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# THERMOLUMINESCENCE AUTHENTICATION AND DATING AT UNIVERSITY OF TORINO

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In the last years, a laboratory for dating and authentication of archaeological finds and historical objects by means of thermoluminescence (TL) technique has been developed at the Physics Department of the University of Torino in collaboration with the Italian Institute for Nuclear Physics (INFN). The facility is part of laboratories within the INFN network CHNet.

The TL dating requires the measurement of two quantities: the total accumulated absorbed radiation dose in selected minerals (so-called palaeodose) and the annual dose due to the natural radioisotope content of the sample and its surrounding environment. From these two measurements, the TL age can be subsequently calculated from the basic equation: age=(palaeodose)/(annual dose).
At now fine grains method [1] is applied in our laboratory, but in future also the quartz inclusion grains procedure will be implemented. After an experimental comparison between chemical preparations of the samples reported in literature, the procedure described in [2] was adopted, being the one that gave the best results on objects of known age even if the material is of poor quality.
Palaeodose is the sum of two terms: the equivalent dose and the supralinearity. In our laboratory the equivalent dose is determined using the additive dose method for multiple aliquots; a calibrated radioactive 90Sr/Y beta source is used to supply the artificial dose. The irradiator was designed by INFN to minimize gamma contribution to the dose. After irradiation, a pre-heating is performed in oven at 150° C for 180 s to reduce the contribution of the TL signal coming from unstable traps. All TL measurements are carried out by means of a TL2000-Ipses reader in nitrogen atmosphere using a 10°C/s heating rate. In order to measure the supralinearity, a second analysis is carried out after removing natural TL by means of a heating (four hours at 450 °C). Finally the anomalous fading is estimated storing irradiated samples in dark at room temperature for few months and comparing the TL signal with the signal of samples immediately after irradiation.
The annual dose can be calculated as the sum of contributions to the dose from alpha, beta and gamma particles generated during radioactive decays. Different approaches are used depending on the uncertainty required in the calculation of the age. In first instance, alpha decay counting measurements by means of a CALPH-Ipses apparatus is used to calculate the contribution to the annual dose from uranium and thorium decay chains. In this case 40-potassium amount is measured by means of ICP (Inductively Coupled Plasma). Otherwise, for greater accuracy and according to the availability of the material, a measurement by means of gamma spectroscopy (HPGe-ORTEC detector) can be performed. Using gamma spectroscopy

it is also possible an estimation of the radon loss. In all cases the efficiency of the alpha particles compared to beta particles in producing a TL signal is calculated comparing the measured equivalent dose values obtained respectively by means of alpha (241Am source in vacuum) and beta particle artificial irradiations. Moreover environmental dosimeters are placed in archaeological site for few months in place of the sample obtained by means of coring. Finally, the annual dose contributions is corrected for the material porosity responsible for the water absorption.

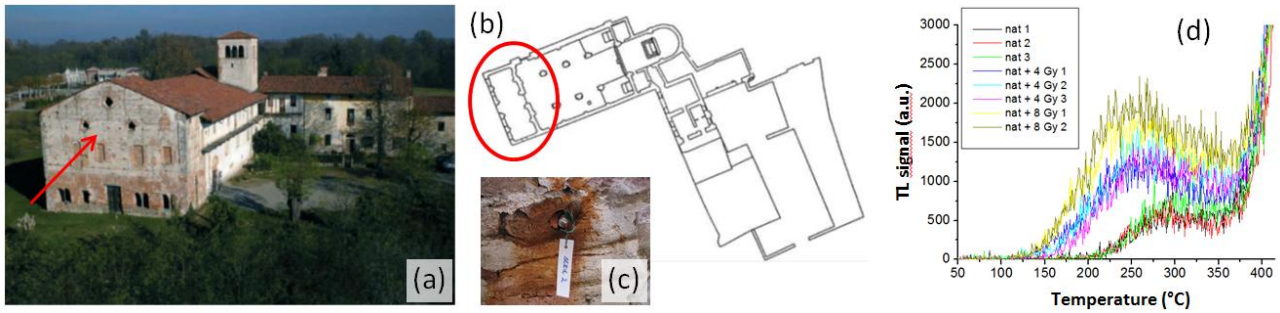


Fig. 1. (a) A photograph of the monastery in Castelletto Cervo (Biella), Italy; (b) the location of the forepart on the site map; (c) the environmental dosimeter inside the sampling hole; (d) TL curves at different artificial irradiation.

The laboratory has already been used in many cases of authentication of artworks coming from museums and private collections [3] and for dating in archaeological sites [4]. In Fig. 1 an example regarding the dating of a monastery in Castelletto Cervo (Biella), Italy is shown. During the eleventh century the monastic institution was founded by the monks of Cluny. The first document that verifies the existence of the monastery is dated back to 1083. However, archaeologists thought that the upper forepart had been built between 1400 AD and 1500 AD. To verify the archaeologists hypothesis a TL dating was performed on two bricks. In the first brick anomalous fading was observed and only a minimum age of about 400 years was estimated. In the second brick anomalous fading was absent, a palaeodose of 4,8 ± 0,4 Gy and an annual dose of 7,9 ± 0,6 Gy/year were measured. The corresponding year of the last burning (presumably the year of construction) was 1400±70 AD in agreement with the hypothesis of archaeologists. In this case more measurements to reduce the uncertainty were not needed being the aim of the study achieved.

## References

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