Luminescence Techniques on Earth Sciences and Cultural Heritage

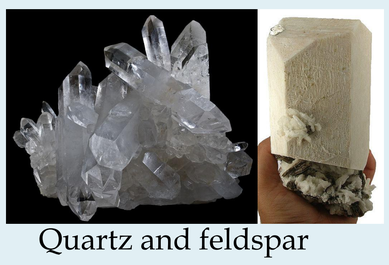
G. Cardoso[1,2], C. Burbidge[1,2], M.I. Dias[1,2], M.I. Prudêncio[1,2], F. Rocha[2]

Introduction

The method of luminescence allows determining the age of non-organic samples, up to several hundreds of thousands of years. Within this period of time the material has undergone a change in the signal to be adjusted to zero by exposure to heat or sunlight. All the stored energy is released and begins a new accumulation of background radiation, thus creating the so-called "luminescence clock" with a zero point, until it is released and measured in the laboratory, allowing the determination, in years, of an event. [2]

Principal signals and materials

1) thermoluminescence (TL)
2) optically stimulated (OSL)
   (a) infrared (IRSL) – feldspar/polimineral
   (b) blue light (BSL) – quartz



Quartz and feldspar

Age determination

The age is determined according with the formula:

Age (ka) = De (Gy)/Dr (Gy/ka),

where De is equivalent dose in grays and Dr is the average dose rate over time.

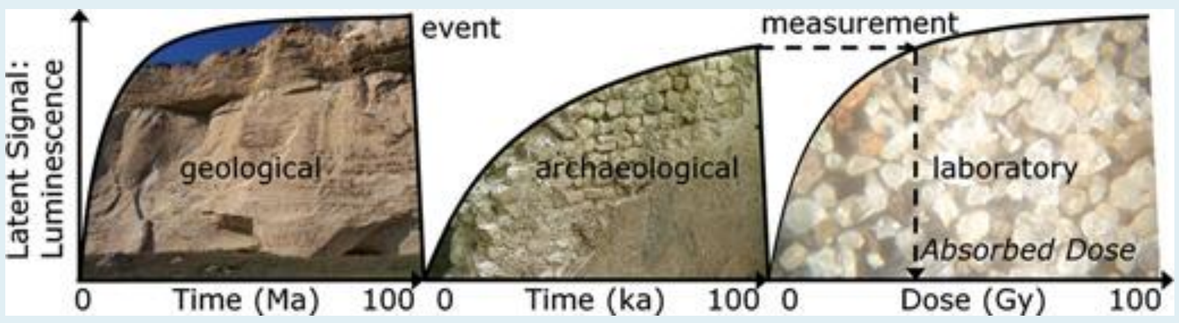
In the laboratory, the De itself insufficient to date the event to be studied. The Dr results from alpha, beta, and gamma radiation, produced principally by the decays of 40K and the 235U, 238U, and 232Th series. It is determined from neutron activation analysis in the laboratory, gamma spectrometry in field, and from measurements of water retention properties, plus the cosmic radiation content.[1]

De can be obtained by:

