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TL studies of Quaternary sediments at the University of Gdansk

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Introduction

A TL laboratory for the dating of Quaternary sediments came into being in our Department in 1982 as the result of increasing interest being shown by scientists working on chrono-stratigraphy and Quaternary geology. The laboratory, run by the authors (the first is a physicist and the second a geomorphologist), is housed in four rooms providing chemical, electronic, analytical and measurement facilities. In this paper we discuss methods for dating Quaternary sediments and the measurement apparatus used in the laboratory.

The laboratory equipment

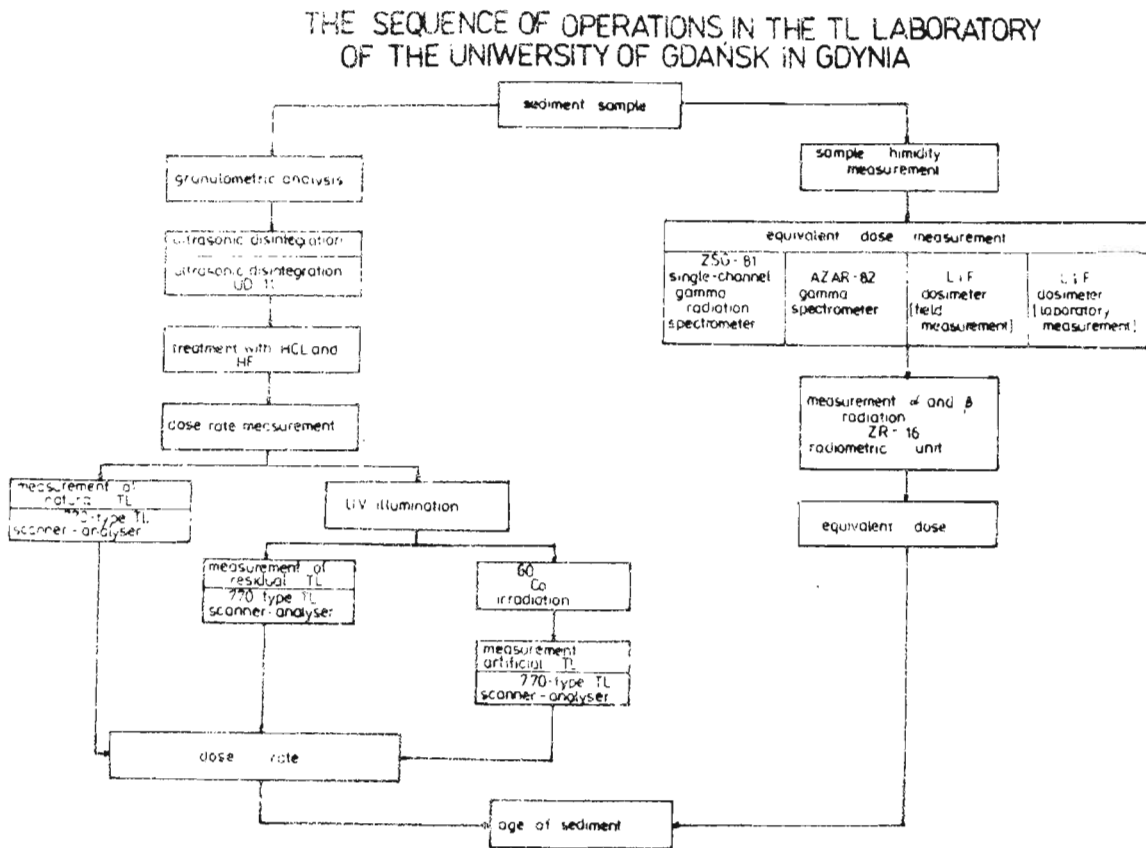
The apparatus used for estimating the dose-rate comprises (see figure):

1. An AZAR gamma spectrometer with cosmic radiation shield (manuf. by ZZUJ "Polon", Warsaw) which is linked to an RC-82 digital recorder.
2. A ZSG-81 single channel gamma spectrometer (manuf. ZZUJ).
3. A ZR-16 radiometric unit with bisectional proportional counter and including an anticoincidence shield for the measurement of alpha and beta radiation.
4. A TL scanner - analyser (type 770, manuf. Inst. of Nuclear Physics in Cracow).

