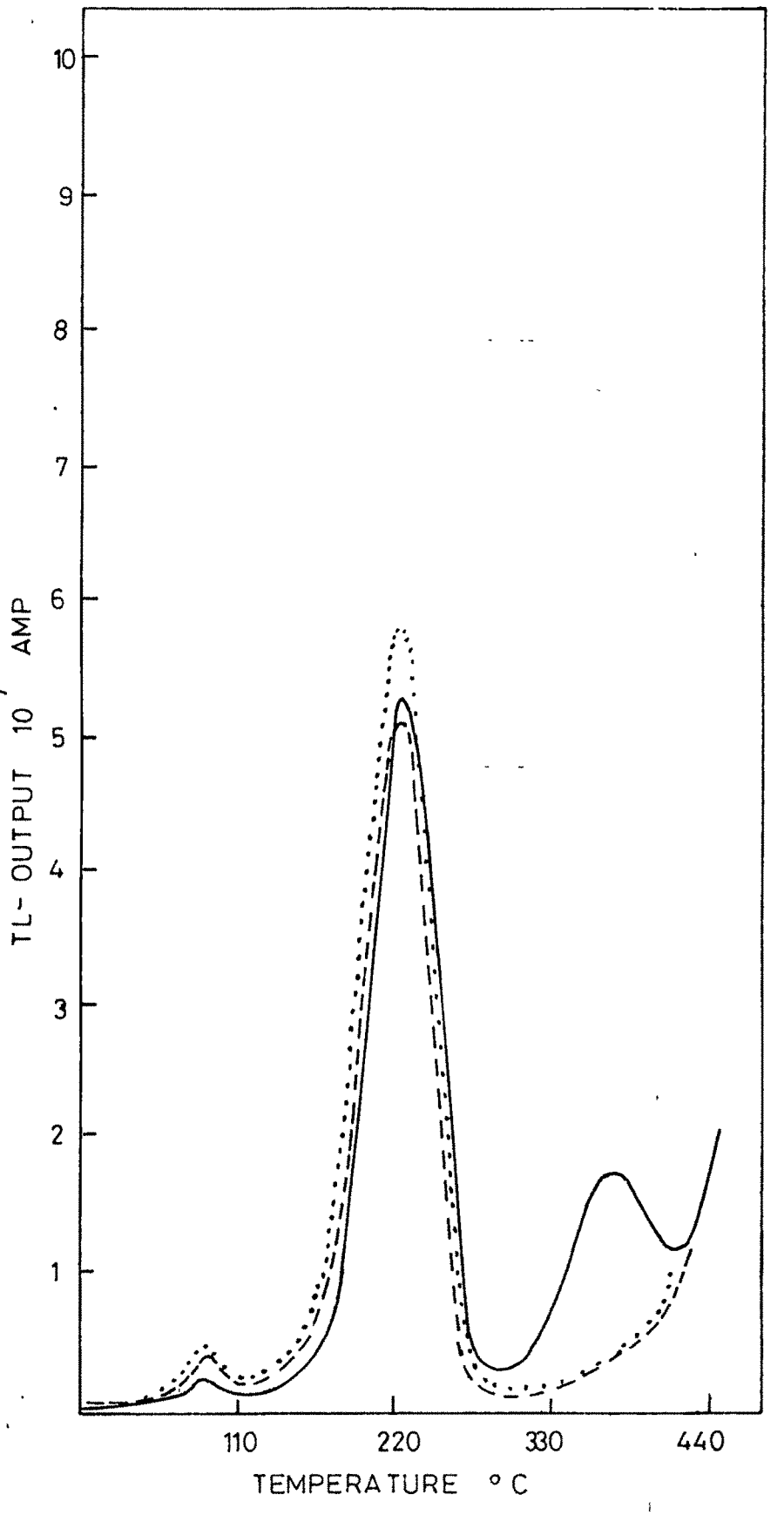


FIG. 9

FIGURE 10 : TL glow curves for NaCl:Ba (10^{-1} m.f.) as-received from solution; exposure 1 min. alpha.

Curves
1. ———— Ist thermal cycle.
2. ---------- IInd thermal cycle.
3. ..... IIIrd thermal cycle.

Sr. No.	Thermal Cycle Number	TL glow peak intensities in units of 10^{-8} Amperes.		
		90°C	220°C	370°C
1.	I	0.15	0.9	7.6
2.	II	0.75	6.0	-
3.	III	1.0	8.3	-

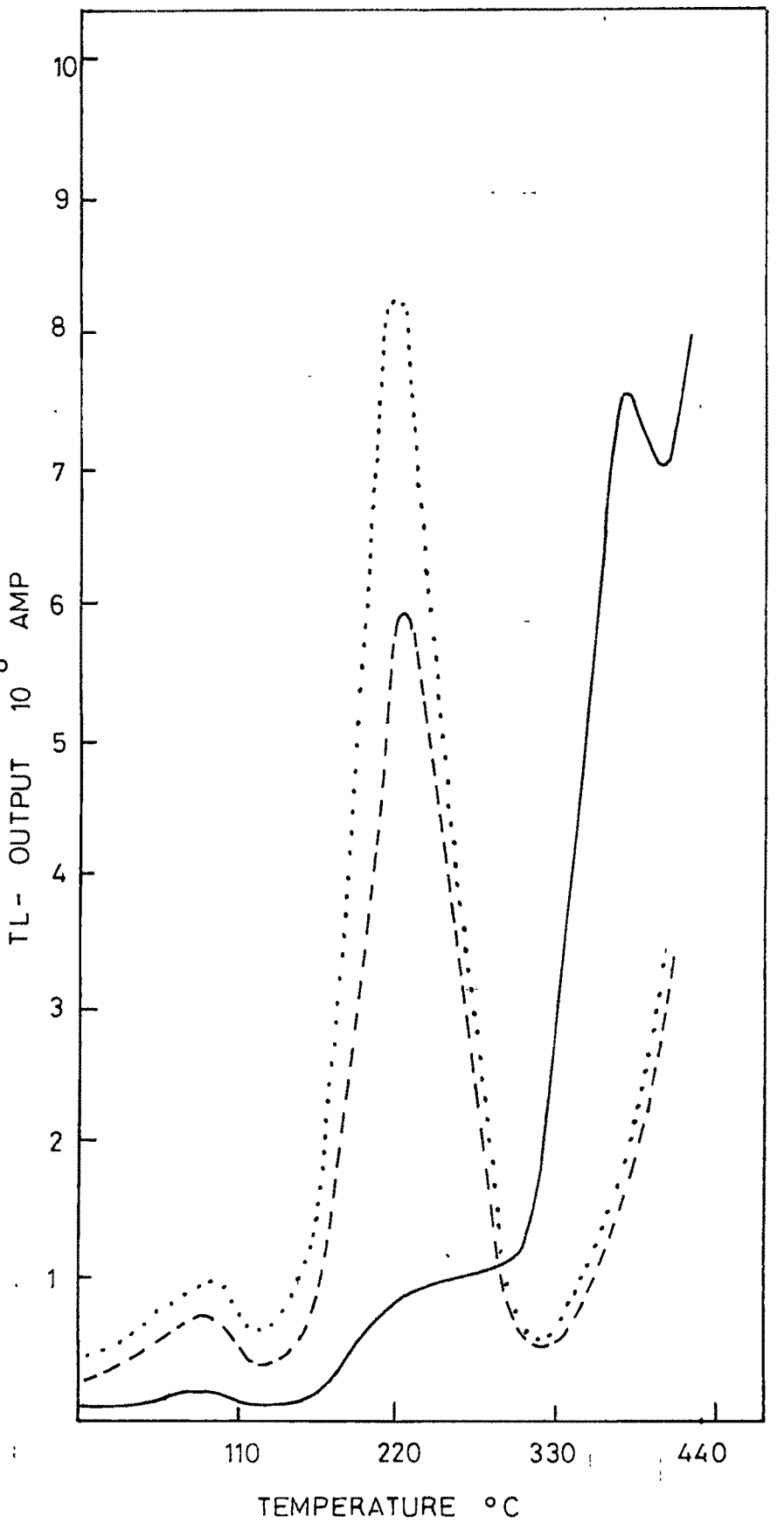


FIG. 10

FIGURE 11 : TL glow curves for NaCl:Ba (10^{-1}m.f.) annealed and quenched from 500°C; exposure 1 min. alpha.

Curves
1. ———— Ist thermal cycle.
2. ---------- IInd thermal cycle.
3. ..... IIIrd thermal cycle.

Sr. No.	Thermal Cycle Number	TL glow peak intensities in units of 10^{-7} Amperes.		
		90°C	200°C	360°C
1	I	0.2	2.0	4.3
2.	II	0.2	2.75	-
3.	III	0.3	4.0	-

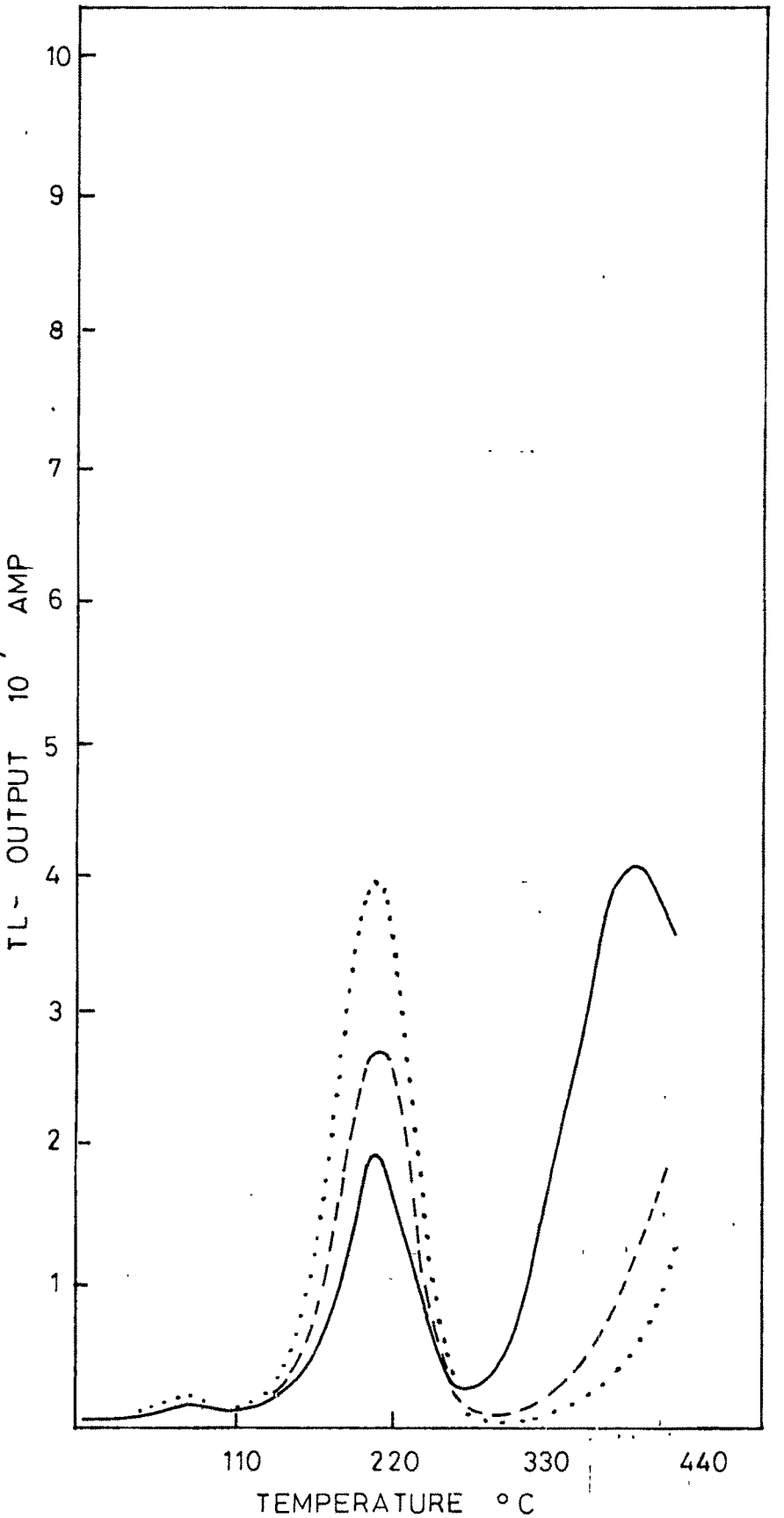


FIG. 11

FIGURE 12 : TL glow curves for NaCl:Ba (10^{-1}m.f.), annealed and quenched from 750°C; exposure 1 min. alpha.

Curves
1. ———— Ist thermal cycle.
2. - - - - - - - - - - IInd thermal cycle.
3. ..... IIIrd thermal cycle.

Sr. No	Thermal Cycle Number	TL glow peak intensities in units of 10^{-7} Amperes.		
		90°C	180°C	360°C
1.	I	0.1	2.5	2.8
2.	II	0.1	2.65	-
3.	III	0.1	2.8	-

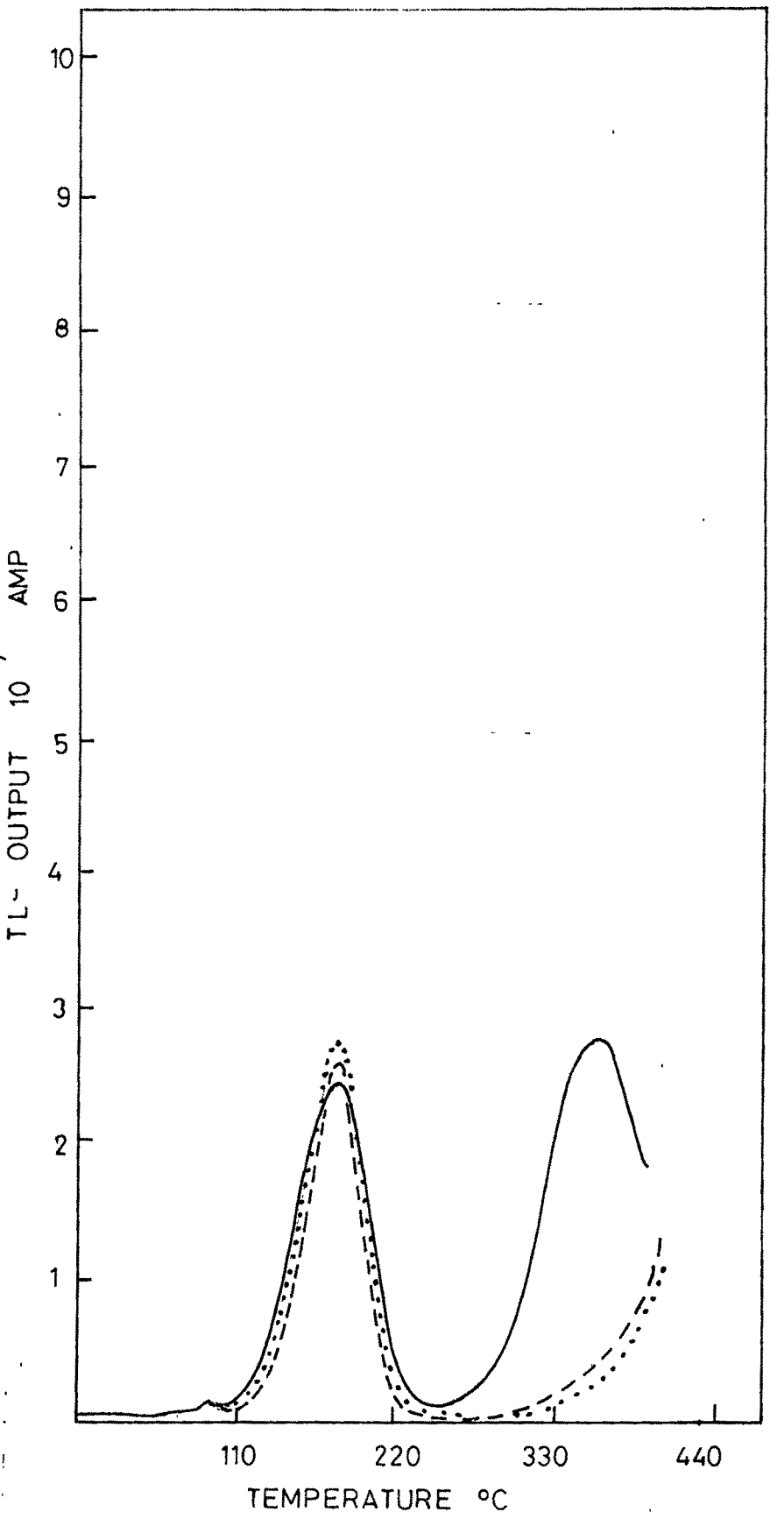


FIG. 12

FIGURE 13A : TL glow curve for pure NaCl, as-received from the solution; exposure 1 min. beta.

Curve 1. ———— Exposure 1 min. beta.

Curve	Exposure	TL glow peak intensities in units of 10^{-7} Amperes.		
		90°C	180°C	240°C
1.	1 min. beta	1.8	-	0.8

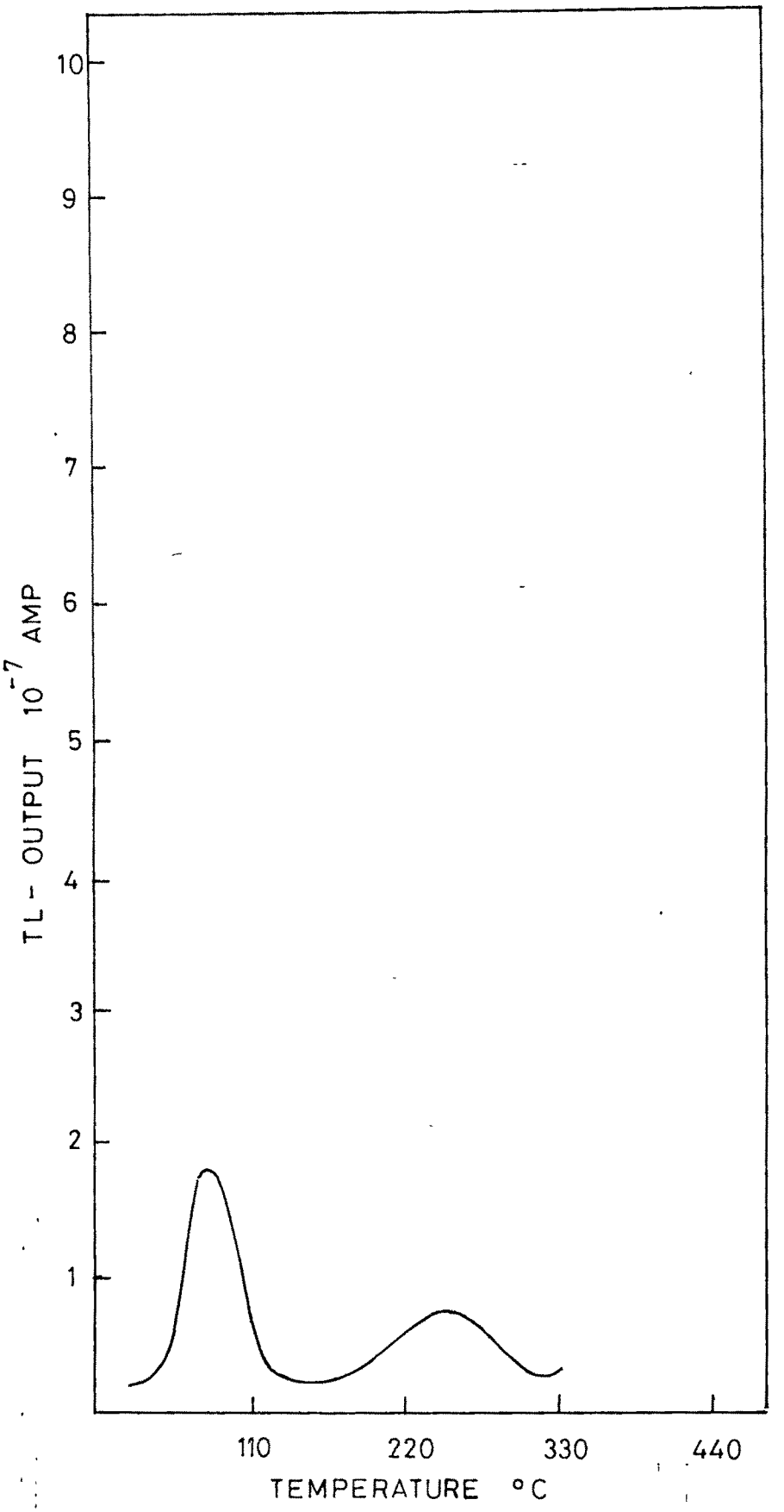


FIG. 13A

FIGURE 13 B : TL glow curve for pure NaCl, as-received from the solution, exposure 1 min. gamma.

Curve 1. ———— Exposure 1 min. gamma.