(i) regeneration - multiple aliquots, single aliquots/grains

(ii) additive dose - multiple aliquots

(iii) Predose - multiple aliquots, single aliquots



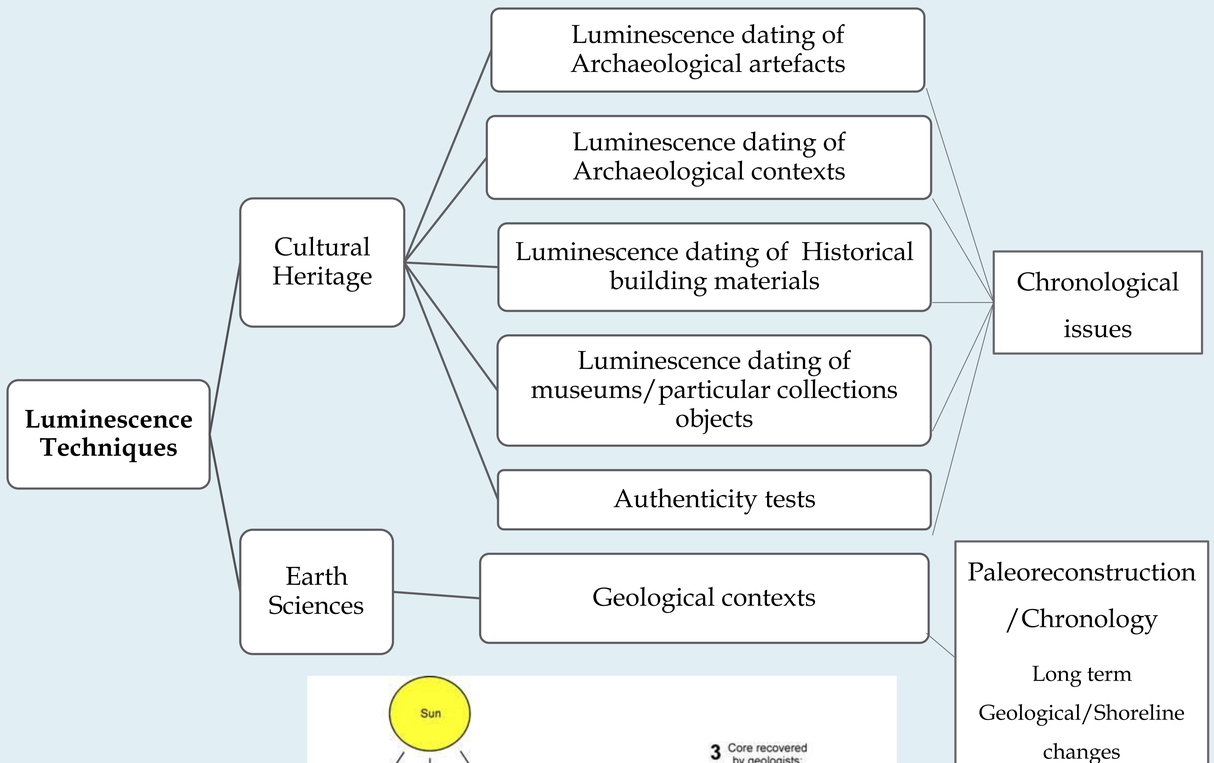
Dosimetric history of a mineral grain for luminescence dating.[4]

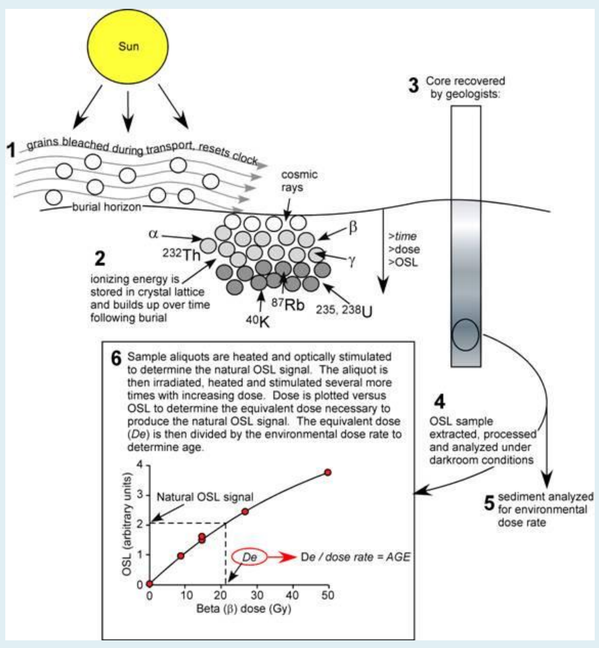
Applications

The materials most commonly used for luminescence are heated artifacts (ceramics, bricks, tiles, porcelain), heated rocks (flint, quartzite) and sediments from cultural heritage contexts and young geological deposits.

In artifact dating and/or authentication, the studied event is the manufacture or last use. For sediments it is the last moment they were exposure to sunlight before being reburied.

The range to date an event can be from few years to 1000000 years.





Generalized processes that produce the luminescence signal (steps 1 and 2), and the sampling and analytical procedure to determine the age of deposition (steps 3 through 6).[3]

References

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[3] O.B. Lian (2007): Luminescence Dating, in: *Encyclopedia of Quaternary Science*. Elsevier.

[4] M.I. Prudêncio, M.I. Dias, C.I. Burbidge, M.J. Trindade (2009): Técnicas nucleares e de luminescência na reconstituição da história da edificação de monumentos. *Pedra & Cal* , 42, 4–6.

[1]Instituto Superior Técnico, Campus Tecnológico e Nuclear, Estrada Nacional 10, Sacavém, 2686-953, Portugal – gcardoso@itn.pt
[2]GeoBioTec – Geobiociências, GeoTecnologias e GeoEngenharias: Departamento de Geociências – Universidade de Aveiro, Campus Universitário de Santiago, Aveiro, 3810 – 193, Portugal.

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