The equipment required for equivalent dose measurements comprises:

1. A THYR-2 vibrator with a set of sieves of mesh size from 40 μ to 6.3 mm (made in GDR).
2. A UD-11 ultrasonic disintegrator (manuf. ELPAN, Poland).
3. A TL scanner, as above, coupled to an NE-240 X-Y recorder (manuf. EMG, Hungary).
4. A Co-60 irradiator (located in the Radiological Inst. of the Gdansk Medical Academy) which is capable of administering doses with an accuracy of better than 1.5%.

Methodology of measurements



Dose-rate

After removal of a sediment sample from the field to the laboratory, it is tested for humidity (%), then dried at 20-50°C. The dose rate, as indicated in the figure, is measured in three ways.

A. Gamma Spectrometry:

A container with $1.5 \times 10^{-3} \text{ m}^3$ of sample is placed in the AZAR-82 spectrometer and each measurement, which takes 2000s, is repeated 20 times. The dose-rate is obtained by determination of the concentrations of K-40, Ra-226 and Th-232. The error associated with the gamma dose-rate determination is estimated to be approximately 3%. The single channel ZSG-81 spectrometer is also used and enables the concentration of uranium and thorium to be determined with a measurement error of about 4%.

B. Beta and Alpha Spectrometry:

Samples are placed directly in the active volume of the ZR16's counter and alpha and beta dose-rates are determined with an error of about 3%.

C. TLD:

LiF dosimeters in perspex containers are placed directly in the sample container and stored in the laboratory for a period of at least three months. The equivalent dose, evaluated using the TL scanner, is obtained with a measurement error of approximately $\pm 15\%$. If field conditions are suitable the dosimeters can also be placed in the sampled deposit.

Determination of Equivalent Dose

We use the reproductive method ($N+SL+Y$) of Wintle and Huntley (1982). The dried sample is subjected to granulometric analysis. A fraction weighing about 2g is selected from the 800-1000 μm fraction for further analysis (Hutt 1977; Fleming, 1970). The outer surfaces of the quartz grains are cleaned in distilled water for 20 mins in the UD-11 ultrasonic disintegrator operating with an ultrathermostat. The sample is then treated with 5% HCl for 1h and then with 5% HF for a similar time. After each acid treatment, the fraction is rinsed with distilled water and then dried at 20-25°C.

One part of the sample prepared in this way is used for measuring the natural TL and the remainder is illuminated with a sunlamp (uv). The thermal radiation is measured and the sample is then given an accurately controlled dose of radiation from the Co-60 irradiator. The artificial TL is then measured. The TL signals, measured using a heating rate of $1.7 \text{ }^\circ\text{C s}^{-1}$, are analysed in the 270-320°C temperature range and their growth investigated as a function of dose.

The Calculation of Age

The age of a sediment is calculated on a Sinclair microcomputer using a Basic programme. The measurement error is computed by the complete differentiation method (Szydtowski, 1981) and we are presently able to obtain an accuracy in the region of 15%.

Conclusion

So far, our TL laboratory has dated some 300 sediments from all over Poland, including till, glaciomarine and marine deposits. Our laboratory works with and carries out comparative studies for the other Polish laboratories in Gliwice, Lublin and Warsaw, and the Soviet laboratories in Kiev and Tallin. Recently we have been sounding out the possibilities of similar co-operation with laboratories in Denmark, Italy, Great Britain and Australia.

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Reviewed by Galina Hutt and accepted after revisions by the Editor.

REVIEWER'S COMMENTS (Dr. Galina Hutt)

This is a paper worthy of publication in *Ancient TL* because it describes the research effort and progress of the new TL dating centre in Poland. The apparatus is modern and suitably comprehensive for the present requirements of TL dating.

The comments I would like to make are concerned with the methodology described by the authors:

1. I am doubtful that the authors are employing the quartz inclusion technique. The use of heavy liquid separation (2.6-2.64 g/cm³) followed by acid treatment of 5% HCl and 1 h and 5% HF for 1 h is not, in my opinion, sufficient to obtain pure quartz samples where the alpha-dosed outer layer of grains has been removed.
2. It is advisable to obtain both first and second dose response curves to check for any change in sensitivity after bleaching.
3. The zeroing technique described gives the ideal zero (i.e. where the maximum bleachable TL has been removed). I believe that most of the samples will not have been zeroed to this level at the time of deposition.

Nonetheless, the good dating results achieved by the laboratory suggest that the above problems were not of great importance for the geological region that they investigated.