Curve	Exposure	TL glow peak intensities in units of 10^{-7} Amperes.		
		90°C	180°C	240°C
1.	1 min. gamma	3.5	1.2	2.7

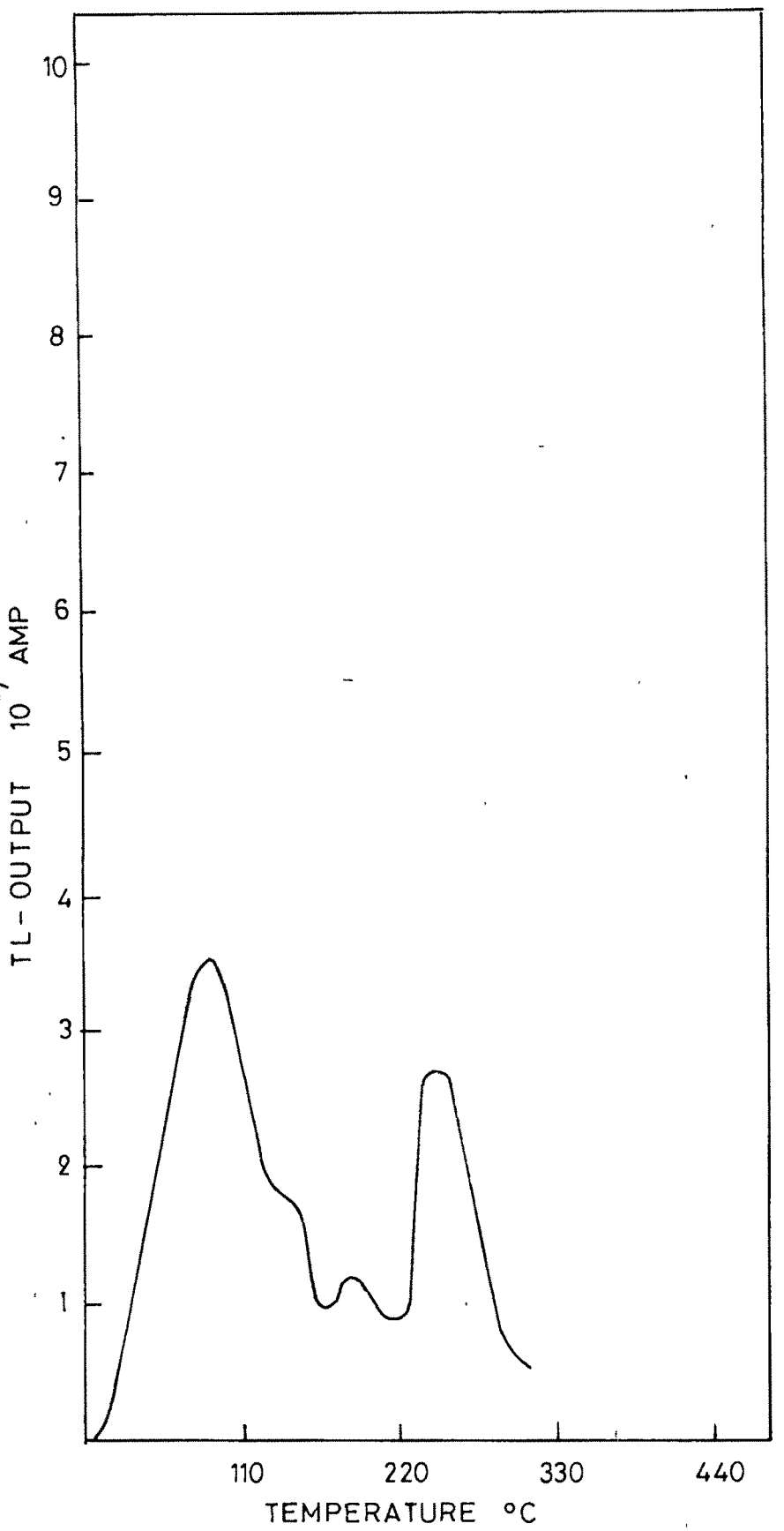


FIG. 13 B

FIGURE 14 A : TL glow curve for pure NaCl, annealed and quenched from 500°C; exposure 1 min. beta.

Curve 1. ———— Exposure 1 min. beta.

Curve	Exposure	TL glow peak intensities in units 10^{-6} Amperes.		
		90°C	140°C	240°C
1.	1 min. beta	0.85	-	2.2

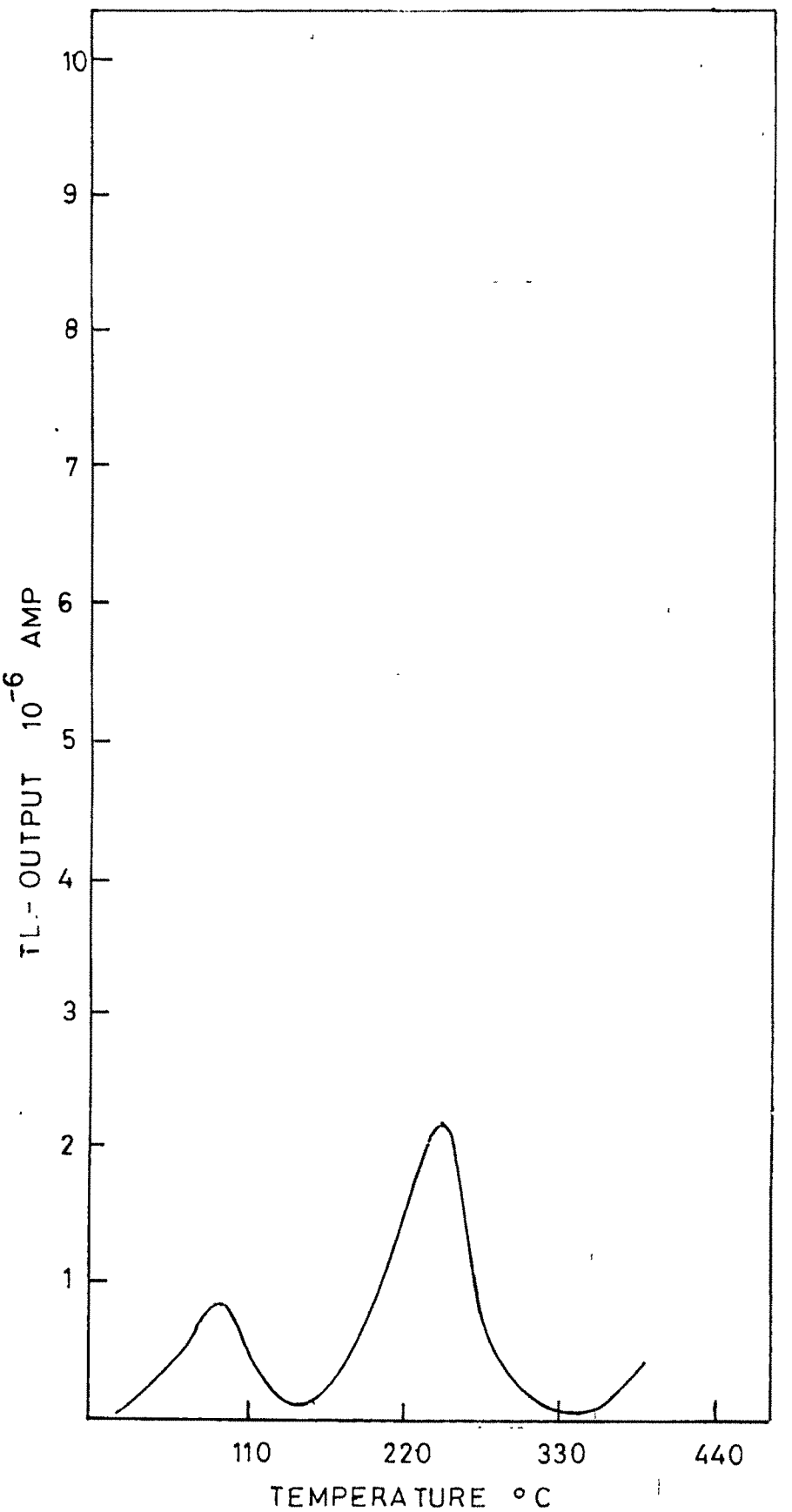


FIG. 14A

FIGURE 14 B : TL glow curve for pure NaCl, annealed and quenched from 500°C, exposure 1 min. gamma.

Curve 1. ———— Exposure 1 min. gamma.

Curve	Exposure	TL glow peak intensities in units of 10^{-6} Amperes.		
		90°C	140°C	240°C
1.	1 min. gamma	0.55	0.5	6.0

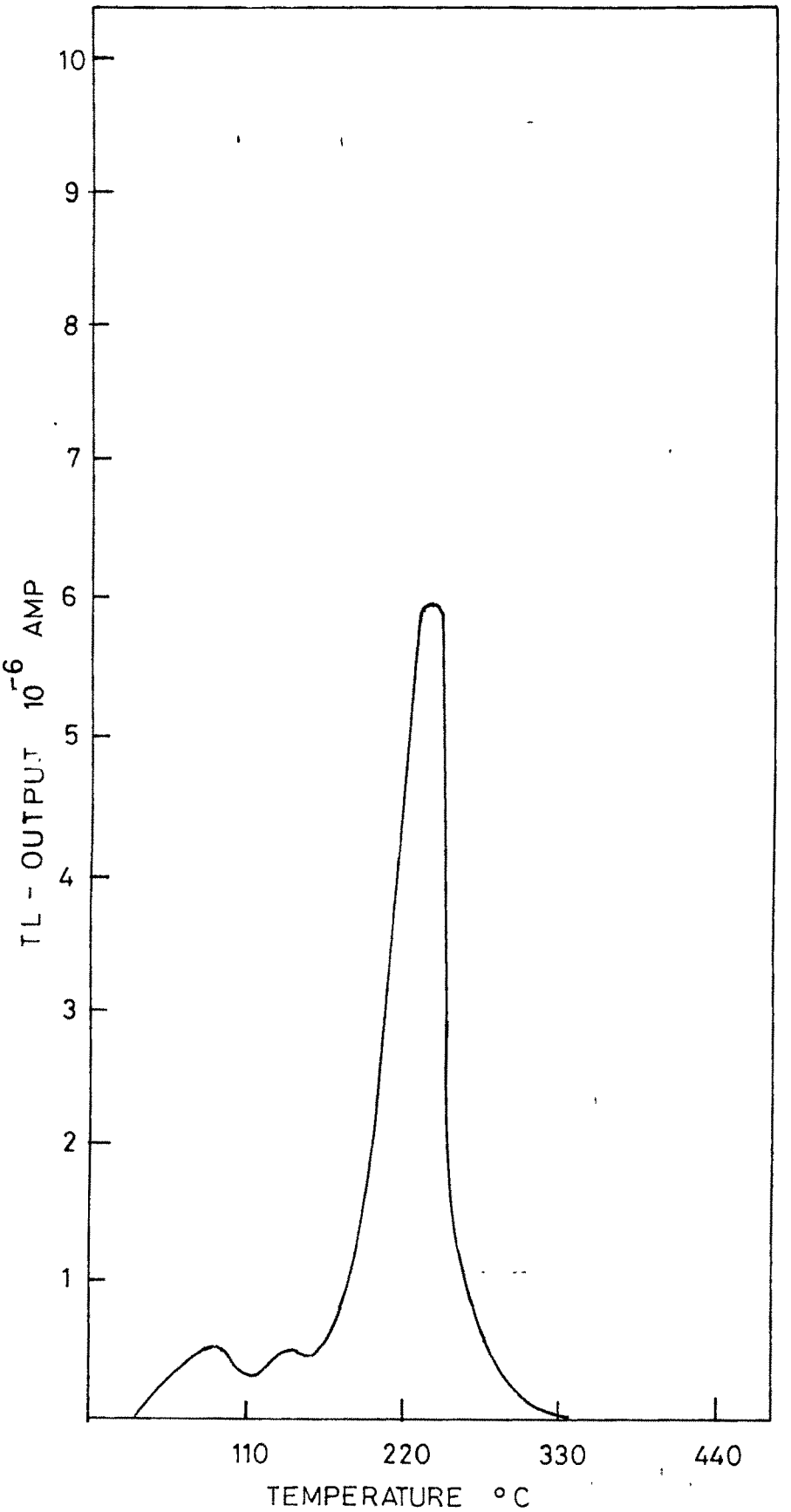


FIG. 14 B

FIGURE 15 A : TL glow curve for pure NaCl, annealed and quenched from 750°C; exposure 1 min. beta.

Curve 1. ———— Exposure 1 min. beta.

Curve	Exposure	TL glow peak intensities in units of 10^{-7} Amperes.		
		90°C	140°C	240°C
1.	1 min. beta	0.8	-	8.0

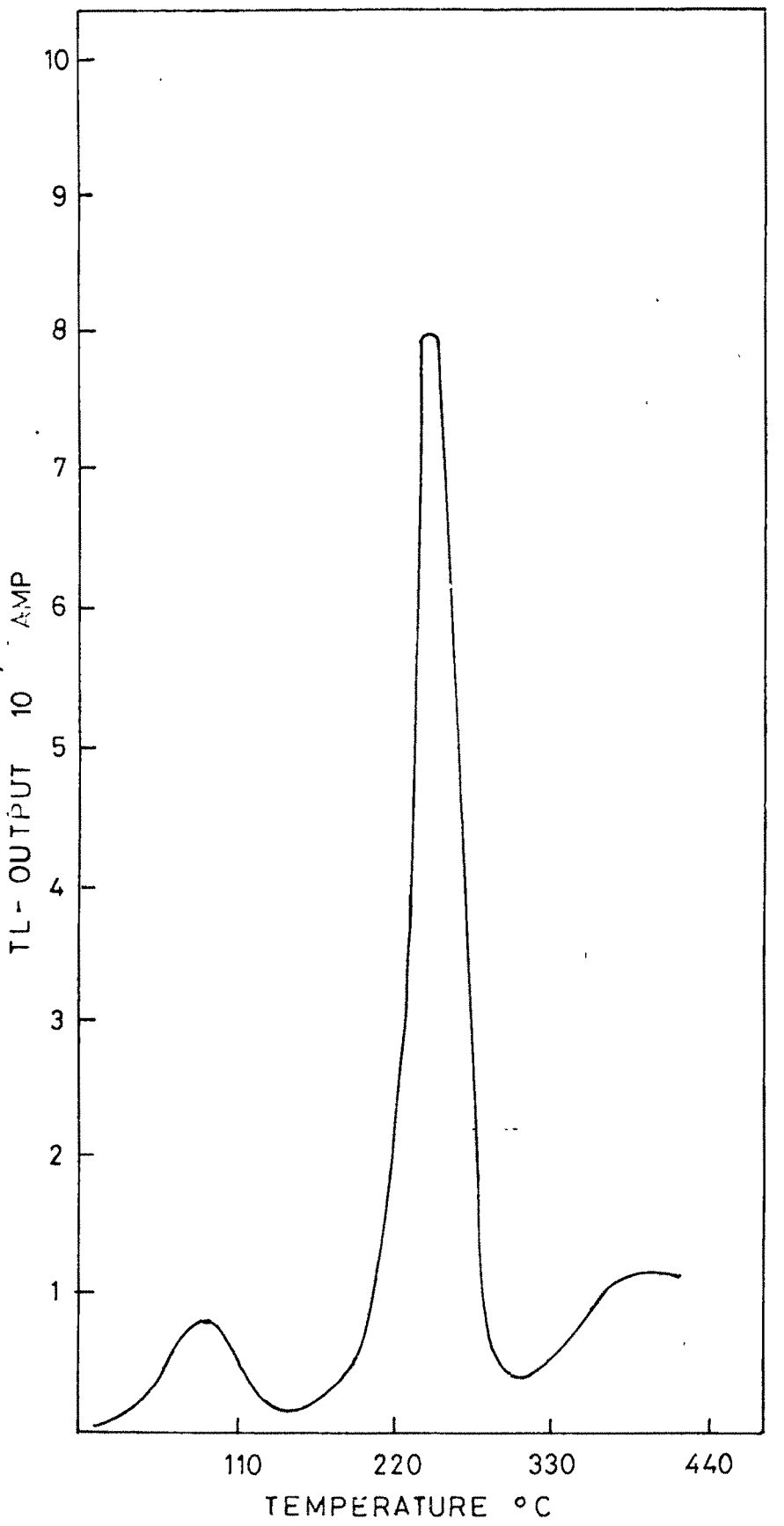


FIG. 15 A

FIGURE 15 B : TL glow curves for pure NaCl, annealed and quenched from 750°C, exposure 1 min. gamma.

Curve 1. ———— Exposure 1 min. gamma.
2. ---------- Exposure 4 min. UV.

Curve	Exposure	TL glow peak intensities in units of 10^{-7} Amperes.			
		90°C	140°C	167°C	240°
1.	1 min. gamma	7.0	8.5	-	18.5
2	4 min. UV	-	-	4.9	-

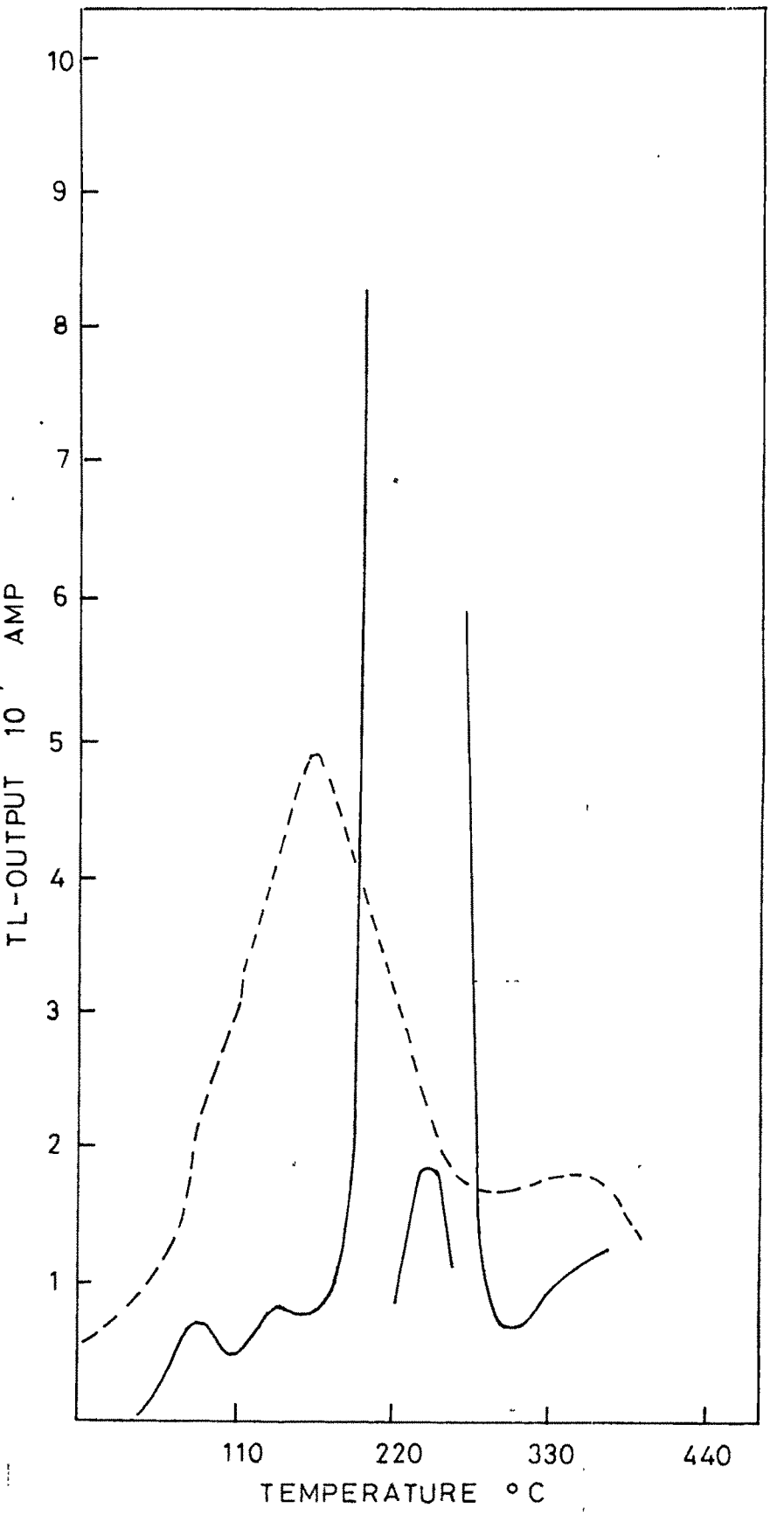


FIG. 15 B

FIGURE 16 A : TL glow curve for NaCl:Ba (10^{-5} m.f.) annealed and quenched from 750°C; exposure 1 min. beta.

Curve 1. ———— Exposure 1 min. beta.

