LABORATORY KOTALLA

SINCE 1979

WORLDWIDE OLDEST PRIVATE LABORATORY SPECIALIZED FOR TL-ANALYSIS

Thermoluminescence Report

No.: 06B280717

06 D2 8071

R.M. KOTALLA D-72401 HAIGERLOCH 486 THERMOLUMINESZENZ LABOR

Analysis Result

On the basis of standard methods and techniques used in the thermoluminescence process, I calculate the last time of firing of the object samples to be:

5 0 0 Years old +/- 20 % Ming

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Haigerloch 04 August 2017

Report on Thermoluminescence Authenticity Tests

The analyzes carried out relate exclusively to the sample material taken from the object shown on page 1, without making a statement about the object as a whole. The test report with the Tl.Nr.**06B280717** by the thermoluminescence method ("authenticity test according to annex") and had the following result:

1. Analysis Result:

Fired in antiquity **Ming**

On the basis of standard methods and techniques used in the thermoluminescence process, I calculate the last time of firing of the object samples to be:

5 0 0 years **+/- 20 %**

2 Horses **fired clay**

H.: 17,5 , 18 cm

3. Origin: China

The photo of the object enclosed on page 1 was taken by myself.

4. Sampling by myself:

A: Chin B.: back left C.: Turned head chin D.: Back Back right

5. Comments:

The enclosed graphs form a constituent part of the expertise and reflect only excerpts from the complete catalogue of measurements. "**the sample is said to be from the object shown in the photo**". . A liability for abuse of the expert options cannot be assumed .The result is given in good faith, however Labor Ralf Kotalla takes no responsibility for financial loss incurred through an erroneous result being given.

AD 1,70 Gy D.: 4,5 mGy/y (AD: alpha est. 0,78/ : D = Age)

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Benjamin / Ralf Kotalla

Ralf KOTALLA D-72401 HAIGERLOCH 486 THERMOLUMINESZENZ LABOR

The expertise is only valid if accompanied by the stamp of the laboratory and the signature of Mr. Ralf Kotalla . Only an original report may be considered valid. If you are presented with a copy , or have any concerns about the report. Please call Ralf Kotalla (Germany) (**49**)**07474 95360** for confirmations of its contents.

Working condition-"TL Authentication

TL-systems:

2 x Lexsysmart Freiberg Instruments ; Daybreak TI 1150; TI 1100;
2 Alpha and Beta Multiple Sample Irradiator Littlemore and 2 Daybreak

Filter:

Schott BG 39-BG29 KG 3 ; Daybreak Corning 7-59 / 5-60; Schott BG-39

ß-Source:
Lex Sr 90 0,131 Gy/sec. 01.04.2017 Daybreak 0,068 Gy/sec 01.04 2017

a-Source:

CM-244 Curium 0,5 mCi

Working method:
Fine grain sedimentation following treatment in diluted hydrochloric acid.
Grain size fraction following repeated sedimentation 10-50 micro m.
Measurements are carried out in an ultra- pure nitrogen atmosphere of
at least 4.6 N2 following a previous vacuum of 0,150 mbar.

Second Glow and Addition method;

Result provides a statement on the last time of firing.
The age specification contained in the TL expertise refers to the so-called "firing age"
of the sample(s) (minerals), i.e. to the time at which they were last heated to a temperature
of over 500 degrees C and mentions the place on the object from which the sample (s)
was / were taken.
TL measurements to specify age can be falsified if objects have been subjected to high X and
Y radiation doses or neutron bombardment.
X - radiation, for example during the course of baggage controls, is no significance.
(Error factor under 0,1 %)

The TL-Report do not provide on the investigation of polymers (synthetic and natural resins)
of all kinds.If an object has been re-modelled, the date of the sample will the last firing and
not the date of re-modelling.

Sampling:
Samples are taken using a carbide drill (diameter 1,4 -2mm) at low speed following previous
removal of the surface.
Samples must be taken not under a strong incidence of light. As a rule, two samples are taken from each test specimen, which are subjected to two separate TL analyses , in each case specifying the drilling position.
The sample quantities are minimal (50-200 mg).If restoration work of the samples is discovered in one of the objects to be tested, the TL expertise carries the appropriate reference.
Condition and restoration on the objects can be proofed by separate methods!!

Photos:

The laboratory requires two photos for the compilation of a TI expertise.
The laboratory guarantees strict confidentiality in the processing of TL-analyses and the compilation of
TL expertise's.

Expertise's are printed out without specifying the name of the commissioning party.