Curve	Exposure	TL glow peak intensities in units of 10^{-6} Amperes.		
		90°C	140°C	240°C
1.	1 min . beta	0.65	0.5	7.8

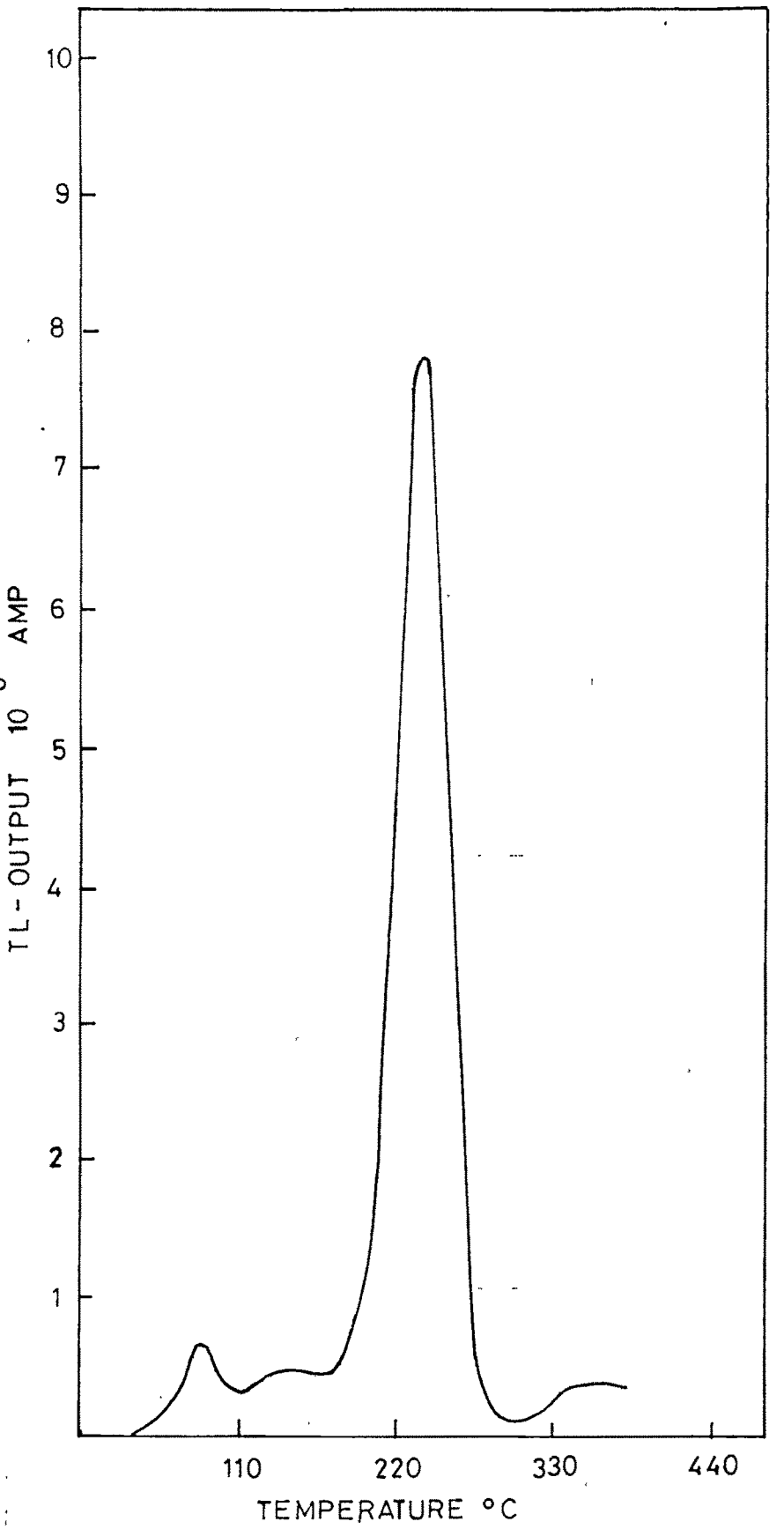


FIG. 16A

FIGURE 16 B : TL glow curve for NaCl:Ba (10^{-5}m.f.) annealed and quenched from 750°C; exposure 1 min. gamma.

Curve 1. ———— Exposure 1 min. gamma.

Curve	Exposure	TL peak intensities in units of 10^{-6} Amperes.		
		90°C	140°C	240°C
1.	1 min. gamma	1.5	1.8	24.0

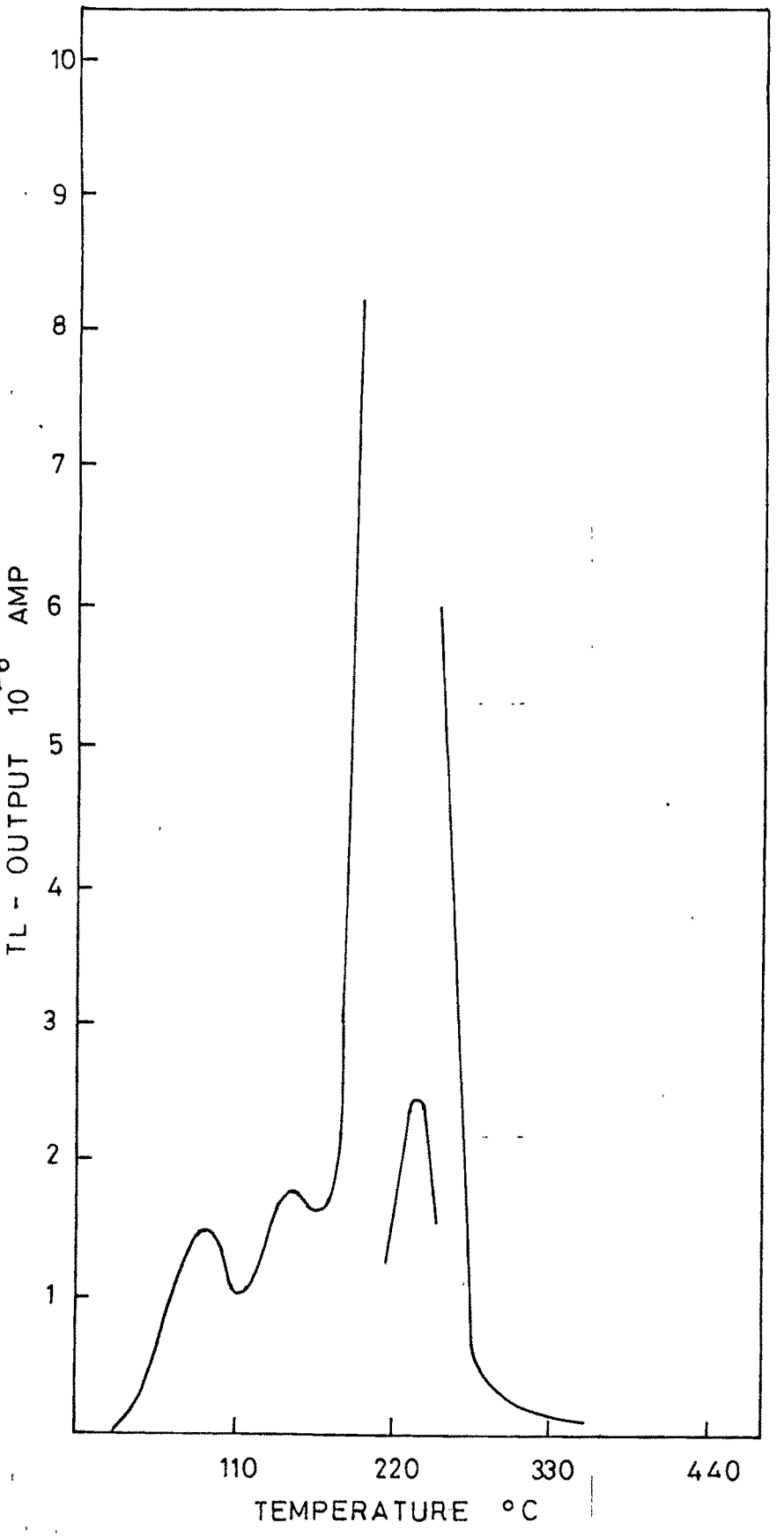


FIG. 16 B

FIGURE 17 A : TL glow curves for NaCl:Ba (10^{-2}m.f.) annealed and quenched from 750°C; exposure 1 min. beta.

Curve 1. ———— Exposure 1 min. beta.

Curve	Exposure	TL glow peak intensities in units of 10^{-6} Amperes.		
		90°C	140°C	220°C
1.	1 min. beta	0.9	2.7	9.0

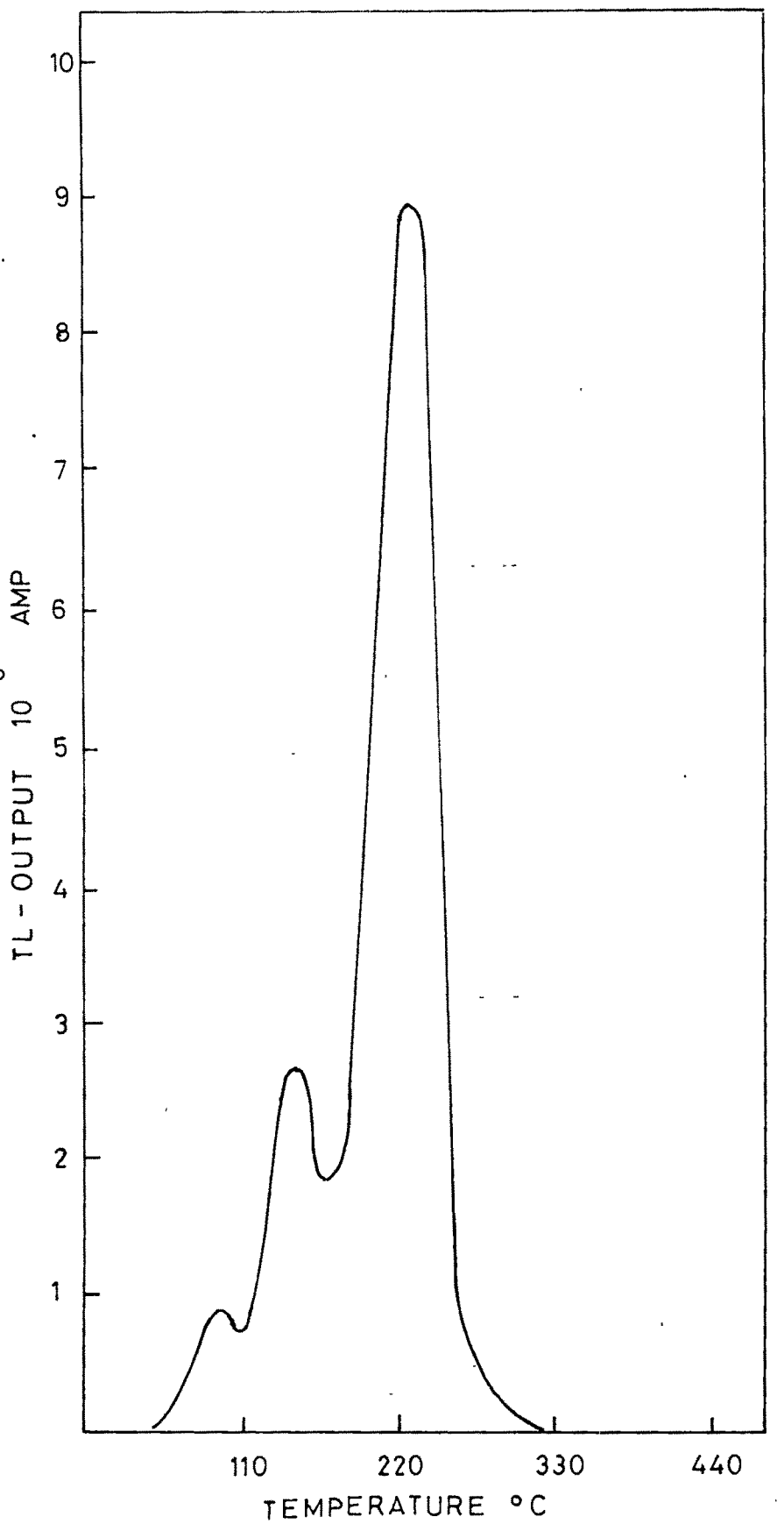


FIG. 17A

FIGURE 17 B : TL glow curves for NaCl:Ba (10^{-2}m.f.) annealed and quenched from 750°C; exposure 1 min. gamma.

Curve 1. ———— Exposure 1 min. gamma.

Curve	Exposure	TL glow peak intensities in units of 10^{-6} Amperes.		
		90°C	140°C	220°C
1.	1 min. gamma	3.0	8.6	42.0

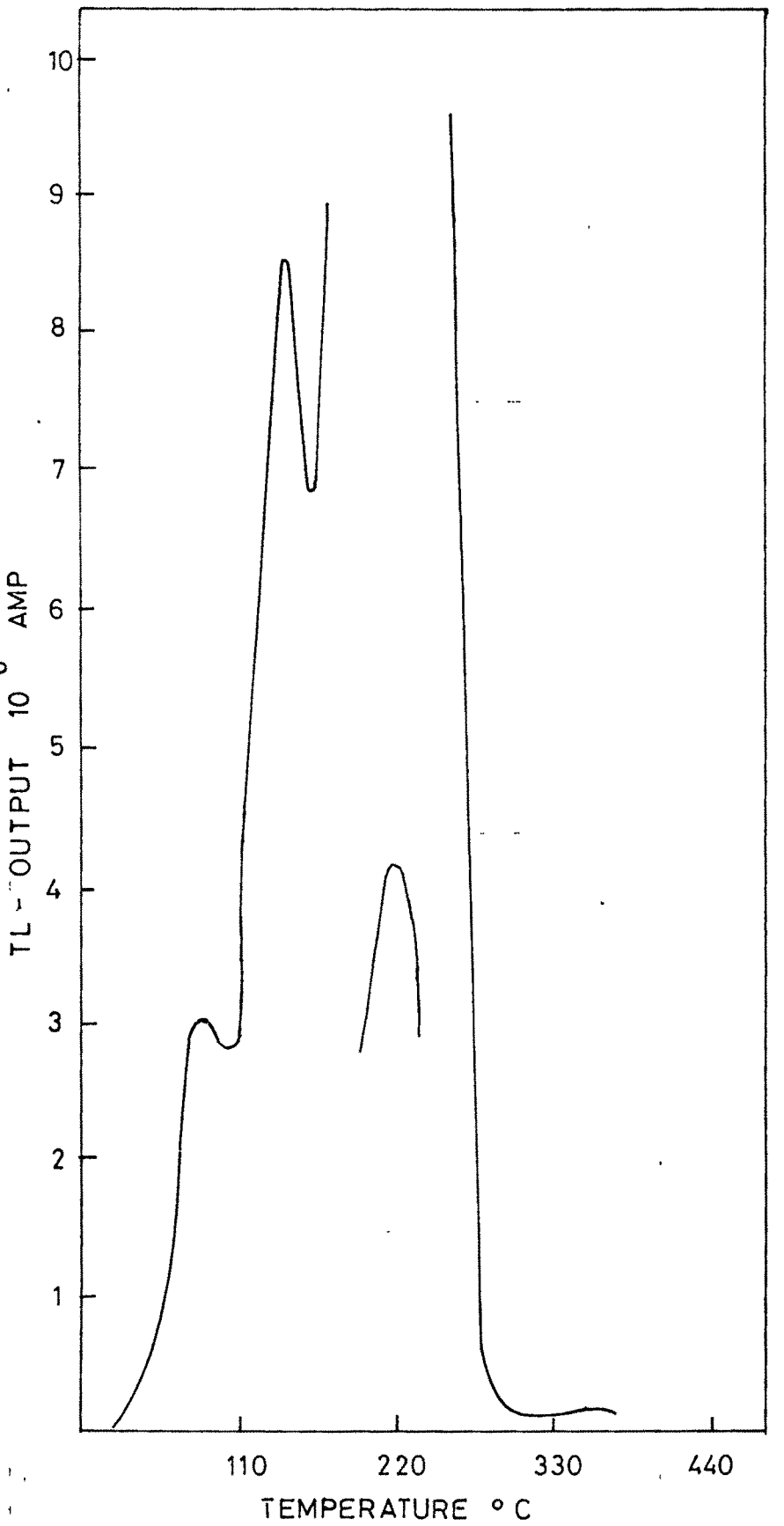


FIG. 17B

FIGURE 18 A : TL glow curve for NaCl:Ba (10^{-1}m.f.) annealed and quenched from 750°C; exposure 1 min. beta.

Curve 1. ———— Exposure 1 min. beta.

Curve	Exposure	TL glow peak intensities in units of 10^{-6} Amperes.		
		90°C	140°C	180°C
1.	1 min. beta	0.3	5.0	10.4

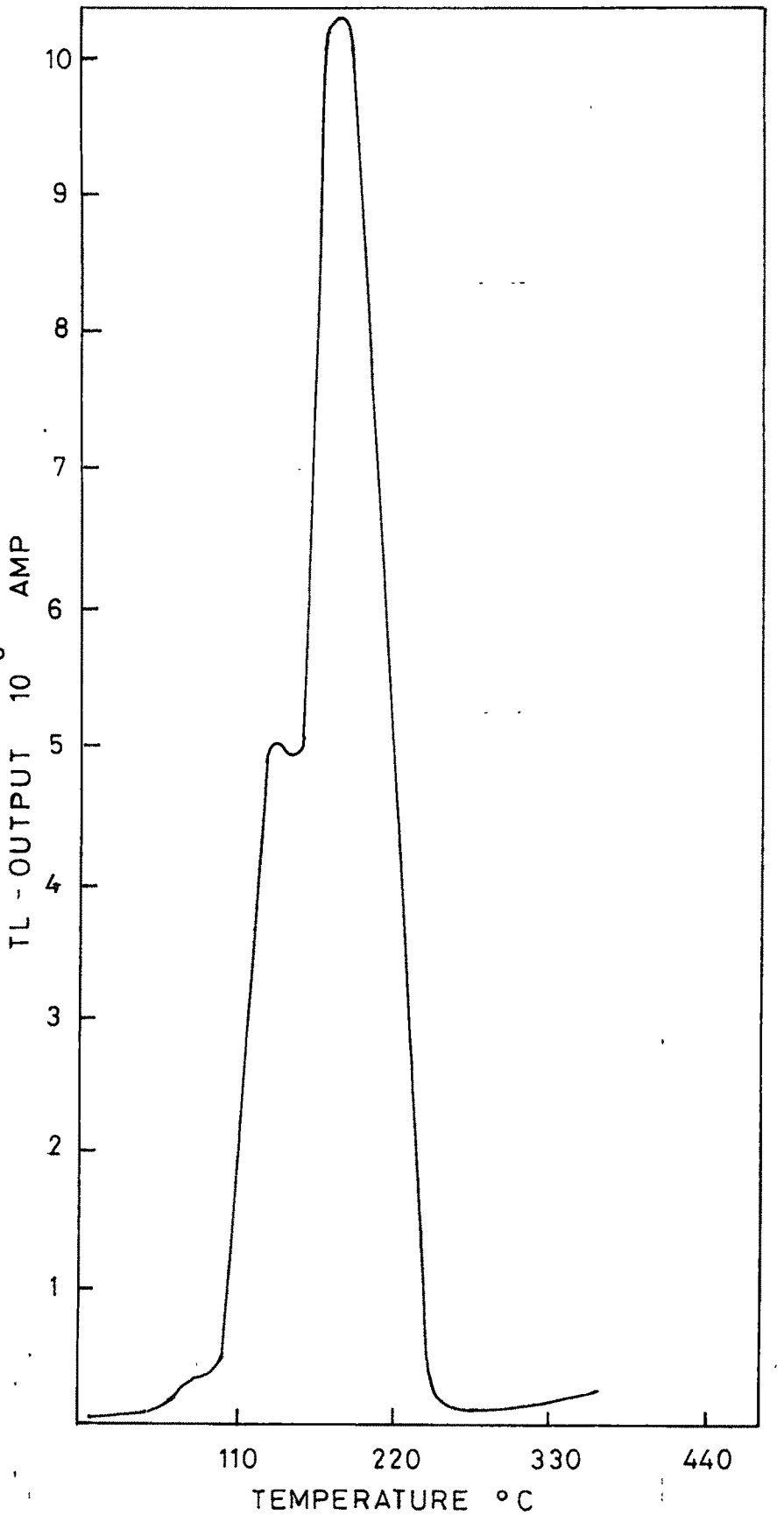


FIG. 18A

FIGURE 18 B : TL glow curve for NaCl:Ba (10^{-1} m.f.) annealed and quenched from 750°C; exposure 1 min. gamma.

Curve 1. ———— Exposure 1 min. gamma.

Curve	Exposure	TL glow peak intensities in units of 10^{-6} Amperes.		
		90°C	140°C	180°C
1.	1 min. gamma	-	21.5	25.5

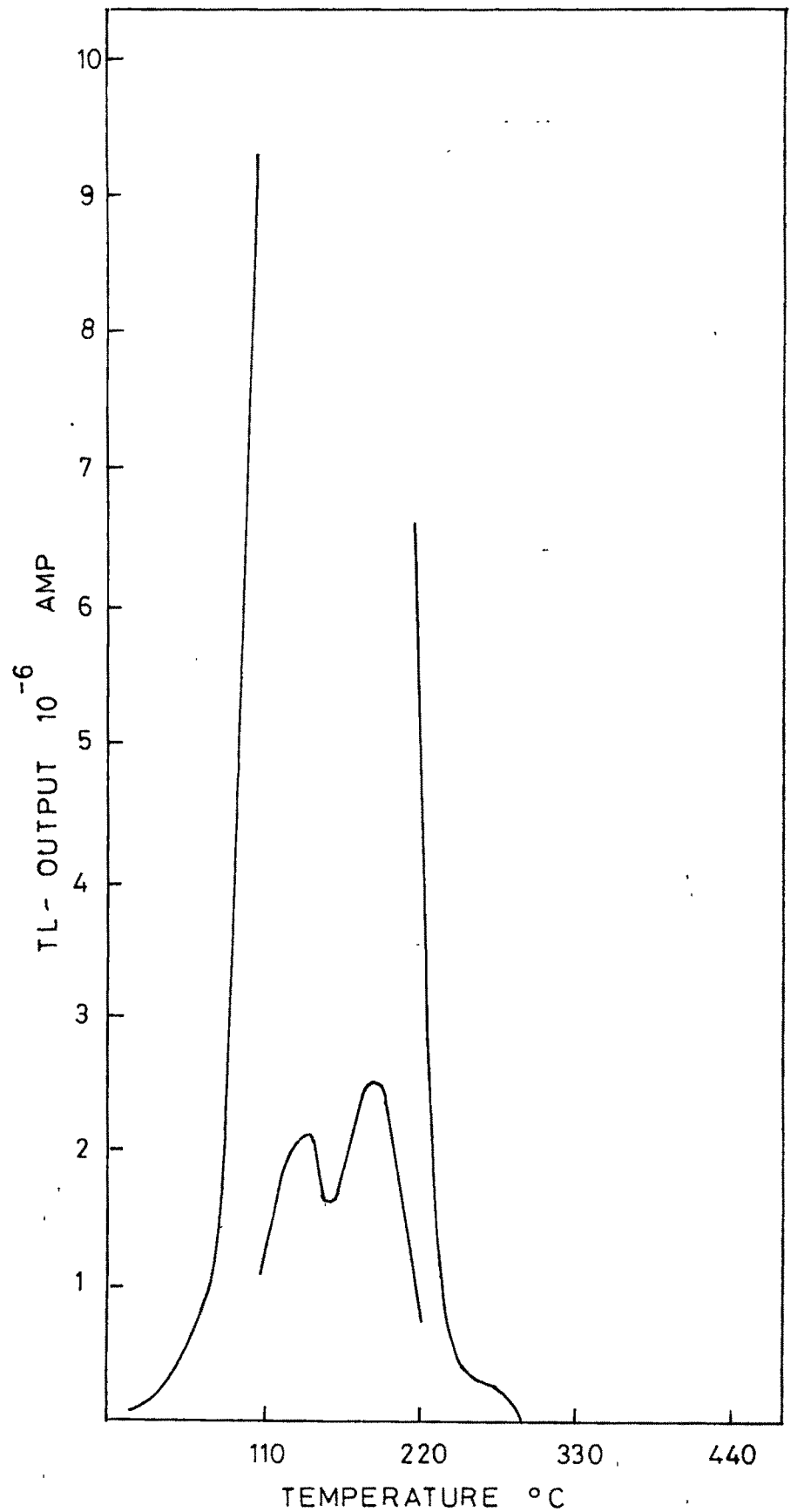


FIG. 18 B

FIGURE 19 : TL glow curves for pure KCl as-received from solution; exposure 1 min. alpha.

Curves
1. ———— Ist thermal cycle.
2. ---------- IInd thermal cycle.
3. ..... IIIrd thermal cycle.

Sr. No.	Thermal Cycle Number	TL glow peak intensities in units of 10^{-8} Amperes.			
		90°C	100°C	170°C	340°C
1.	I	0.3	-	-	5.0
2.	II	0.4	0.6	-	-
3.	III	0.5	0.7	-	-

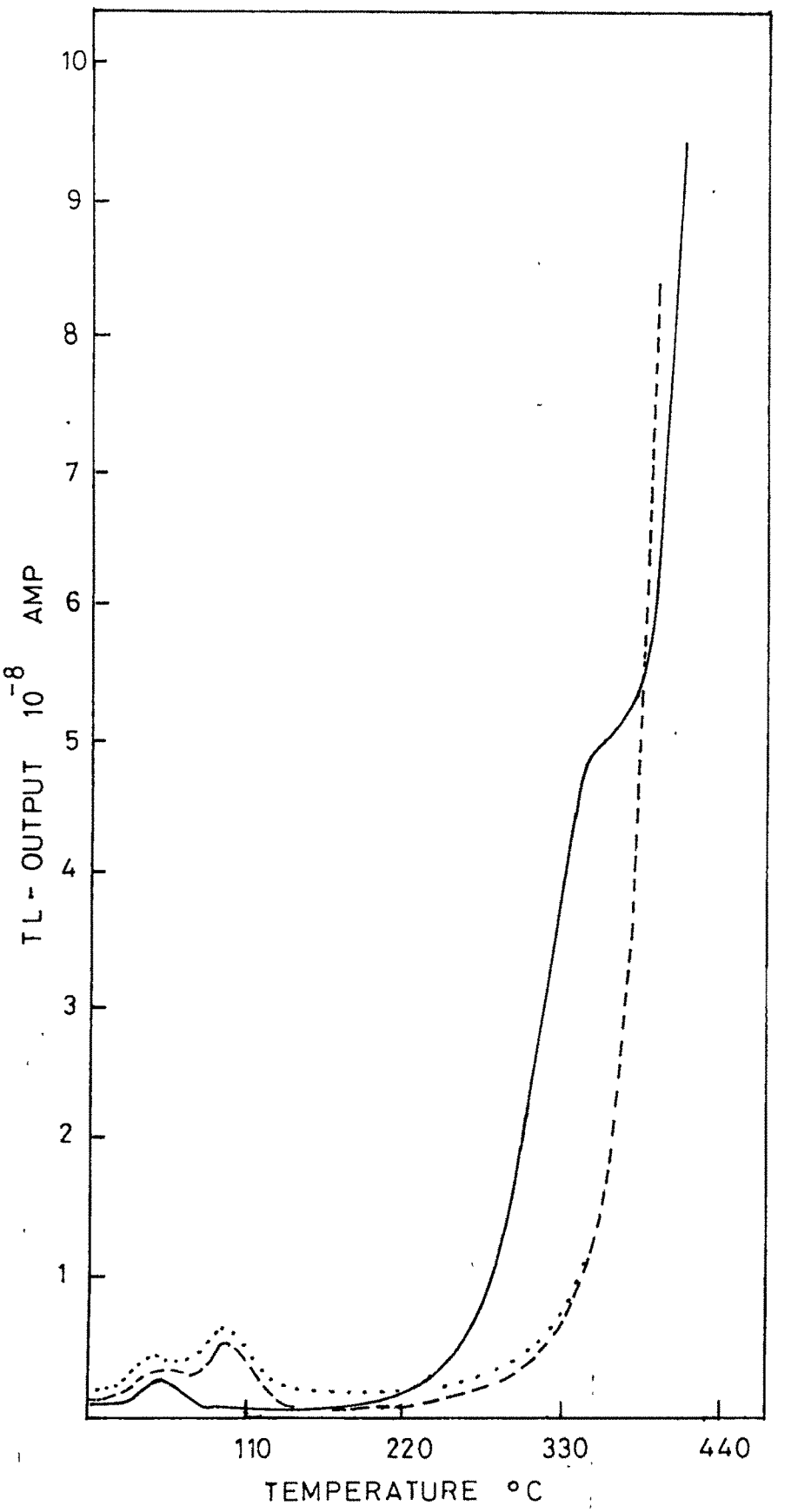


FIG. 19

FIGURE 20 : TL glow curves for pure KCl, annealed and quenched from 500°C, exposure 1 min. alpha.

Curves
1. ———— Ist thermal cycle.
2. ---------- IInd thermal cycle.
3. ..... IIIrd thermal cycle.

Sr. No.	Thermal Cycle Number	TL glow peak intensities in units of 10^{-8} Amperes.			
		50°C	100°C	170°C	340°C
1.	I	0.3	-	-	5.0
2.	II	-	0.5	-	-
3.	III	-	0.5	-	-

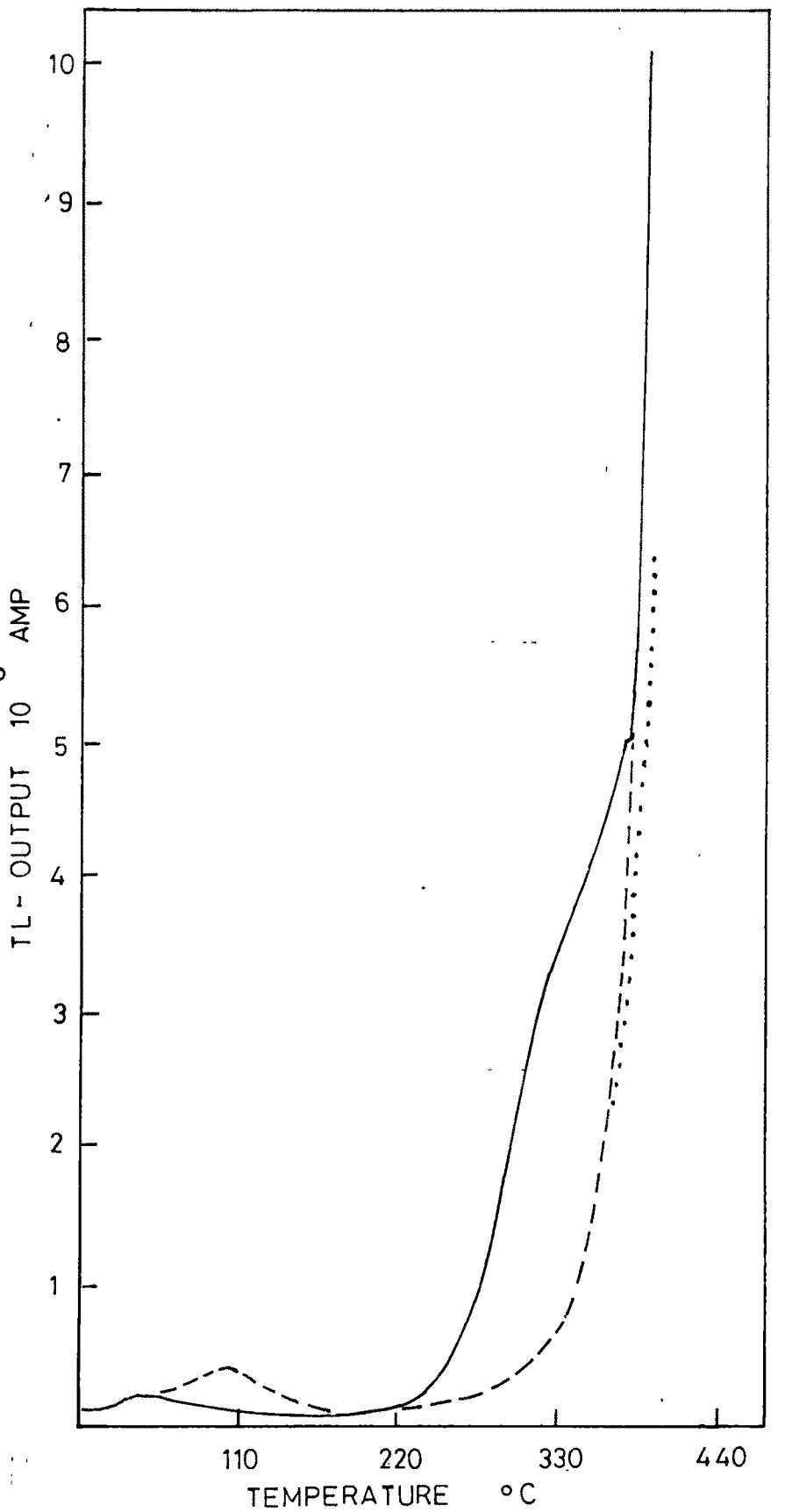


FIG. 20

FIGURE 21 : TL glow curves for pure KCl annealed and quenched from 750°C, exposure 1 min. alpha.

Curves
1. ———— Ist thermal cycle.
2. ---------- IInd thermal cycle.
3. ..... IIIrd thermal cycle.

Sr. No.	Thermal Cycle Number	TL glow peak intensities in units of 10^{-8} Amperes.			
		50°C	100°C	170°C	340°C
1.	I	0.3	-	-	4.0
2.	II	-	0.4	-	-
3.	III	-	0.4	-	-

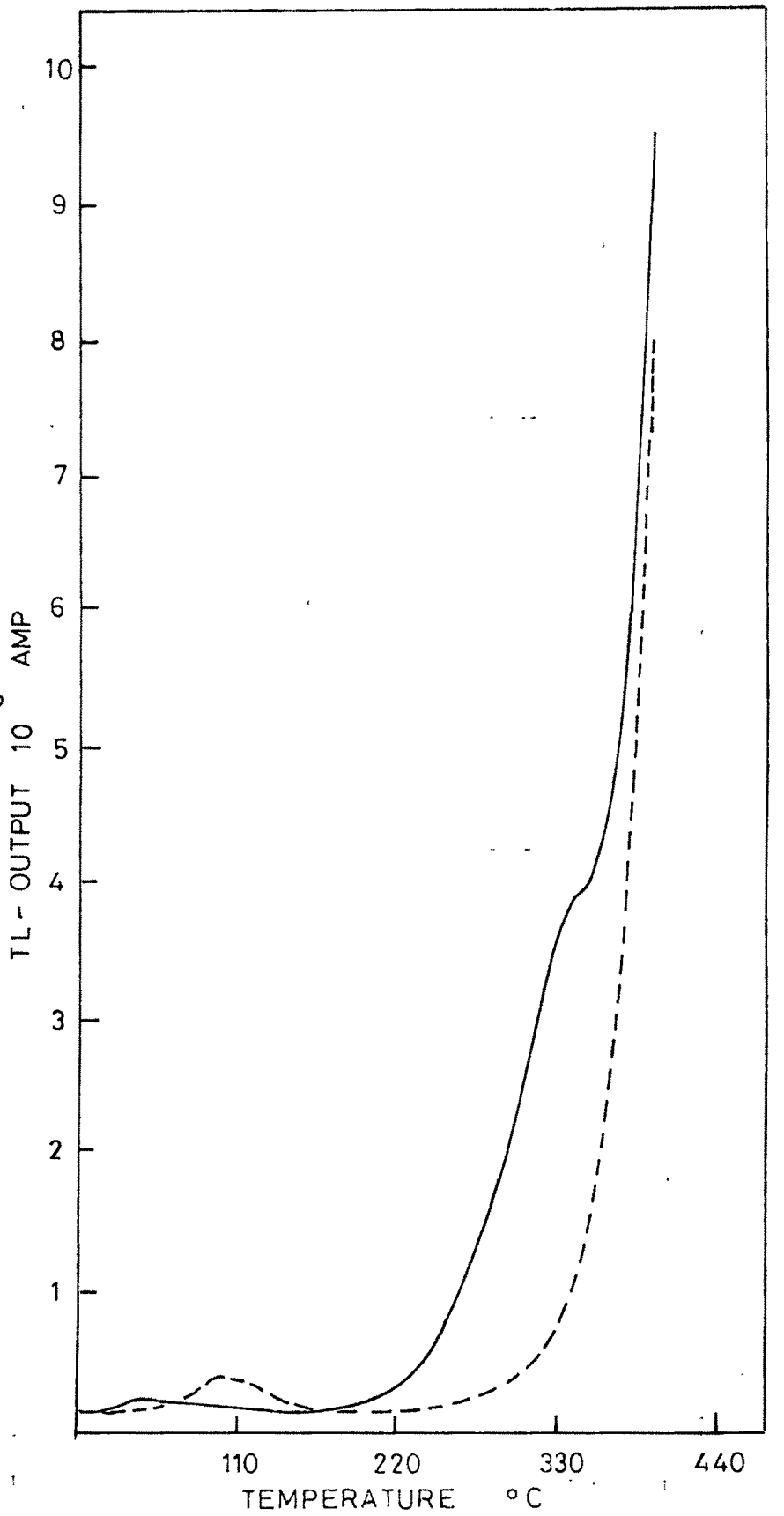


FIG. 21

FIGURE 22 TL glow curves for pure KCl, as-received from solution; exposure 1 min. alpha.

Curves
1. ———— Ist thermal cycle.
2. ---------- IInd thermal cycle.
3. ..... IIIrd thermal cycle.

Sr. No.	Thermal Cycle Number	TL glow peak intensities in units of 10^{-8} Amperes.			
		50°C	100°C	170°C	340°C
1.	I	0.4	-	-	8.8
2.	II	0.7	1.8	-	-
3.	III	0.7	1.9	-	-

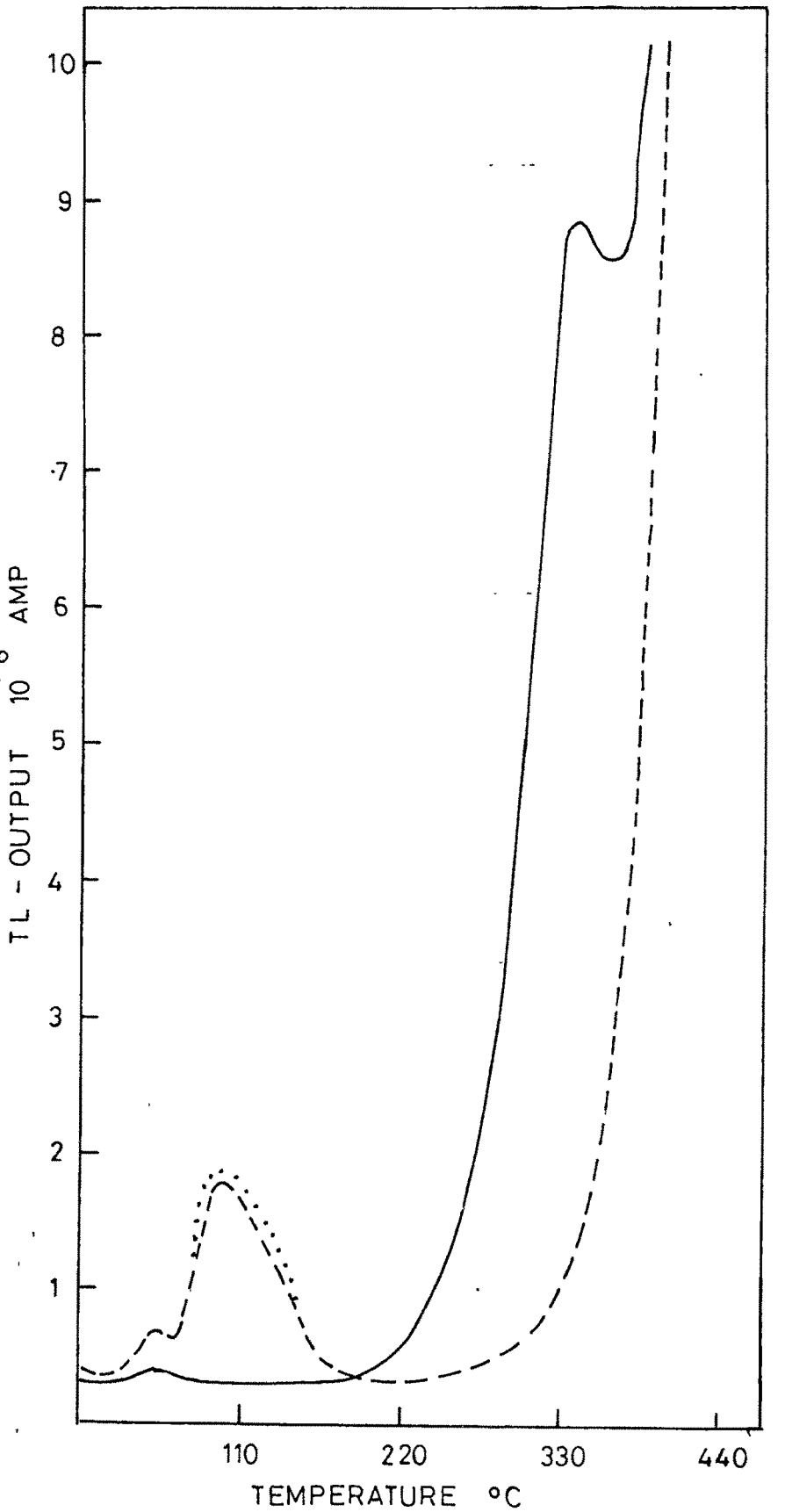


FIG. 22

FIGURE 23 : TL glow curves for KCl:Ba (10^{-5}m.f.) annealed and quenched from 500°C; exposure 1 min. alpha.

Curves
1. ———— Ist thermal cycle.
2. ---------- IInd thermal cycle.
3. ..... IIIrd thermal cycle.

Sr. No.	Thermal Cycle Number	TL glow peak intensities in units of 10^{-8} Amperes.			
		50°C	100°C	170°C	340°C
1.	I	0.3	-	-	7.3
2.	II	0.6	1.9	-	-
3.	III	0.6	2.2	-	-

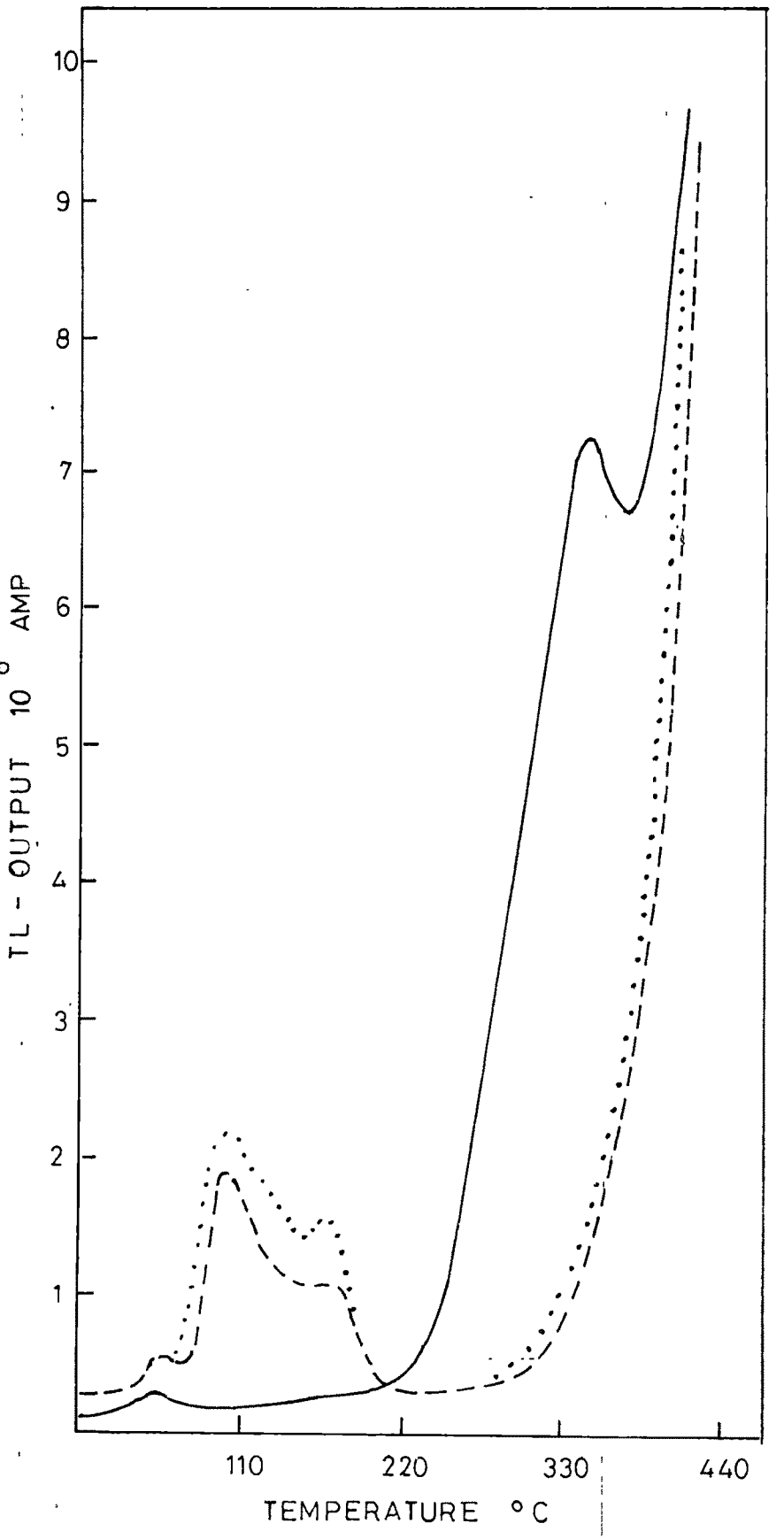


FIG. 23

FIGURE 24 : TL glow curves for KCl:Ba (10^{-5}m.f.) annealed and quenched from 750°C; exposure 1 min. alpha.

Curves
1. ———— Ist thermal cycle.
2. ---------- IInd thermal cycle.
3. ..... IIIrd thermal cycle.

Sr. No.	Thermal Cycle Number	TL glow peak intensities in units of 10^{-8} Amperes.			
		50°C	100°C	170°C	340°C
1.	I	0.3	-	0.5	6.2
2.	II	-	0.5	0.9	-
3.	III	-	0.6	1.5	-

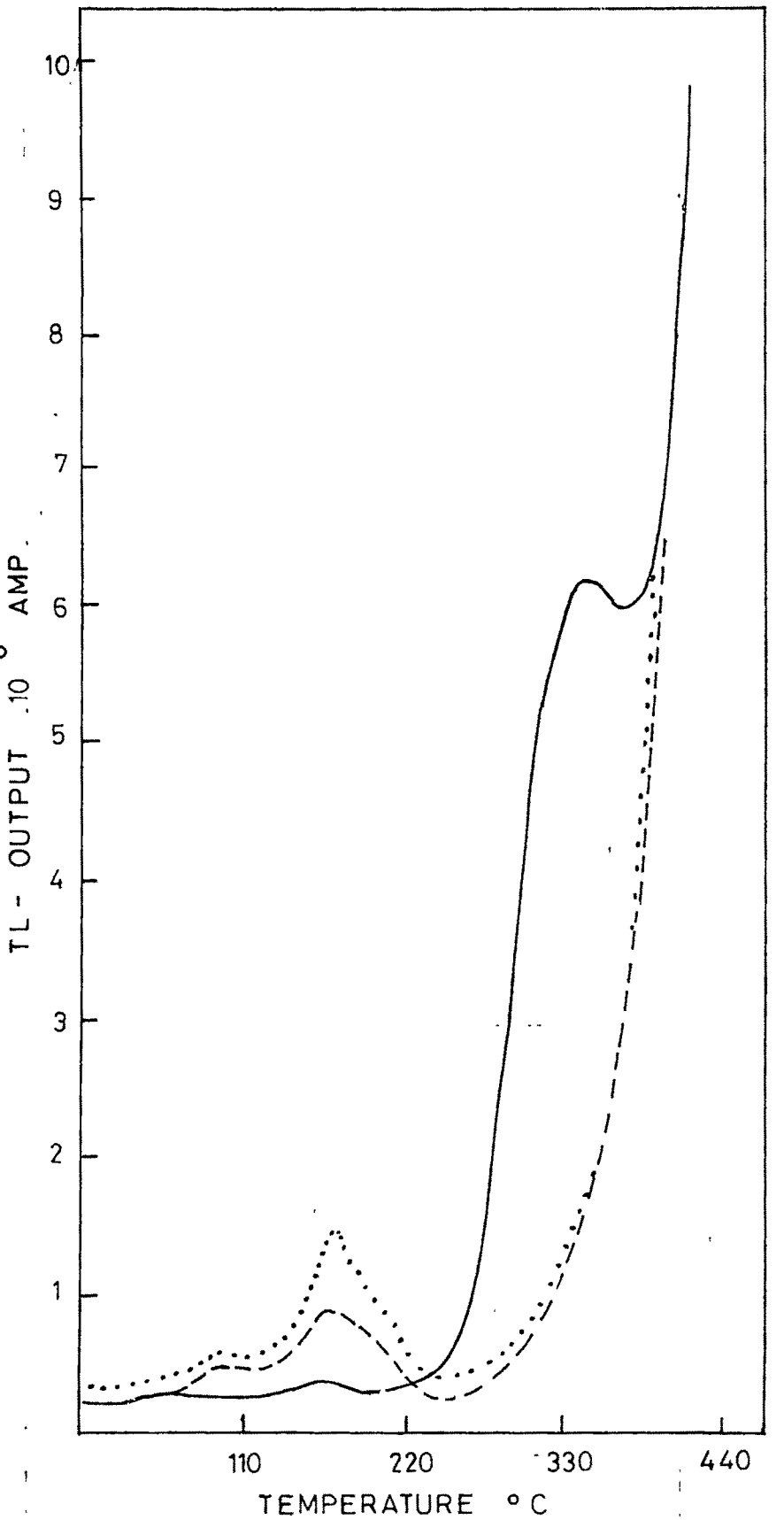


FIG. 24

FIGURE 25 : TL glow curves for KCl:Ba (10^{-2}m.f.) as-received from solution exposure 1 min. alpha.

Curves
1. ———— Ist thermal cycle.
2. -- . ----- IInd thermal cycle.
3. ..... IIIrd thermal cycle.

Sr. No.	Thermal Cycle Number	TL glow peak intensities in units of 10^{-8} Amperes.			
		50°C	100°C	170°C	340°C
1.	I	0.3	-	-	5.3
2.	II	0.4	0.65	-	-
3.	III	0.4	0.65	-	-

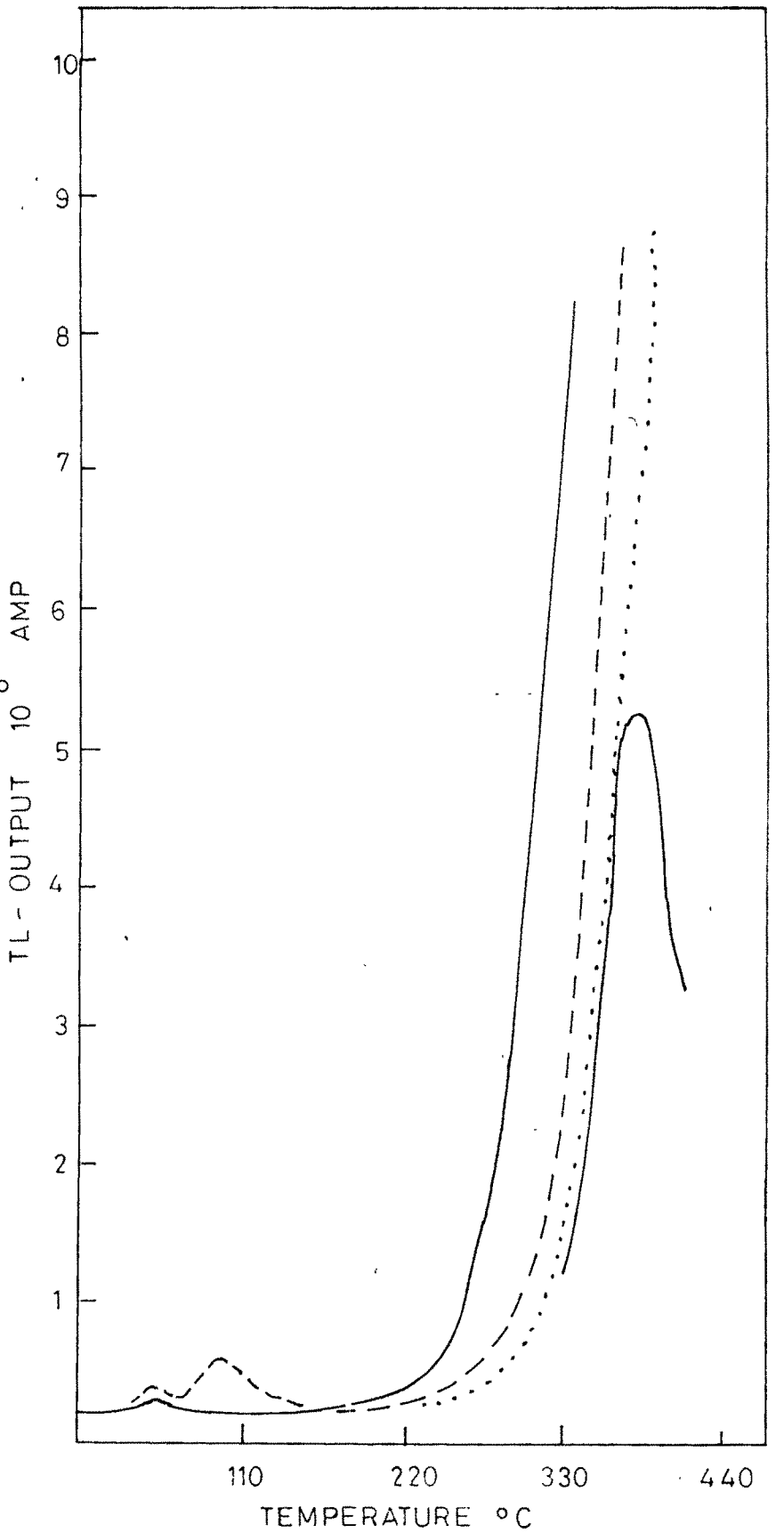


FIG. 25

FIGURE 26 : TL glow curves for KCl:Ba (10^{-2}m.f.) annealed and quenched from 500°C; exposure 1 min. alpha.

Curves
1. ———— Ist thermal cycle.
2. -------- -- IInd thermal cycle.
3. ..... IIIrd thermal cycle.

Sr. No.	Thermal Cycle Number	TL glow peak intensities in units of 10^{-8} Amperes.			
		50°C	100°C	170°C	340°C
1.	I	0.4	-	1.15	8.4
2.	II	0.5	1.0	4.8	-
3.	III	-	1.2	6.5	-

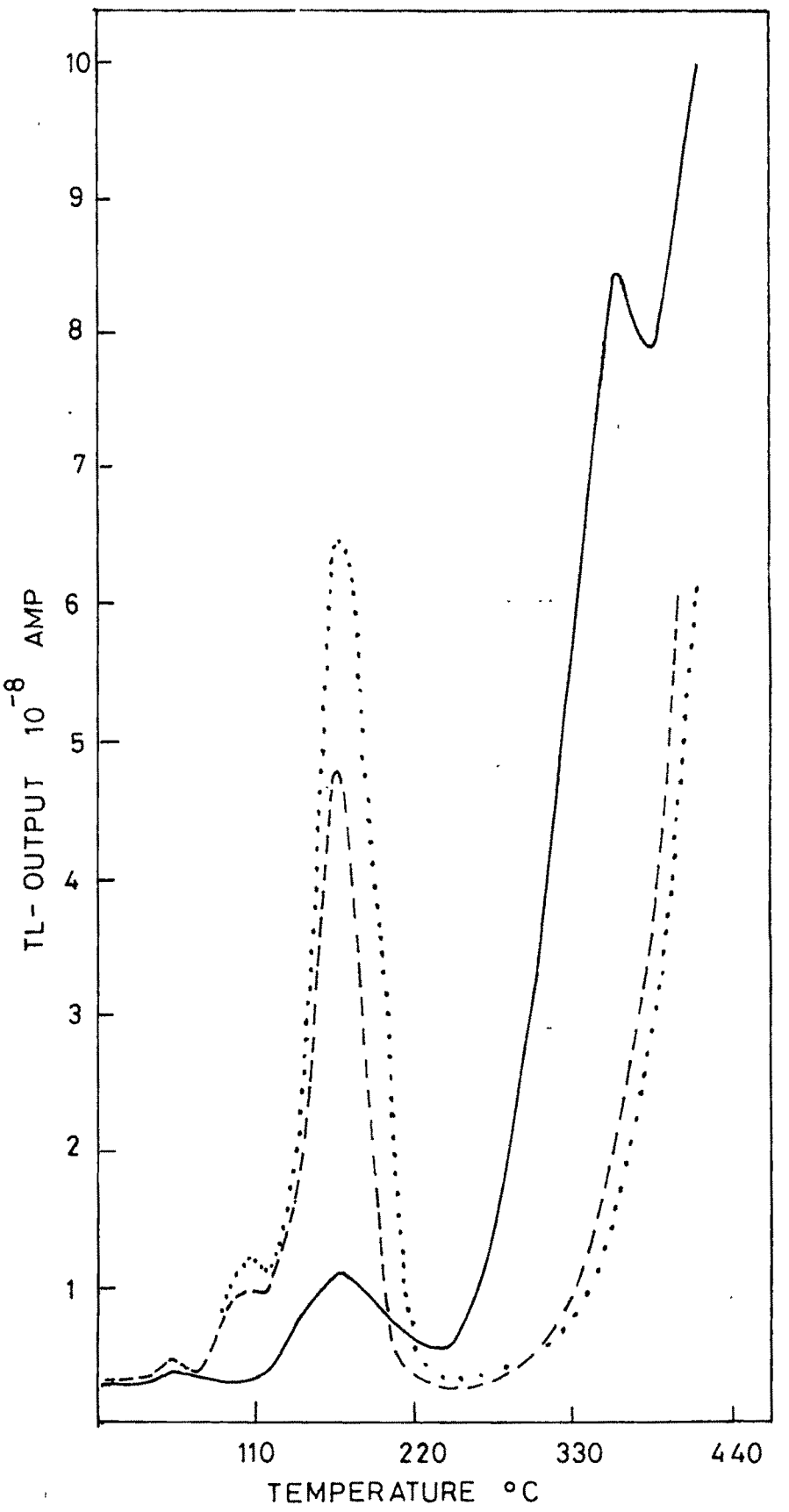


FIG. 26

FIGURE 27 : TL glow curves for KCl:Ba (10^{-2}m.f.) annealed and quenched from 750°C; exposure 1 min. alpha.

Curves
1. ———— Ist thermal cycle.
2. ---------- IInd thermal cycle.
3. ..... IIIrd thermal cycle.

Sr. No.	Thermal Cycle Number	TL glow peak intensities in units of 10^{-8} Amperes.			
		50°C	100°C	170°C	340°C
1.	I	-	-	1.2	22.0
2.	II	-	0.75	1.3	-
3.	III	-	0.75	1.5	-

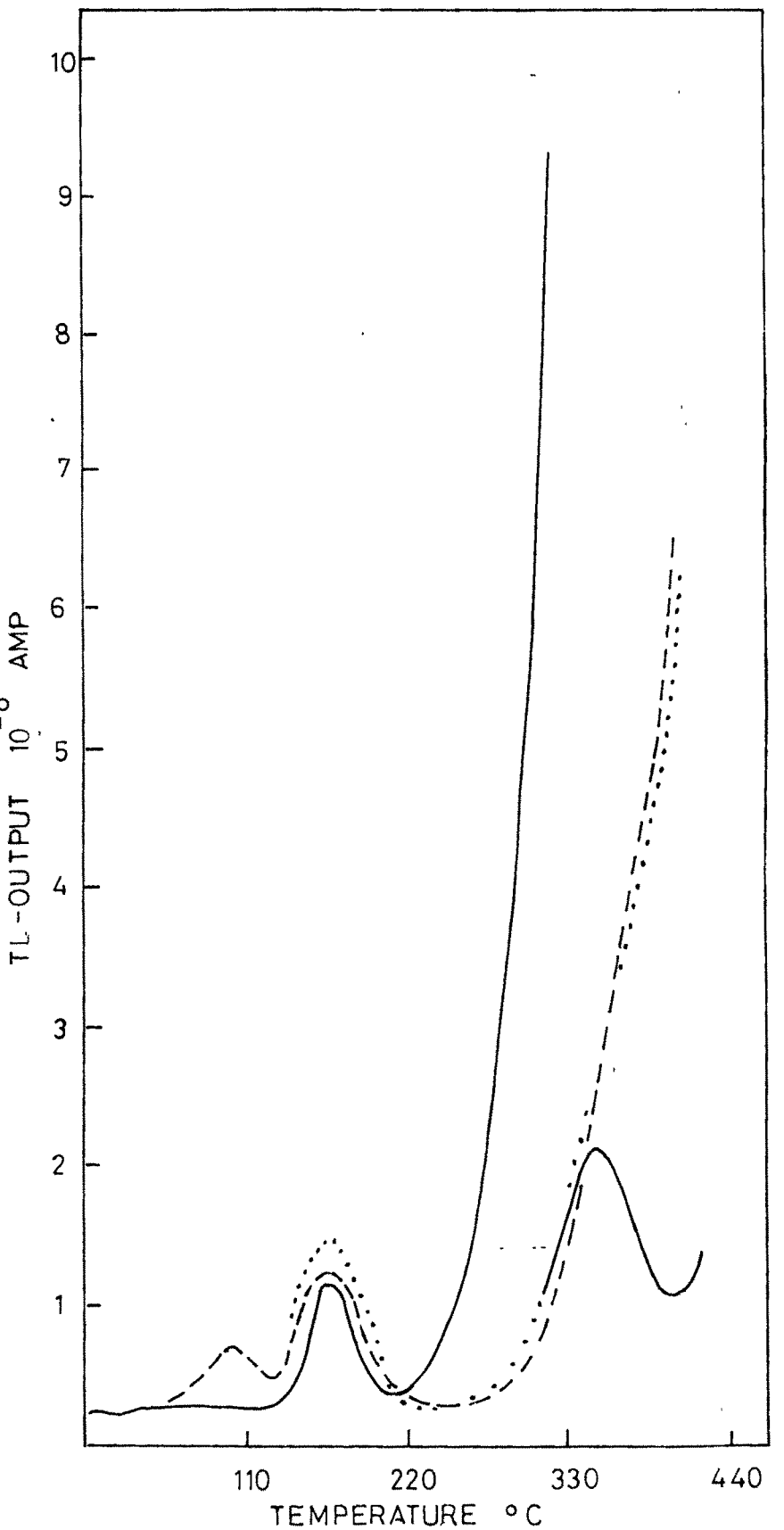


FIG. 27

FIGURE 28 : TL glow curves for KCl:Ba (10^{-1}m.f.) as-received from solution; exposure 1 min. alpha.

Curves
1. ———— Ist thermal cycle.
2. - - - - - - - - - - IInd thermal cycle.
3. ..... IIIrd thermal cycle.