Principles of the TL - Method

There in was given evidence that the measuring of thermoluminescence emitted from objects made of fired clay could be effectively used for the dating and verification of such objects.
Quarz and feldspar as well as a number of other minerals have the ability to store energy generated by radioactive radiation. Under exposure to great heat such minerals release this energy again in form of light impulses. Radioactive radiation is created by the traces of uranium-, thorium-, kalium-, and rubidiumisotope which can be found almost everywhere in the earth's crust.

Clay, which is used in the production of every day objects as well as objects of art,
generally contains such minerals and radioactive isotopes.

All radioactive energy accumulated and stored by the unfired clay in geological time is destroyed at the point of firing. After a period of cooling the energy storing process starts anew and a certain amount of stored energy is gained annually. At the re-heating of a material sample taken from the fired object impulses of emitted light can be measured in the laboratory which correspond with the time interval between the present observation and the last firing. These findings have provided us with the basic principles of scientific dating methods.

The TL-test concerns itself with 3 variables:

1. The so-called 'archaeological energy ' or N T L - .
the name already indicates that an archaeological, i.e. historical aging has been
registered since the last firing of the object.

2. The 'neutral energy ' - ß or NTL + ß (alpha)
which is the amount of energy emitted by the same material after renewed exposure
to radiation from a gauged radioactive source.

3. The 'annual energy rate ' or J D
which represents the annual increase of accumulatively stored energy.

These variables interrelate in the following ways:

$$\frac{\text{archaeological energy}}{\text{neutral energy}} = \text{archae.dose} \qquad \frac{\text{archaeological dose AD}}{\text{annual energy rate D}} = \text{age}$$

Archaeological / historical and neutral energy rates already provide initial clues to the final test result.

a) In a case where archaeological energy can be established the neutral energy
curve, in certain areas, runs proportional to the archaeological curve.
b) In the case of a recent copy no proportional run of curves can be observed
due to the obvious absence of any archaeological / historical energy.
In order to determine the 'annual energy rate and thereby the exact age of an object,
the object specific energy output of the three basic radiation types; alpha, beta and gamma rays, has to be defined. At this point which touches at the boundaries of nuclear physics, the exact dating of objects of art often becomes problematic.
A precise evaluation of the gamma radiation energy is only possible when the exact geological conditions at the location of origin of the examined find are known. Since this is very often no longer possible an insecurity factor of +/- 20 to 35% of the calculated age has to be taken into account.
Alpha and beta rates can be measured in the material samples taken from the object.
The exactness of the result, i.e. the calculated age depends on the grade of precision with which these values can be determined. A relative limitation of such insecurities can be archived with the provision of comparative data from secured excavation sites and other safe' sources. Empiric values which can often serve to fill the gaps left in the purely analytical evidence supplying process.

The Laboratory Kotalla, as one of the oldest institutes of its kind, is consequently in the fortunate position of being able to take full advantage of their extensive archives.