Sr. No.	Thermal Cycle Number	TL glow peak intensities in units of 10^{-8} Amperes.			
		50°C	100°C	170°C	340°C
1.	I	0.4	-	0.3	5.0
2.	II	0.5	0.9	1.6	-
3.	III	0.6	1.0	1.7	-

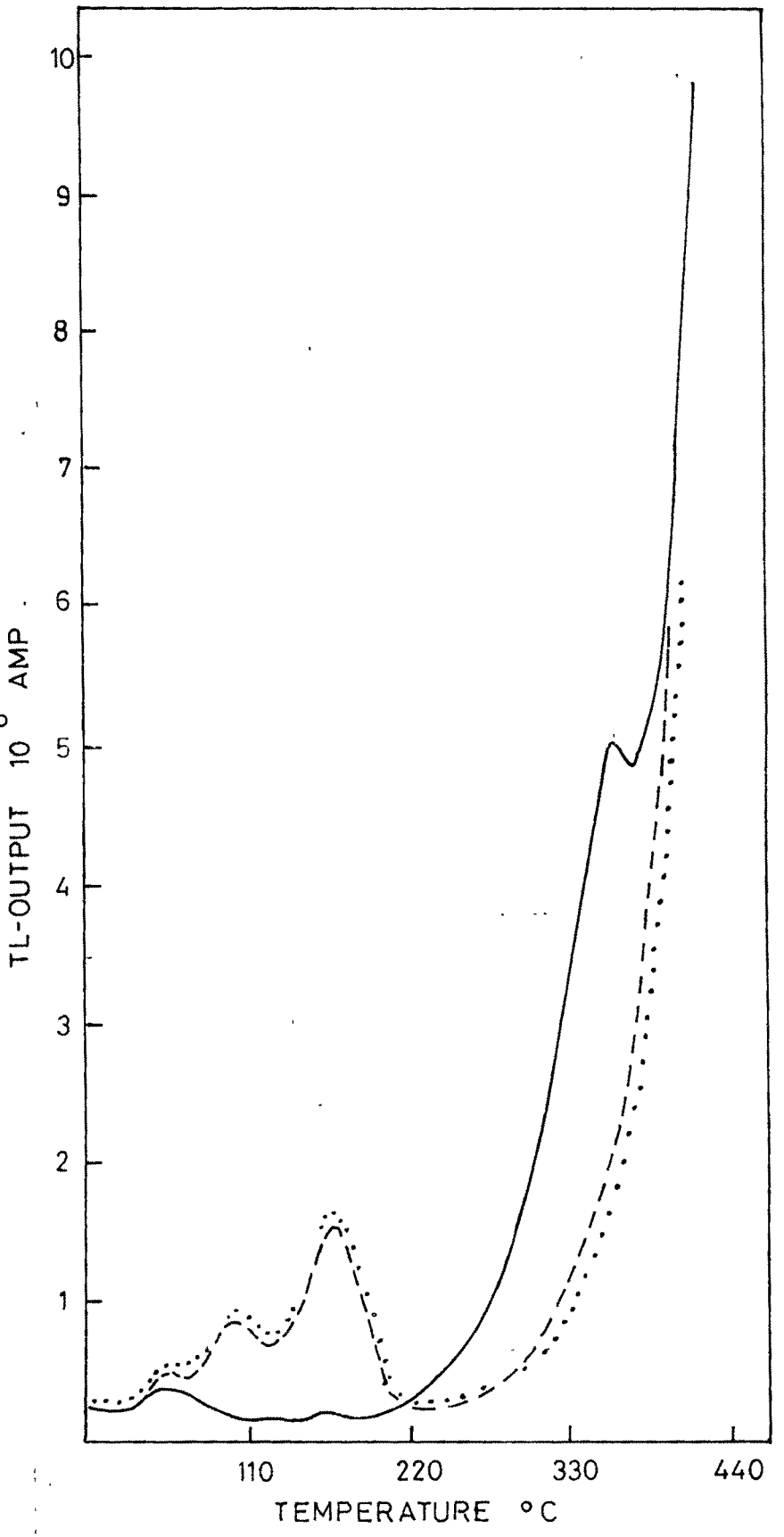


FIG. 28

FIGURE 29 : TL glow curves for KCl:Ba (10^{-1}m.f.) annealed and quenched from 500°C, exposure 1 min. alpha.

Curves
1. ———— Ist thermal cycle.
2. - - - - - - - - - - IInd thermal cycle.
3. ..... IIIrd thermal cycle.

Sr. No.	Thermal Cycle Numbe	TL glow peak intensities in units of 10^{-8} Amperes.			
		50°C	100°C	170°C	340°C
1.	I	0.1	-	1.5	9.8
2.	II	-	1.4	7.8	-
3.	III	-	1.4	8.6	-

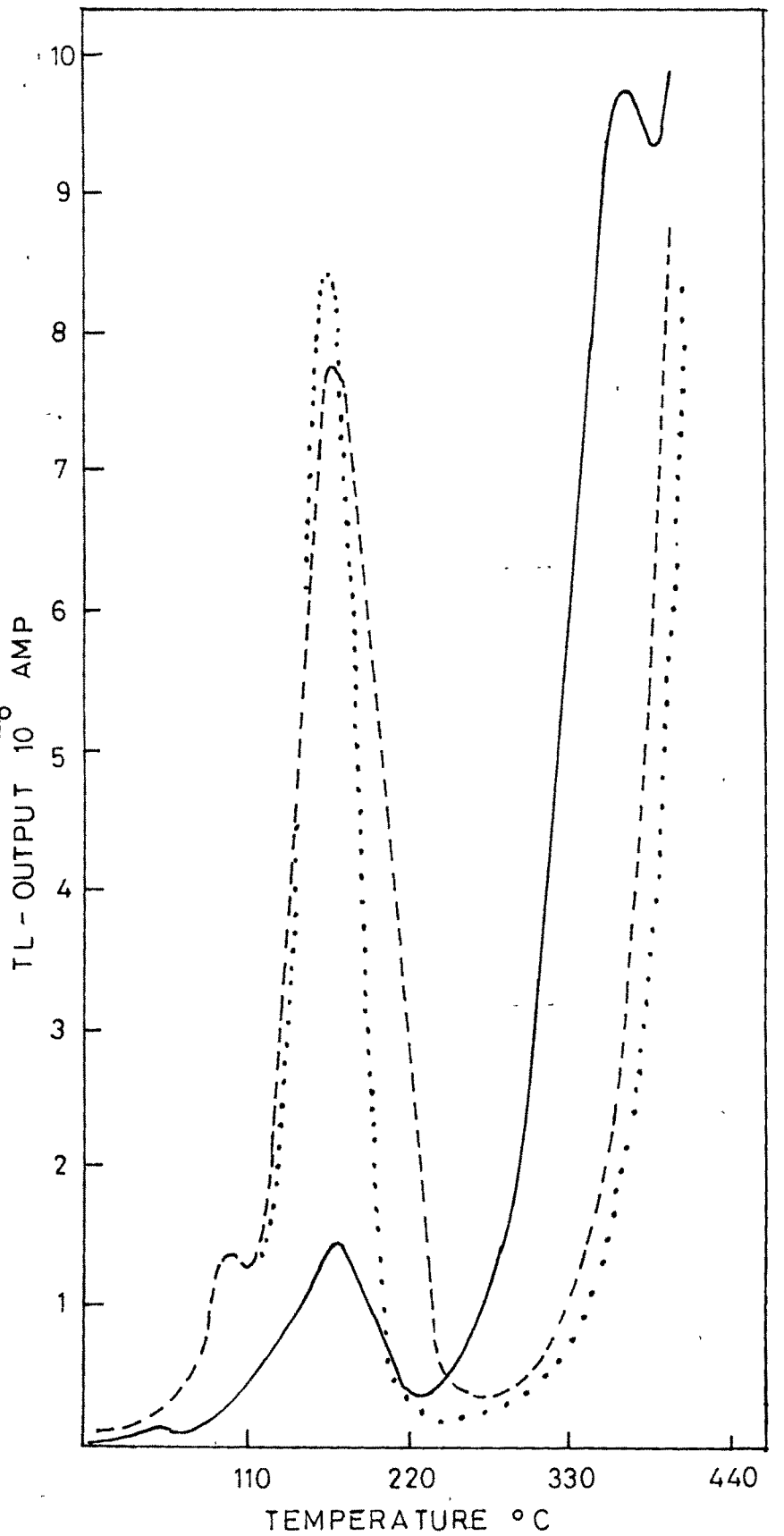


FIG. 29

FIGURE 30 : TL glow curves of KCl:Ba (10^{-1} m.f.) annealed and quenched from 50°C; exposure 1 min. alpha.

Curves
1. ———— Ist thermal cycle.
2. --------- IInd thermal cycle.
3. ..... IIIrd thermal cycle.

Sr. No.	Thermal Cycle Number	TL glow peak intensities in units of 10^{-8} Amperes.			
		50°C	100°C	170°C	340°C
1.	I	-	-	0.4	4.0
2.	II	-	-	1.9	-
3.	III	-	-	-	-

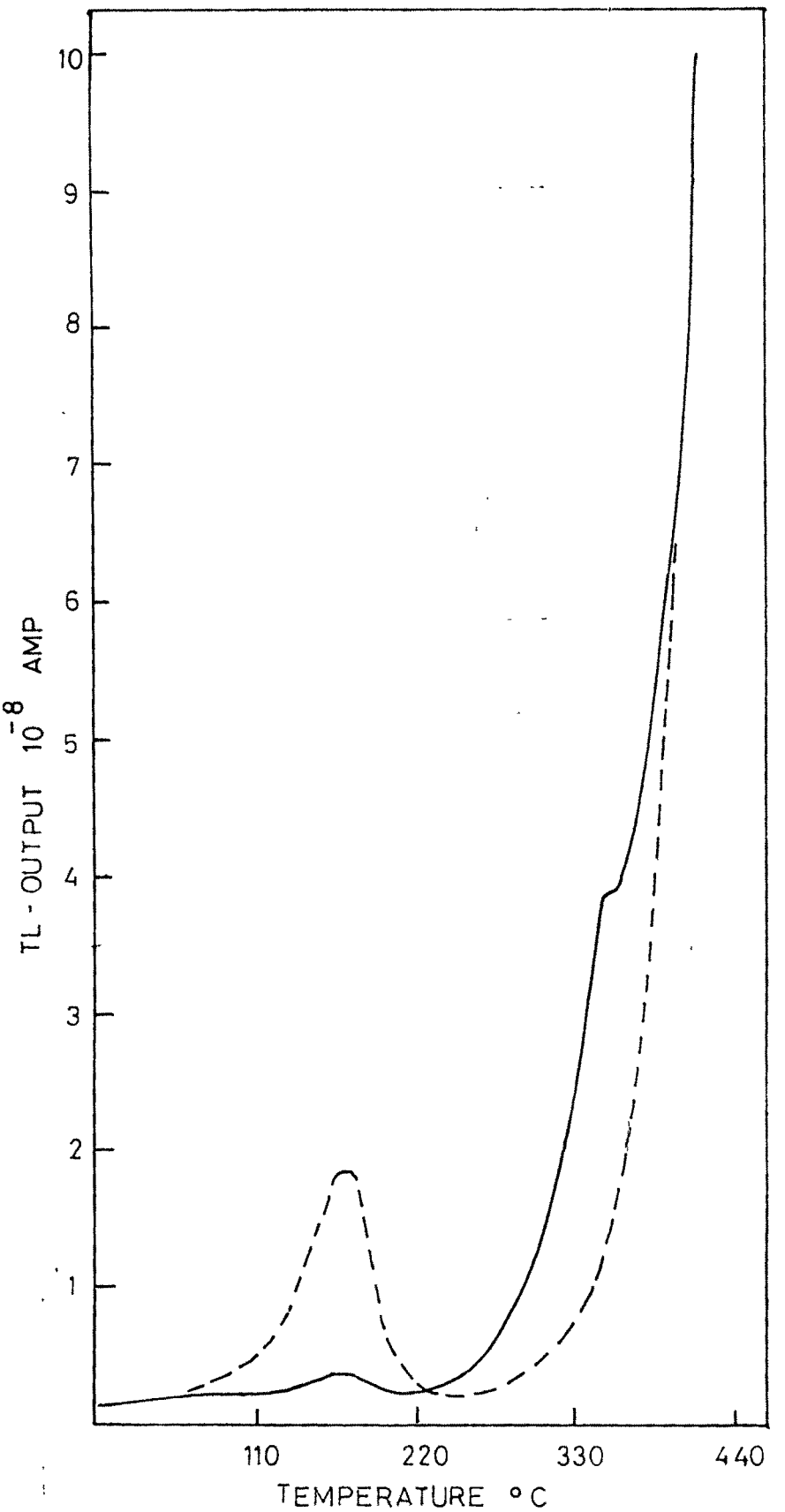


FIG. 30

FIGURE 31 : TL curves for pure NaCl.

First thermal cycles for

1. As received from solution.
2. Annealed and quenched from 500°C.
3. Annealed and quenched from 750°C.

Exposure 1 min. alpha.

Curves 1. ————————

2. ----------

3. .....

Curve No.	TL glow peak intensities in units of 10^{-8} Amperes.			
	90°C	220°C	240°C	340°C
1.	0.5	-	1.2	6.5
2.	0.8	1.7	-	3.0
3.	0.4	2.1	-	17.0

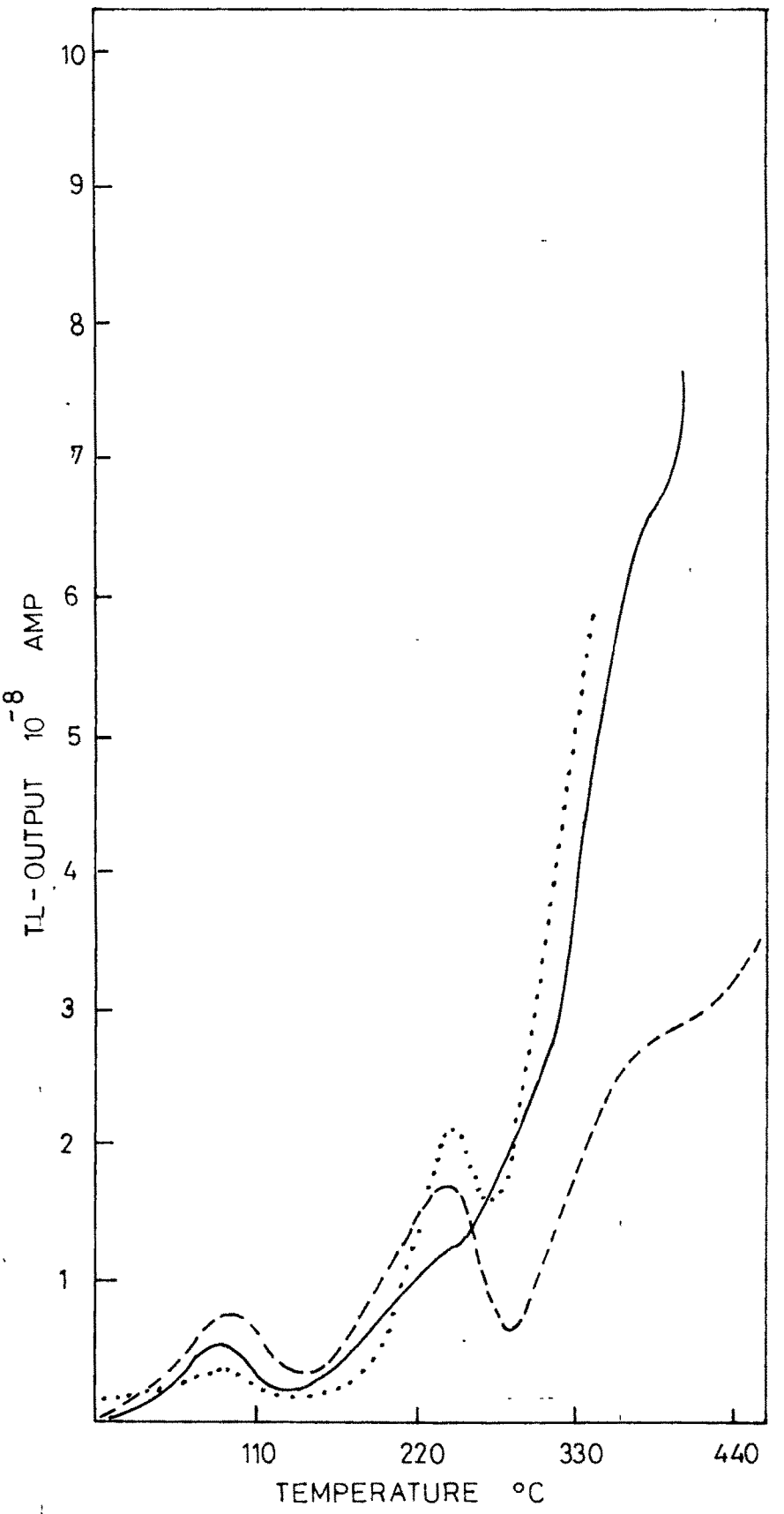


FIG. 31

FIGURE 32 : TL glow curves for NaCl:Ba (10^{-5}m.f.).
First thermal cyclesfor
1. As received from solution.
2. Annealed and quenched from 500°C
3. Annealed and quenched from 750°C.

Exposure 1 min. alpha.

Curves
1. ————————
2. ----------
3. ....

Curve No.	TL glow peak intensities in units of 10^{-7} Amperes.		
	90°C	240°C	340°C
1.	0.25	0.6	0.75
2.	0.2	5.25	0.6
3.	0.2	1.8	0.9

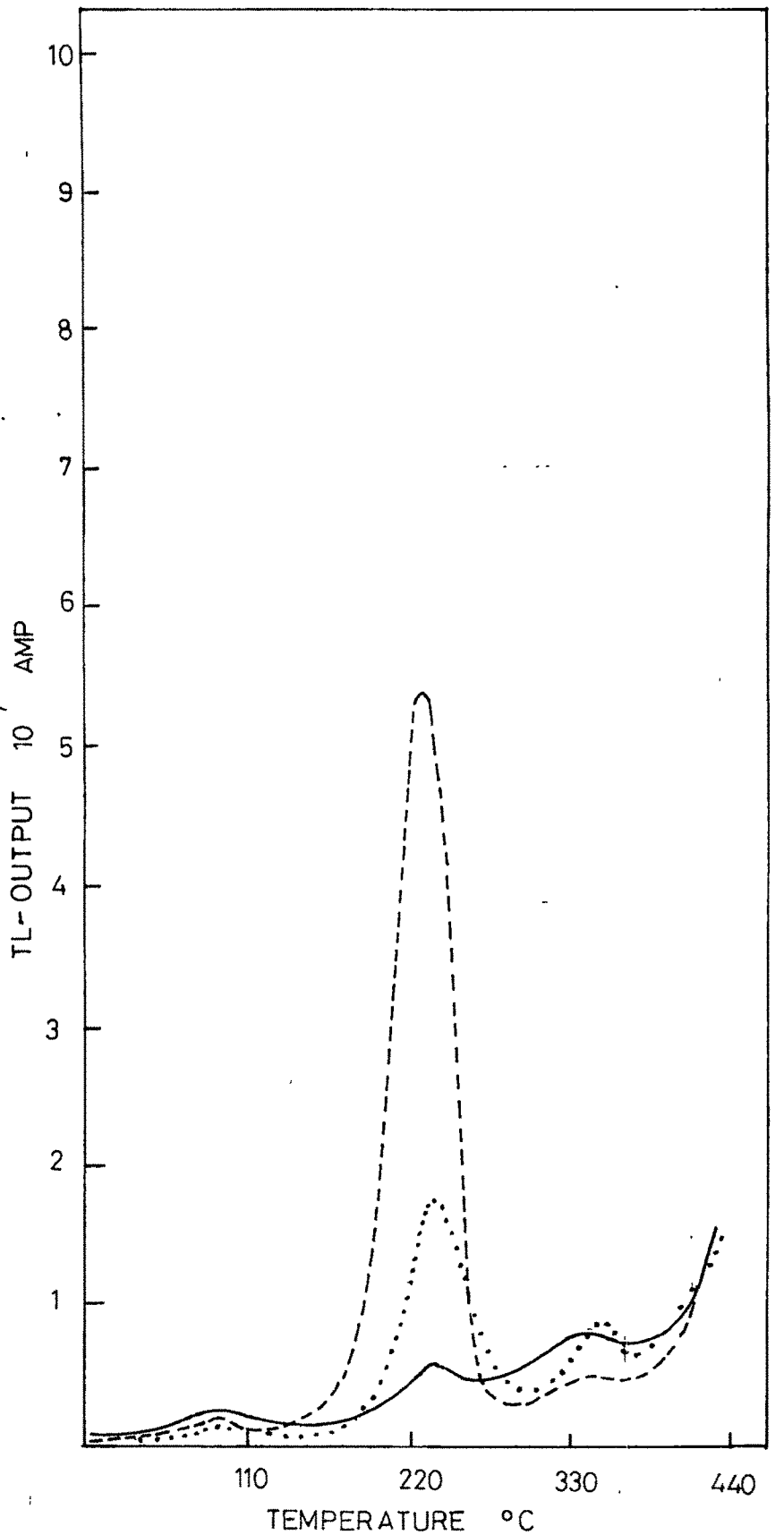


FIG. 32

FIGURE 33 : TL glow curves of NaCl:Ba (10^{-2}m.f.).
First thermal cycles for
1. As received from solution.
2. Annealed and quenched from 500°C
3. Annealed and quenched from 750°C.

Exposure 1 min. alpha.

Curves
1. ————————
2. ----------
3. ....

Curve No.	TL glow peak intensities in units of 10^{-7} Amperes.		
	90°C	220°C	370°C
1	0.25	1.5	1.75
2	0.3	5.5	1.85
3	0.25	5.3	1.8

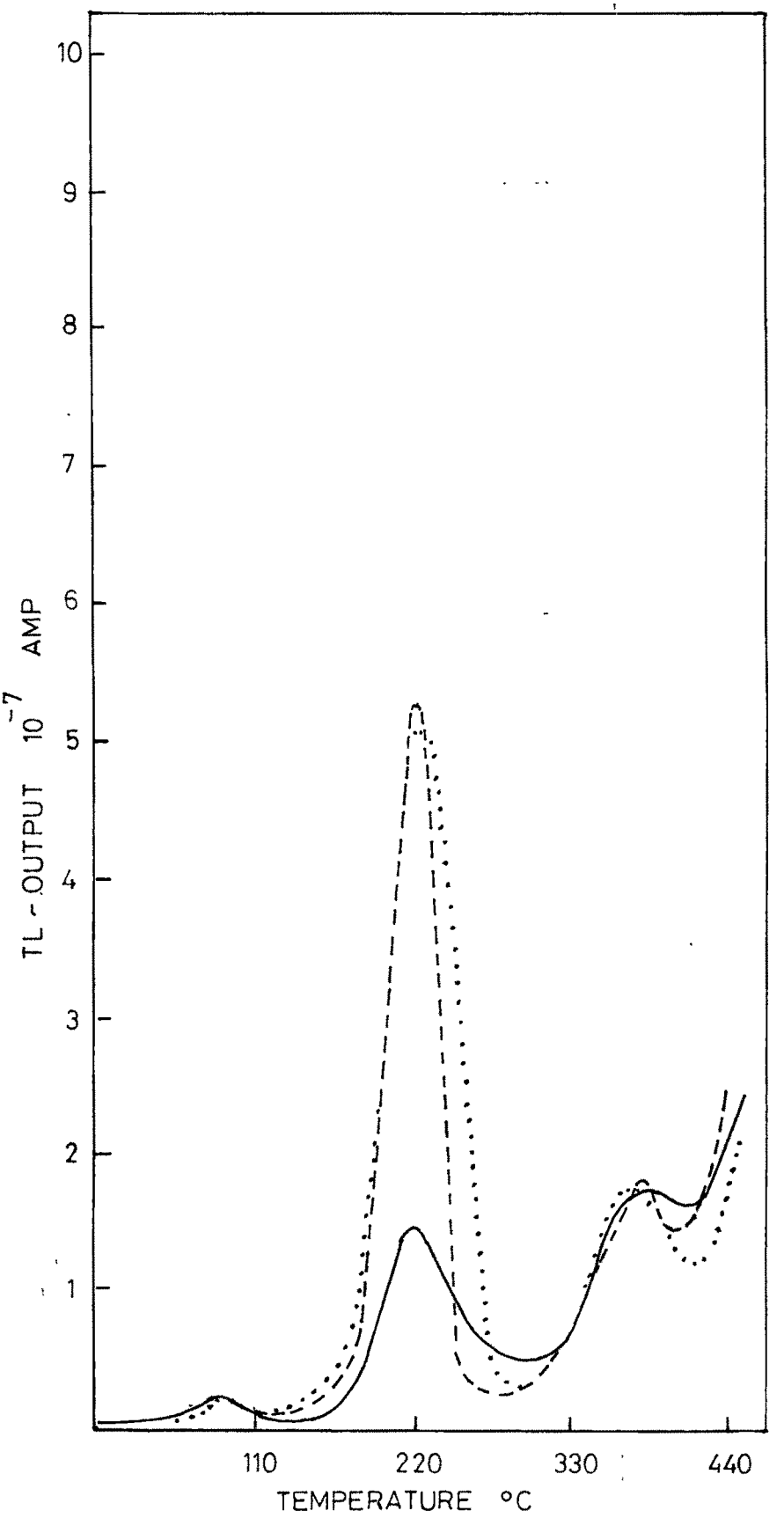


FIG. 33

FIGURE 34 : TL glow curves for NaCl:Ba (10^{-1}m.f.).
First thermal cycles for

1. As received from solution.
2. Annealed and quenched from 500°C
3. Annealed and quenched from 750°C.

Exposure 1 min. alpha.

Curves
1. — · ————
2. ----------
3. .....

Curve No.	TL glow peak intensities in units of 10^{-7} Amperes.				
	90°C	180°C	200°C	220°C	370/360°C
1	0.15	-	-	0.9	7.6
2	0.2	-	2.0	-	4.3
3.	0.1	2.5	-	-	2.8

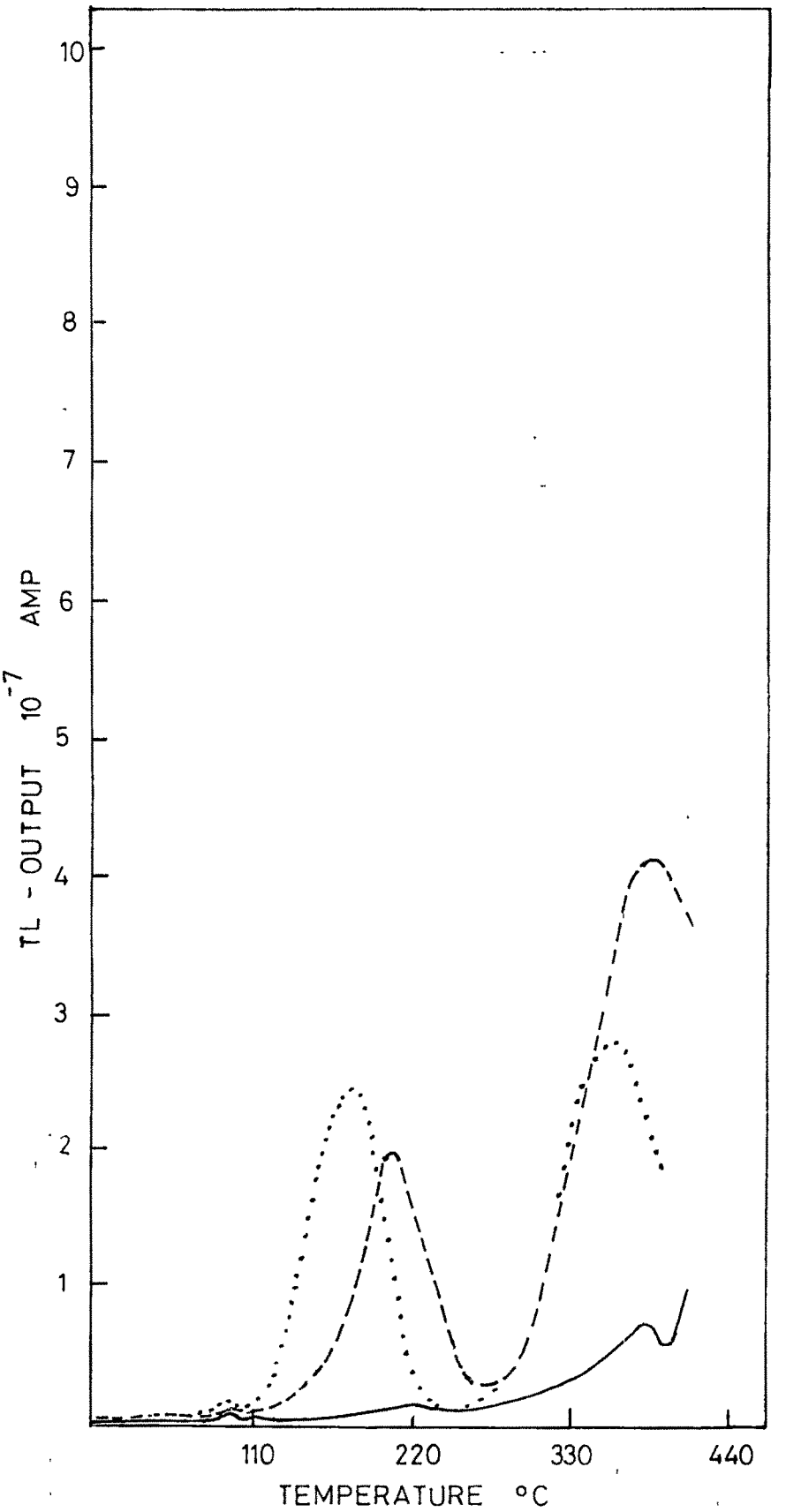


FIG. 34

FIGURE 35 A : TL glow curves for pure NaCl, annealed and quenched from 750°C.

Without exposure

Curves
1. ———— Ist thermal cycle.
2. - - - - - - - - - - IInd thermal cycle.
3. ..... IIIrd thermal cycle.

Sr. No.	Thermal Cycle Number	TL glow peak intensities in units of 10^{-7} Amperes.
		340°C
1.	I	1.5
2.	II	-
3.	III	-

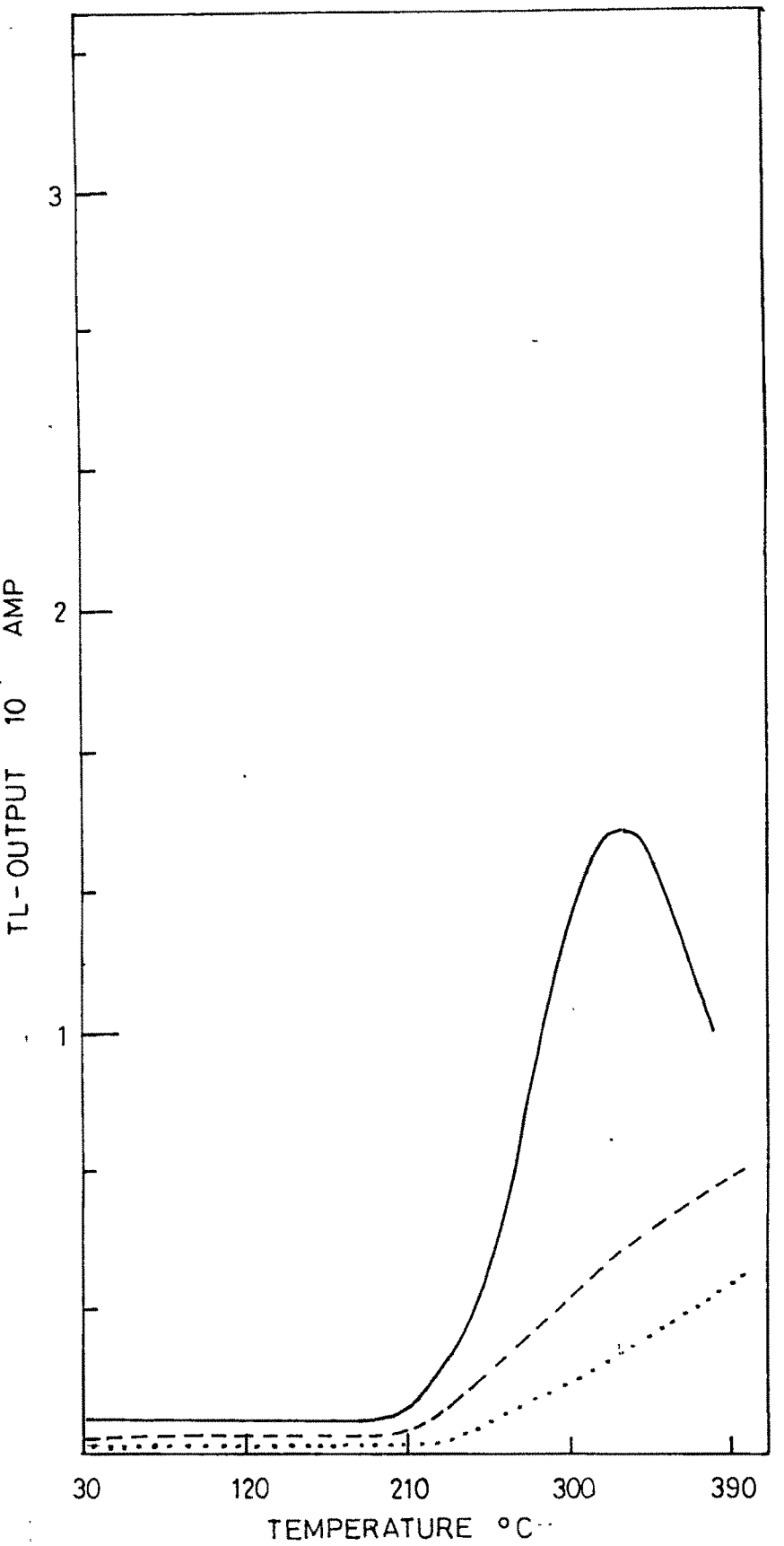


FIG. 35 A

FIGURE 35 B : TL glow curves for KCl:Ba, annealed and quenched from 750°C.

Without exposure.

Curves
1. ———————— Ist thermal cycle.
2. ---'---------- IInd thermal cycle.
3. .....'..... IIIrd thermal cycle.

Sr. No.	Thermal Cycle Number	TL glow peak intensities in units of 10^{-8} Amperes.
		340°C
1.	I	2.9
2.	II	-
3.	III	-

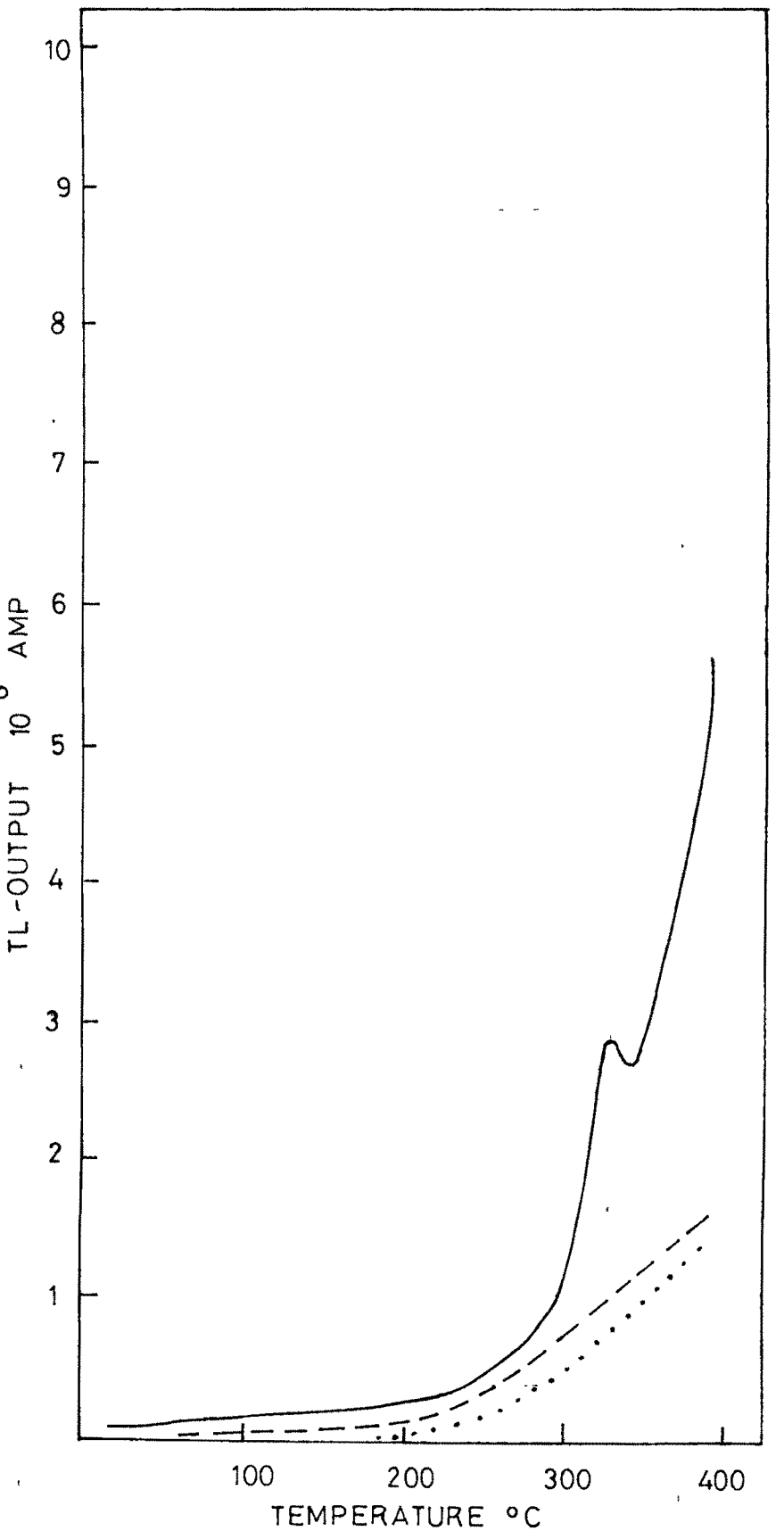


FIG. 35 B

FIGURE 36 : TL behaviours of NaCl and NaCl:Ba (10^{-2}m.f.) annealed and quenched from 750°C, exposure 2.4 x 10^{4} rads gamma.

TL - glow curves (Fig. 36 A) and
TL - emission spectra (Fig. 36 B) at 85°C (1b), 120°C (2b), 160°C (3b), 200°C (4b) and 230°C (5b).

Curves :
1. For NaCl (T) ----------
2. For NaCl:Ba (T) ——————

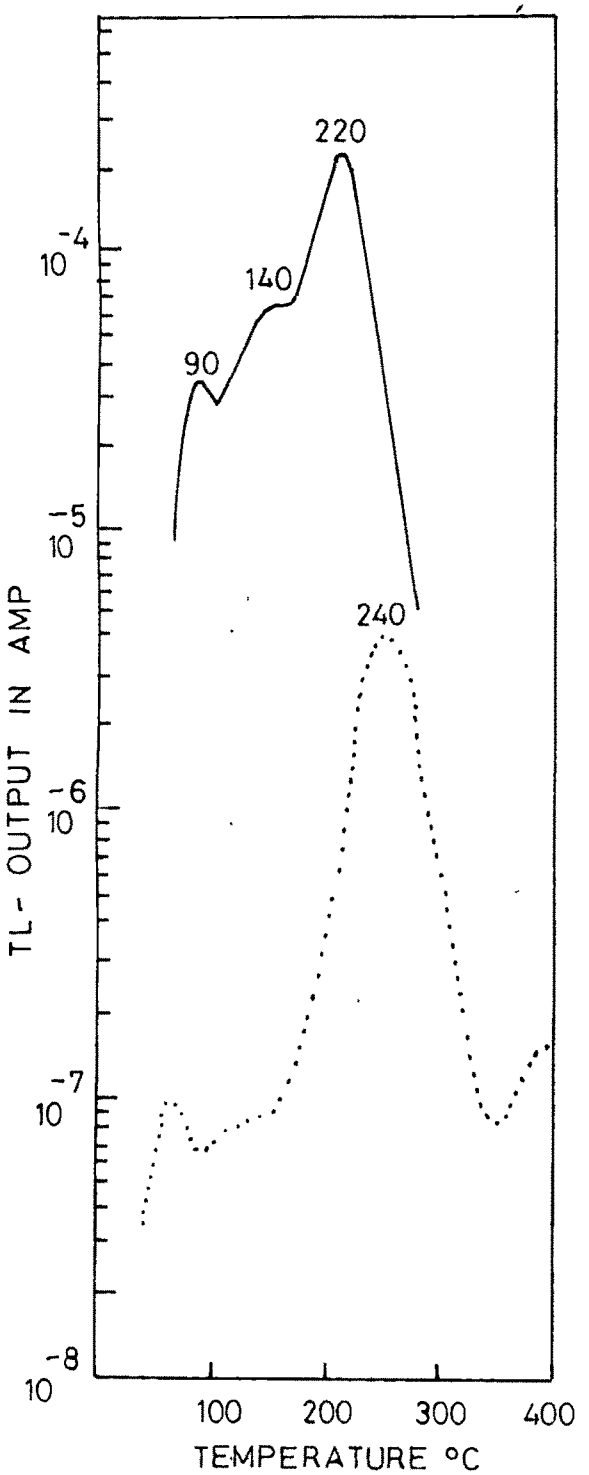


FIG. 36 A

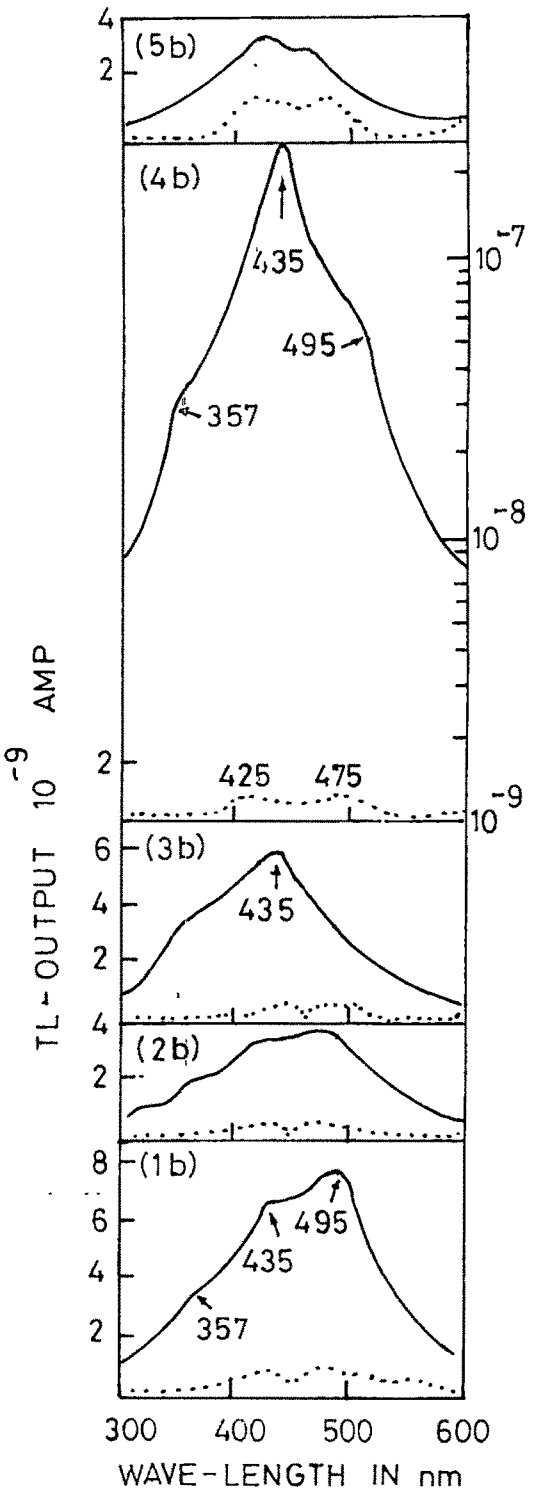
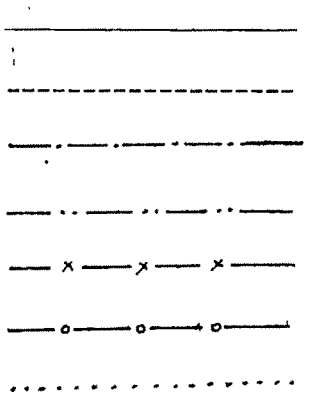


FIG. 36 B

FIGURE 37 : TL glow curves for NaCl:Ba (T) for different alpha doses.



Dose I	———————	3.8×10^2 rad.
" II	- - - - - - - - - - - - - - - - - -	1.14×10^3 rad.
" III	—·—·—·—·—	3.8×10^3 rad.
" IV	—··—··—··—	1.14×10^4 rad.
" V	—×—×—×—	3.8×10^4 rad.
" VI	—o—o—o—	1.14×10^5 rad.
" VII	.....	3.8×10^5 rad.

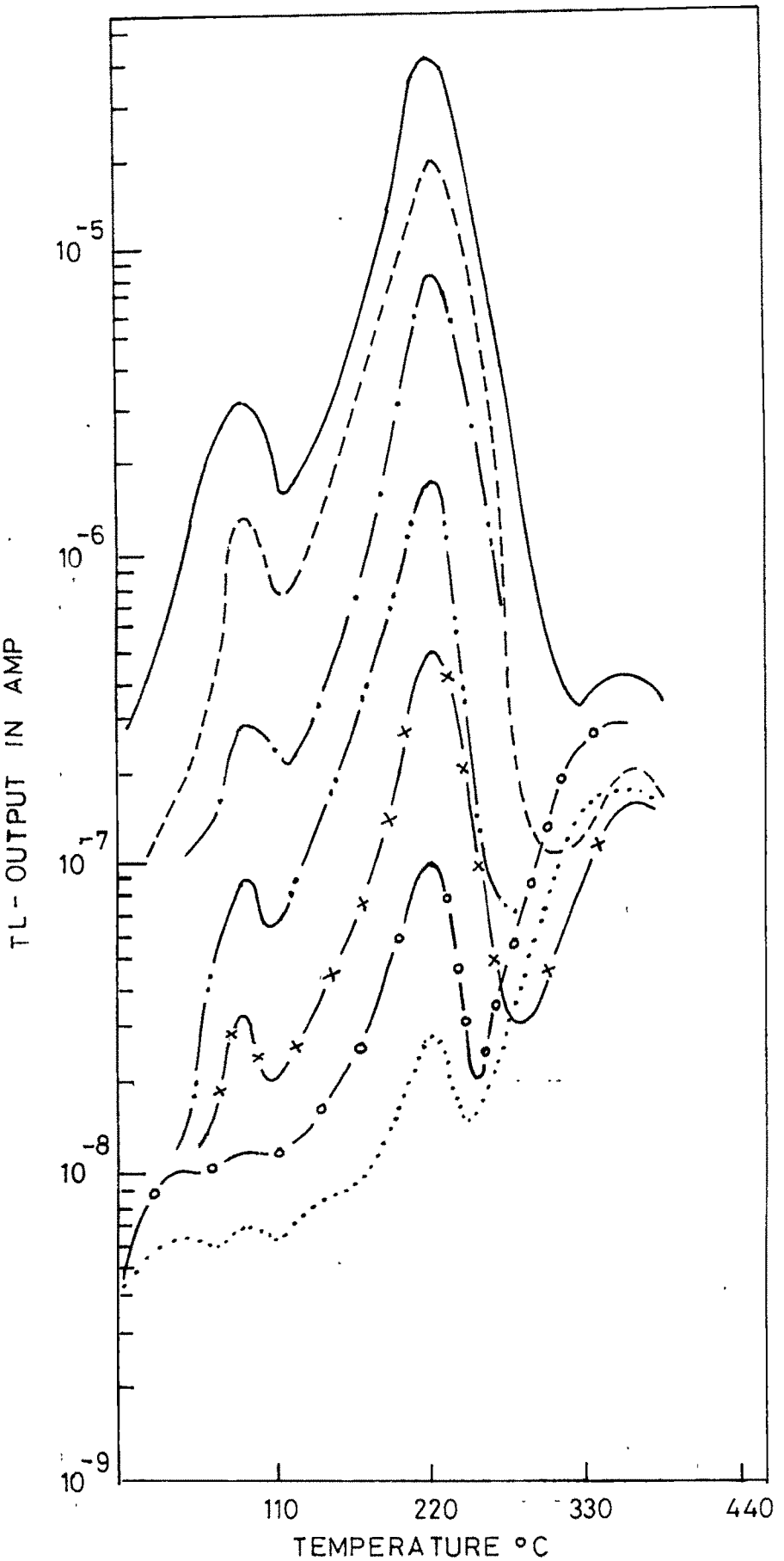

TL - OUTPUT IN AMP
10^-5
10^-6
10^-7
10^-8
10^-9
110
220
330
440
TEMPERATURE °C

FIG. 37

FIGURE 38 : TL output versus alpha dose for 220°C peak in NaCl:Ba (T).

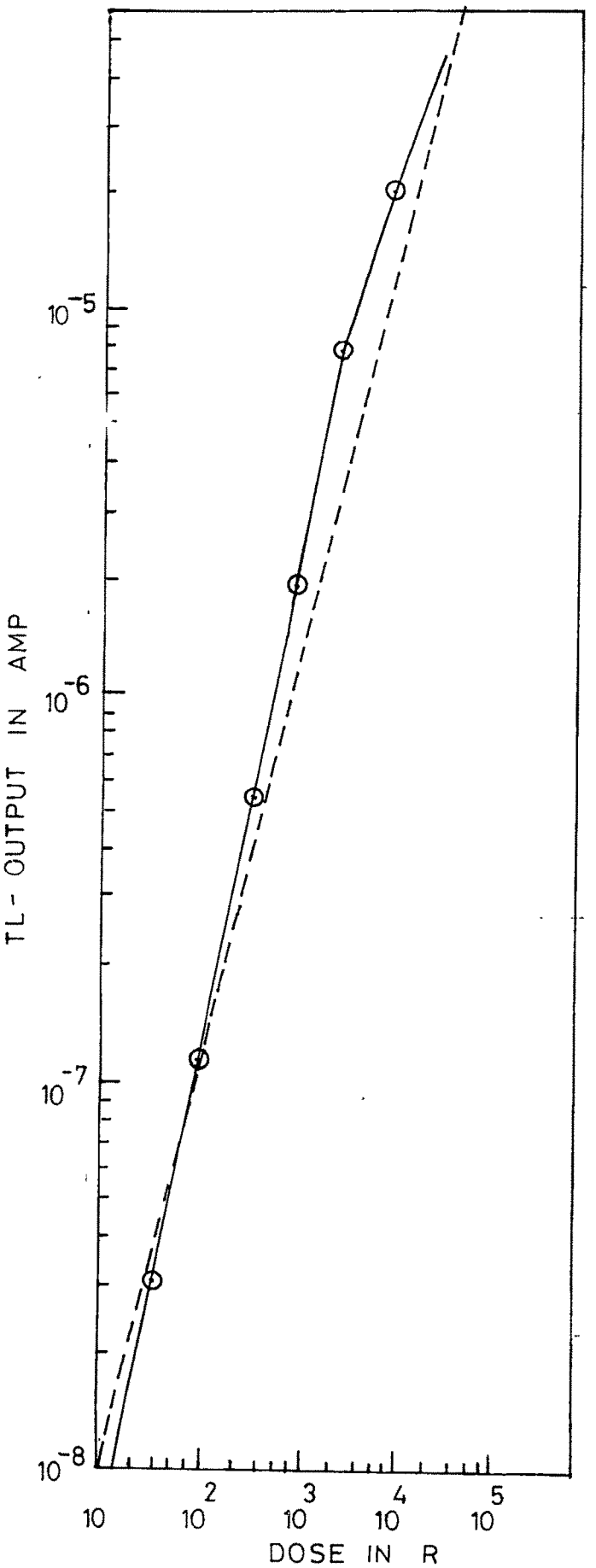


FIG. 38

FIGURE 39 : Response of TL output of 220°C peak versus temperature decay time in hours after excitation.

(alpha dose = 1.0×10^4 rad.)

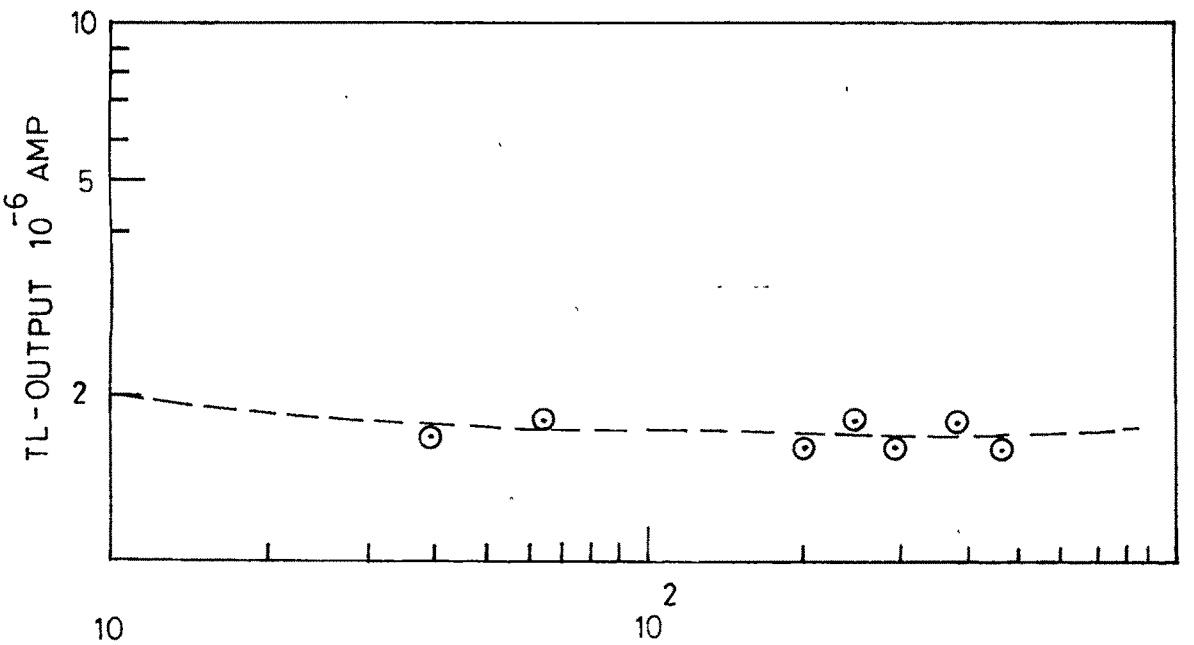


FIG. 39

FIGURE 40 : TL glow curves for KCl:Ba (T) for different alpha doses.

Dose	I	.....	3.8×10^2 rad.
Dose	II	- - - - - - - -	1.14×10^3 rad.
Dose	III	—·—·—·—	3.8×10^3 rad.
Dose	IV	—×—×—×—	1.14×10^4 rad.
Dose	V	—oo— oo— oo—	3.8×10^4 rad.
Dose	VI	—— —— ——	1.14×10^5 rad.
Dose	VII	———————	3.8×10^5 rad.

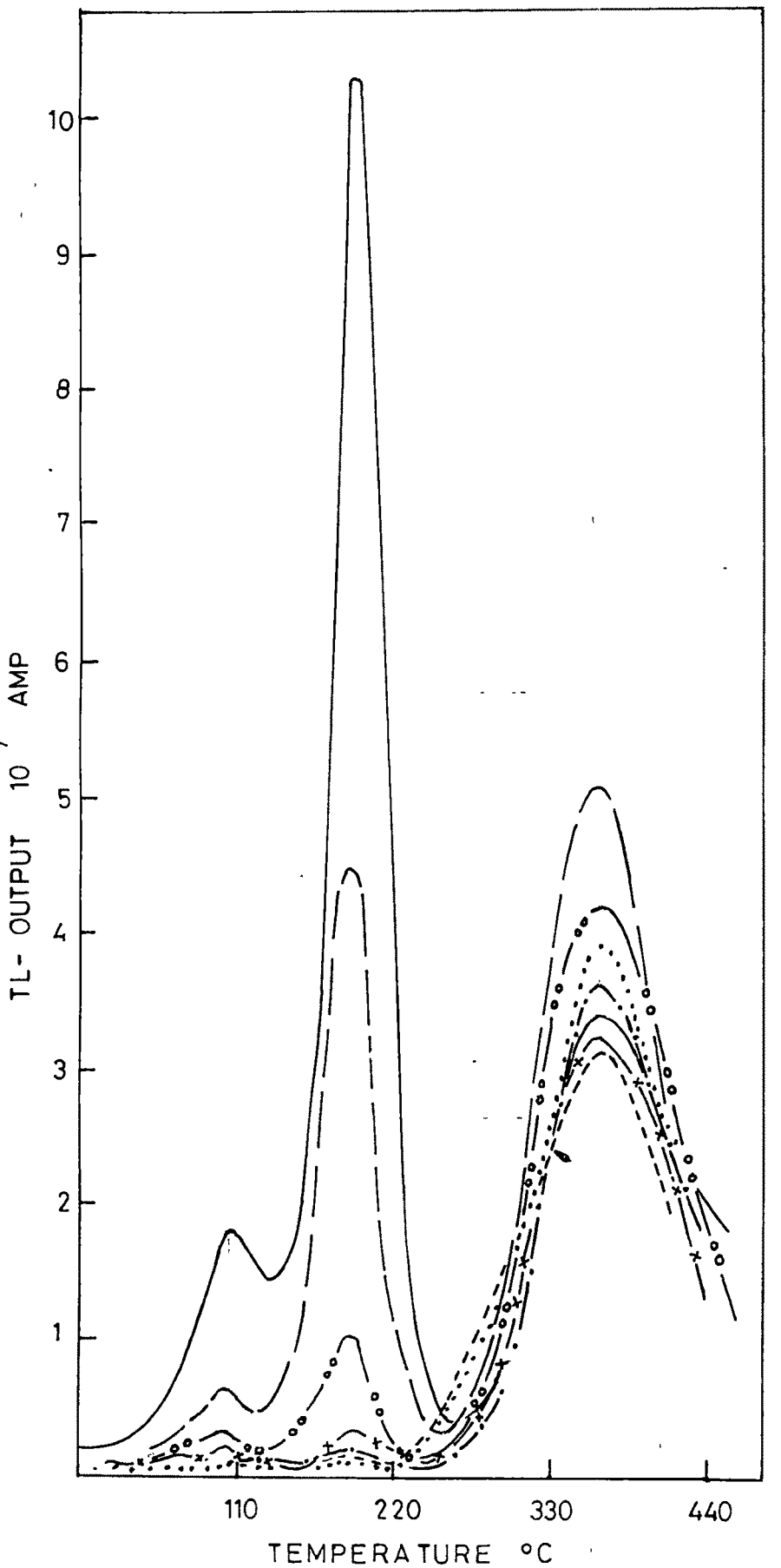


FIG. 40

FIGURE 41 : TL output versus alpha dose for 170°C peak in KCl:Ba (T).

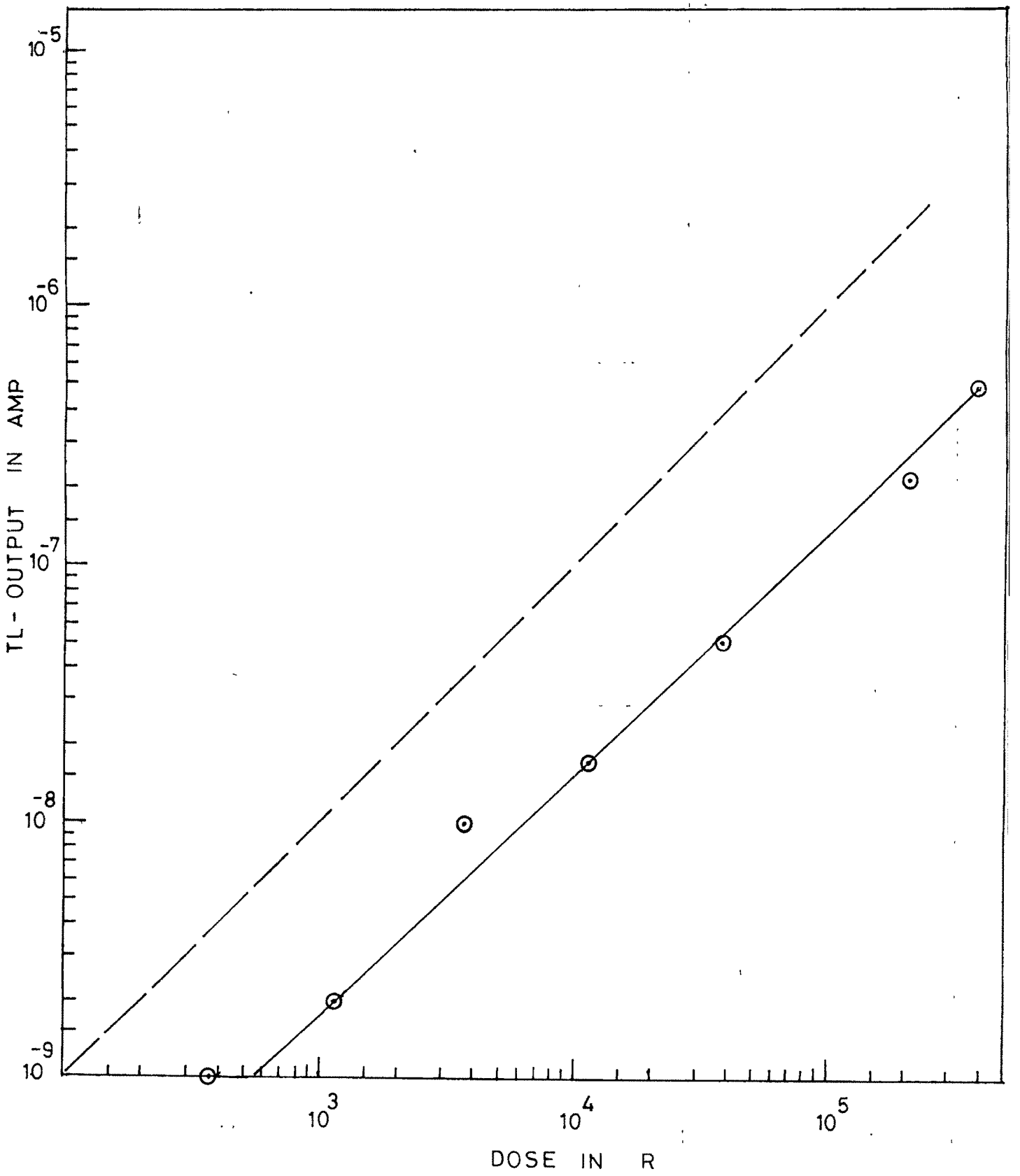


FIG. 41