File name: 06 B 2807 17 D.dat Remark: D-Probe Gesäß rechts
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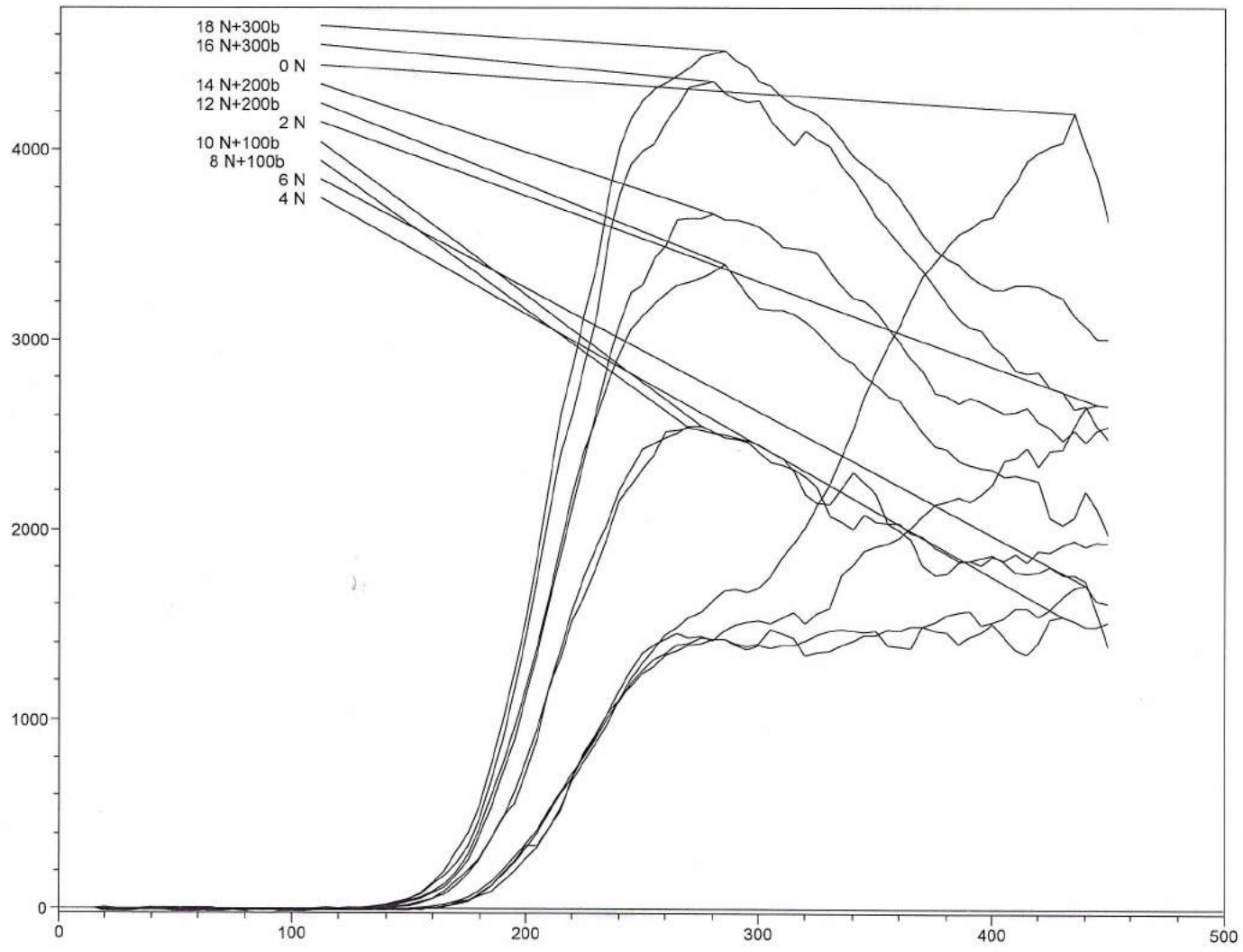
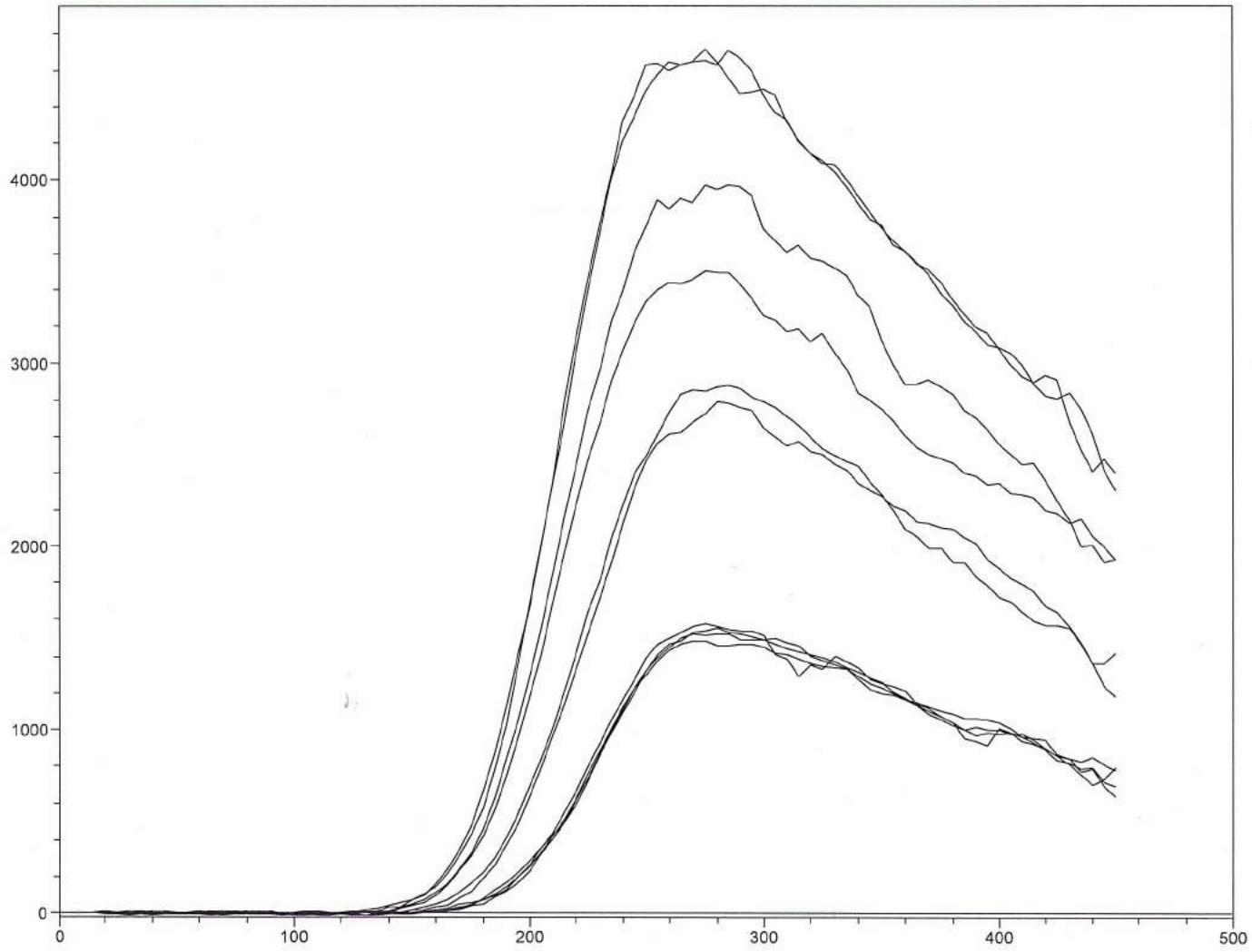
Type of data: TL curves - Subtracted curves
Printed on: 03.08.2017
Comment:

Luminescence



Luminescence



File name: 06 B 2807 17 C.dat Remark: C-probe Kopf links geneigt
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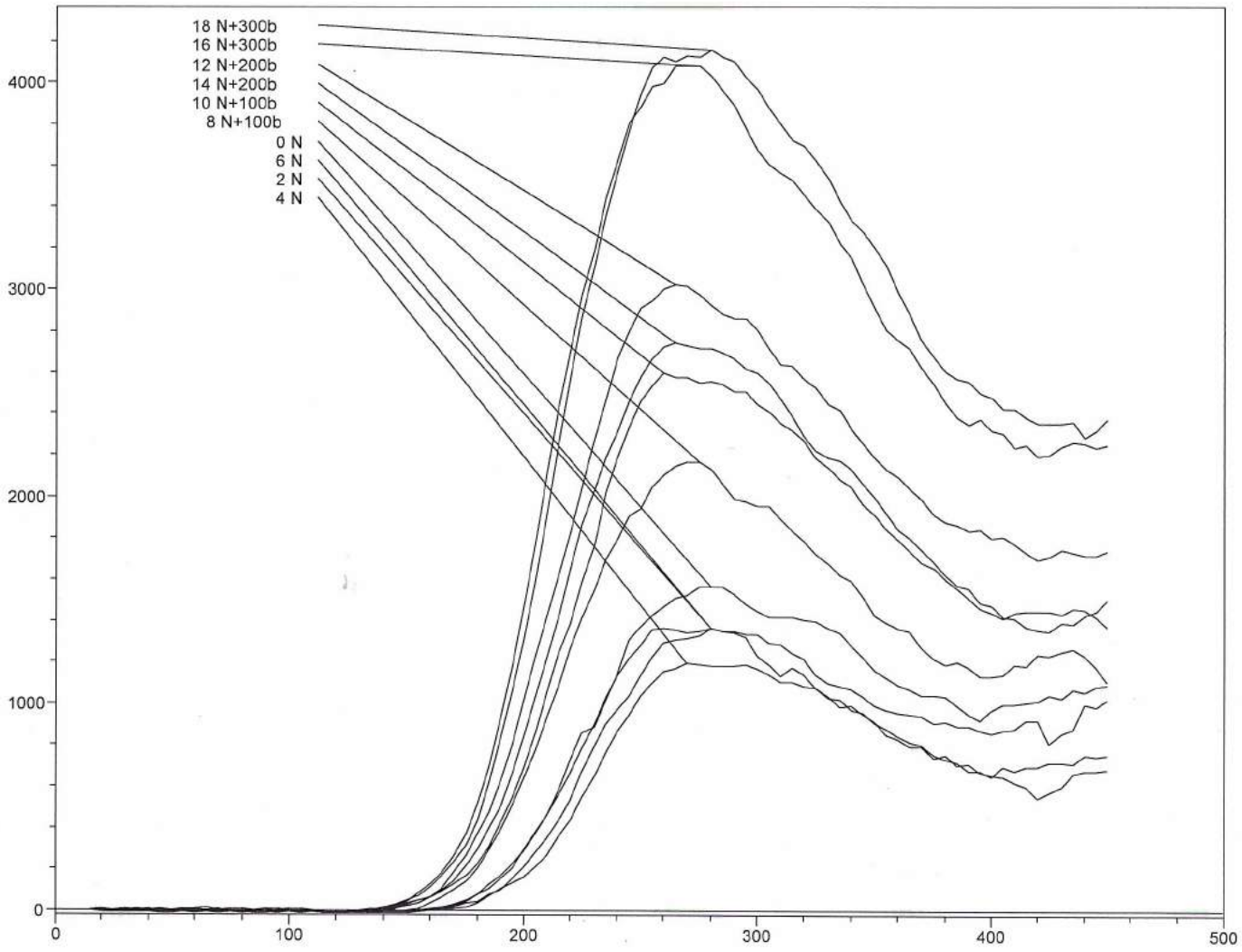
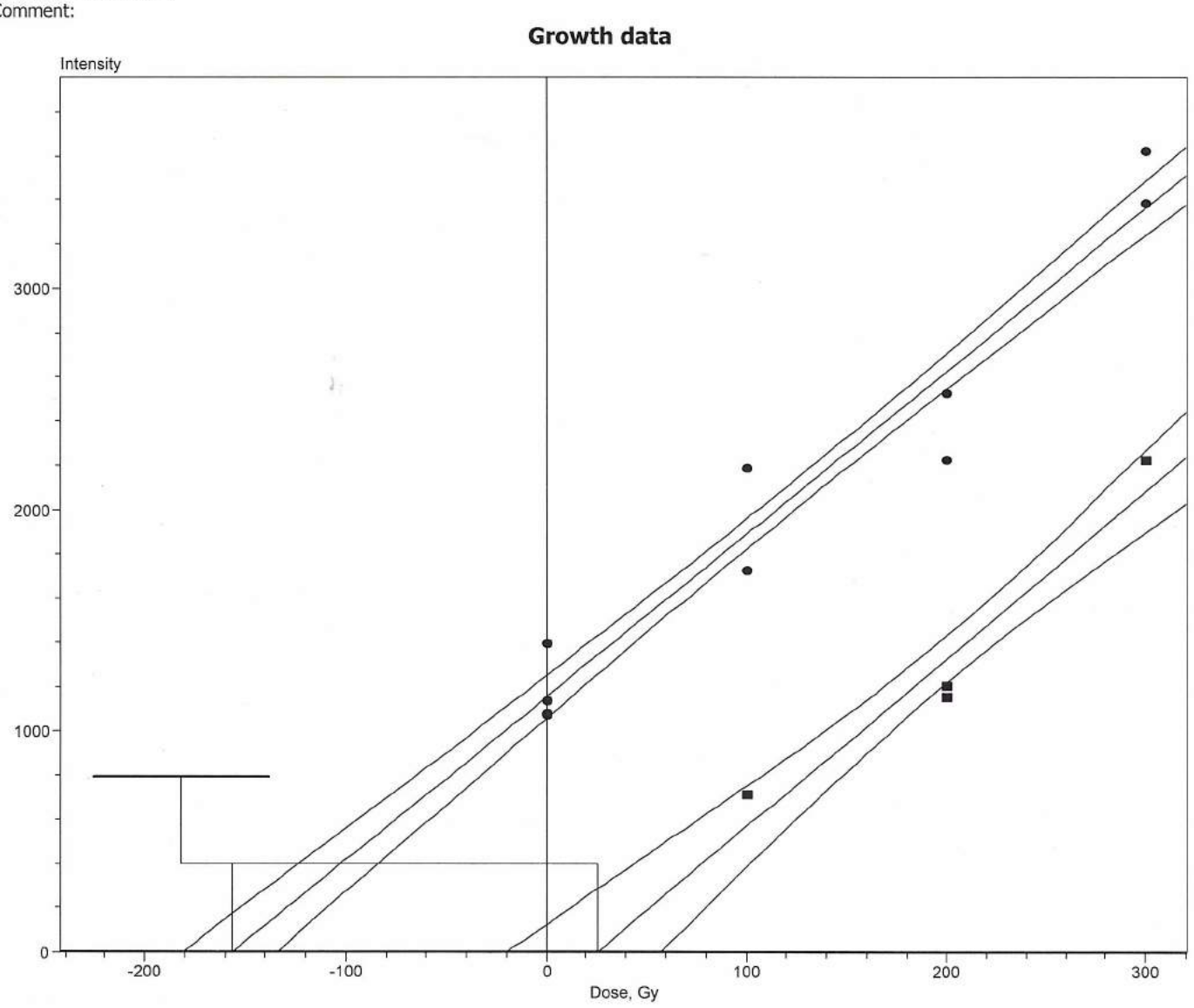
Type of data: TL curves - Subtracted curves
Printed on: 03.08.2017
Comment:

File name: 06 B 2807 17 A.dat Remark: A-Probe Ming 17,5 cm Kinn
Full path: C:\TLData\TL1\TL1\TL-2017\Renz\
Type of data: TL curves - Subtracted curves
Printed on: 02.08.2017
Comment:

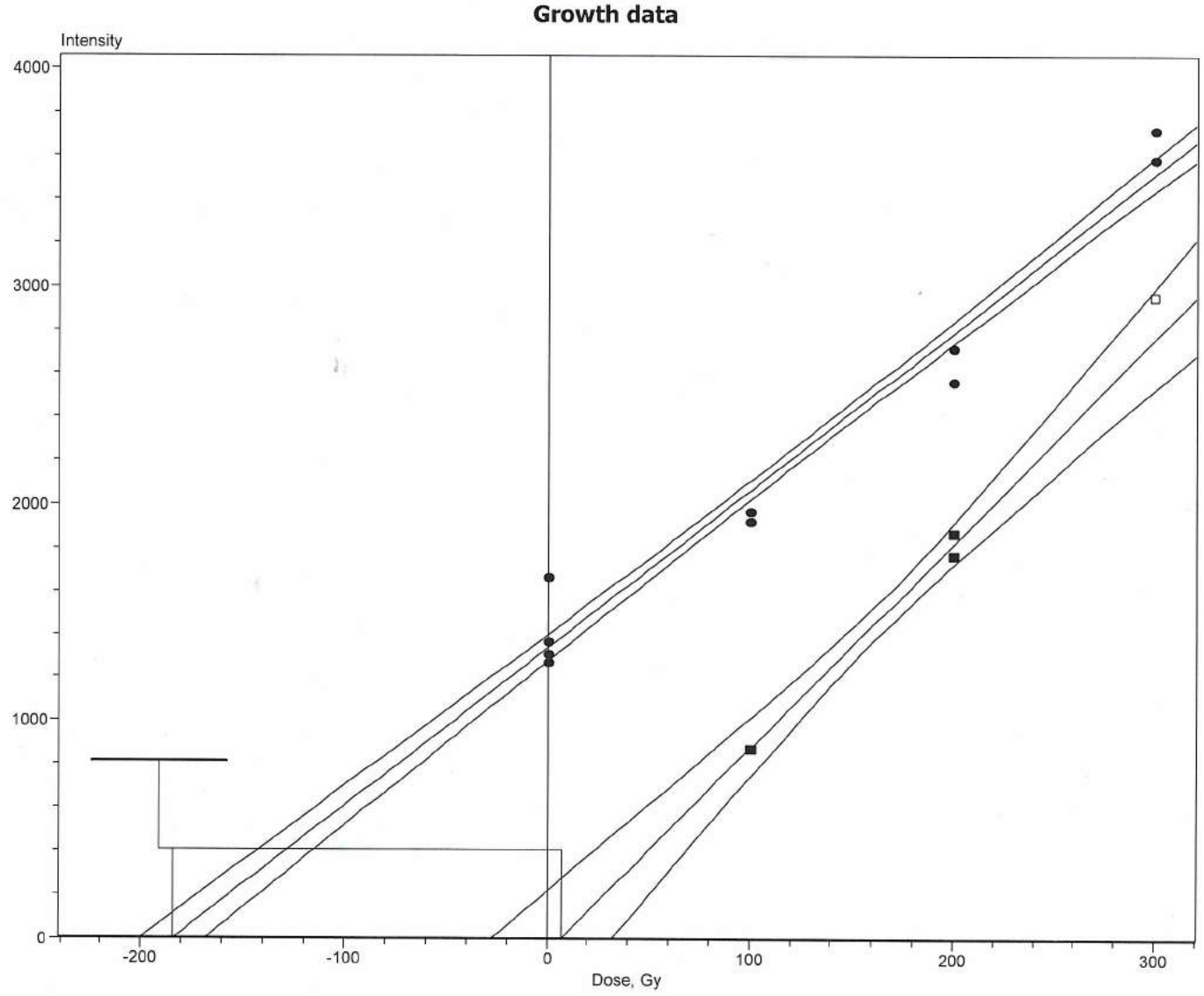
Luminescence



File name: 06 B 2807 17 A.dat Remark: A-Probe Ming 17,5 cm Kinn
Full path: C:\TLData\TL1\TL1\TL-2017\Renz\
Type of data: TL 5deg 10/s
Method: First/Second glow - Ceramic
Temperature(s): 325C
Result: AD = 181,9+/-43,9 O.K.
First fitted function: Linear
First fitted function parameters:
  a0 = 1151+/-96
  a1 = 7,366+/-0,574
Second fitted function: Linear
Second fitted function parameters:
  a0 = -194,4+/-318
  a1 = 7,587+/-1,5
Printed on: 04.08.2017
Comment:



File name: 06 B 2807 17 B.dat Remark: B-probe left buttock
Full path: C:\TLData\TL1\TL1\TL-2017\Renz\
Type of data: TL 5deg 10/s
Method: First/Second glow - Ceramic
Temperature(s): 330C
Result: AD = 191+/-33,5 O.K.
First fitted function: Linear
First fitted function parameters:
a0 = 1336+/-61,1
a1 = 7,26+/-0,365
Second fitted function: Linear
Second fitted function parameters:
a0 = -65,33+/-285
a1 = 9,407+/-1,65
Printed on: 05.08.2017
Comment:



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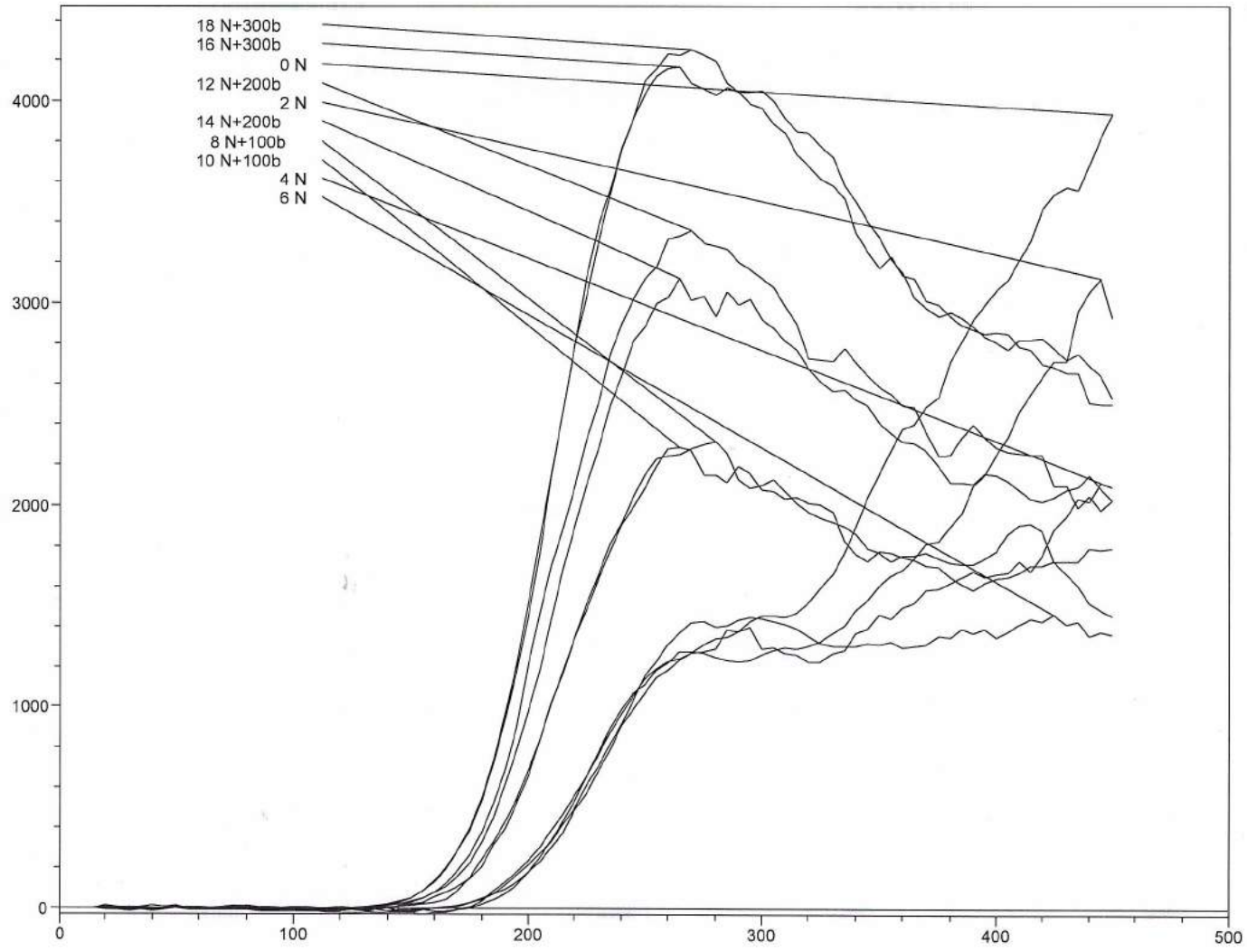
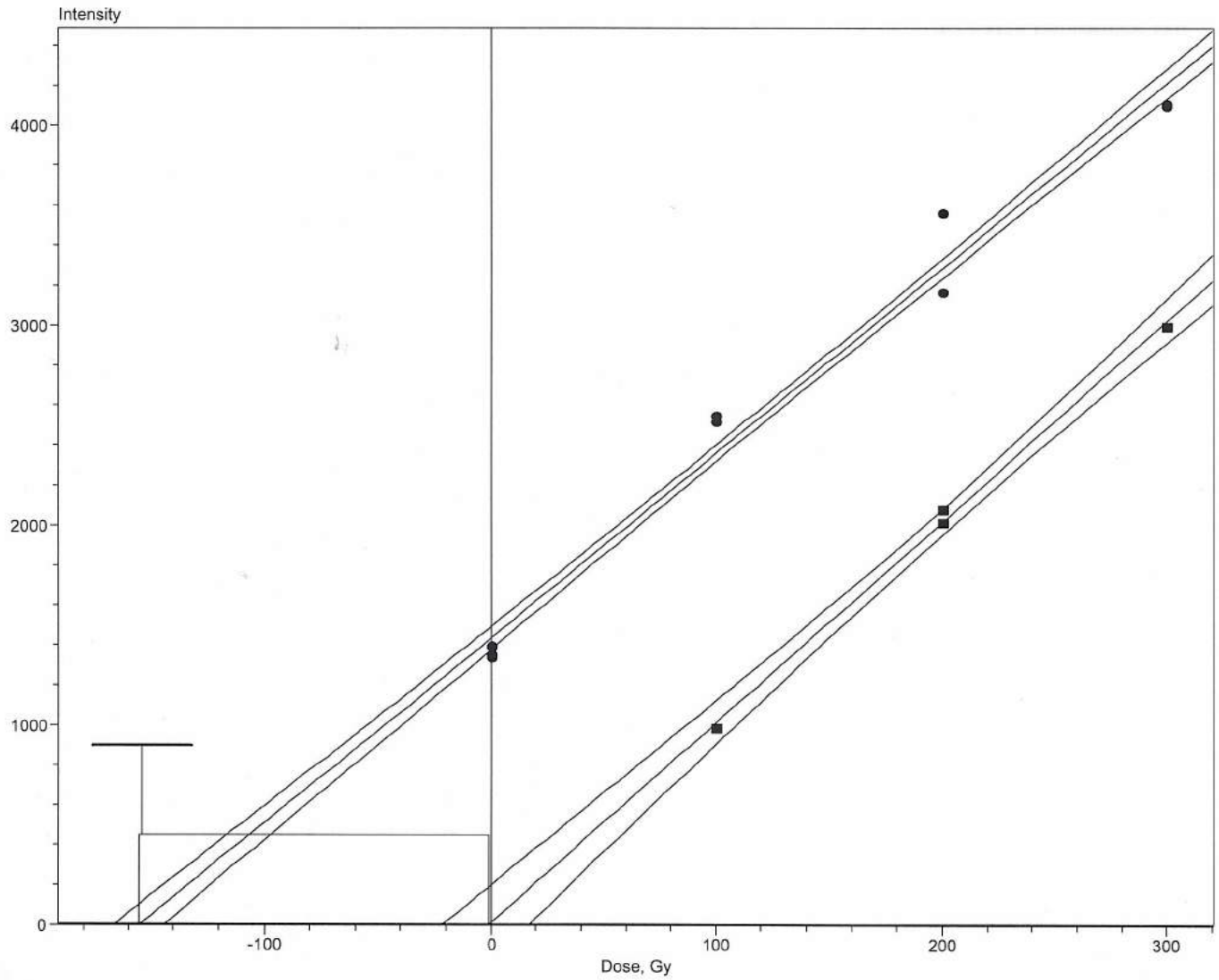
Luminescence



File name: 06 B 2807 17 C.dat Remark: C-probe Kopf links geneigt
Full path: C:\TLData\TL1\TL1\TL-2017\Renz\
Type of data: TL 5deg 10/s
Method: First/Second glow - Ceramic
Temperature(s): 325C
Result: AD = 154,2+/-22 O.K.
First fitted function: Linear
First fitted function parameters:
  a0 = 1434+/-57,4
  a1 = 9,239+/-0,343
Second fitted function: Linear
Second fitted function parameters:
  a0 = 9,417+/-190
  a1 = 10,04+/-0,895
Printed on: 05.08.2017
Comment:

Growth data



File name: 06 B 2807 17 D.dat Remark: D-Probe Gesäß rechts
Full path: C:\TLData\TL1\TL1\TL-2017\Renz\
Type of data: TL 5deg 10/s
Method: First/Second glow - Ceramic
Temperature(s): 325C
Result: AD = 149,9+/-64,3 O.K.
First fitted function: Linear
First fitted function parameters:
  a0 = 1555+/-118
  a1 = 8,37+/-0,708
Second fitted function: Linear
Second fitted function parameters:
  a0 = 280,7+/-392
  a1 = 7,828+/-1,85
Printed on: 05.08.2017
Comment: