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OPTICALLY STIMULATED LUMINESCENCE DATING OF QUARTZ FROM LATE-QUATERNARY SEDIMENTS IN HUNGARY

THAMÓ-BOZSÓ, E., NÁDOR, A., MAGYARI, Á. & BABINSZKI, E.
Geological Institute of Hungary, Stefánia út 14, H-1143 Budapest, Hungary
E-mail: bozso@mafi.hu

Optically stimulated luminescence (OSL) dating

It is a rapidly developing technique, which provides absolute chronologies for Late Quaternary clastic sedimentary rocks. OSL dating of quartz from sandy fraction can be applied up to an age of 100-200 ka. The basis of OSL dating is that OSL traps (defects in the crystal lattice) become empty due to sunlight exposure. After burial, grains are exposed to low-level ionizing radiation, which is produced by the decay of naturally occurring radioactive isotopes of K, U, Th of the surrounding sediments, and minor cosmic radiation. During this exposure to ionizing radiation, free charge carriers (electrons and holes) are produced, and some of them are trapped at defects in the crystal lattice. The total amount of charge in the OSL traps is proportional to the value and duration of the radiation, so it increases with burial time. Trapped charges are released from OSL traps when the mineral is exposed to light. Recombination of electrons released from traps and holes results luminescence, which is a very small light flux. The brightness of the luminescence signal reflects the amount of charge trapped, and hence the irradiation dose the sample received since burial (equivalent dose). After sampling and special sample preparation in dark conditions, measuring the natural luminescence signal of the sample, and the luminescence signals in response to different artificial radioactive doses, samples are excited by exposure to light, the equivalent dose (Gy) in the sample can be calculated. Measuring the value of radiation from surrounding sediments and water content of the sample, and calculating the value of cosmic radiation gives the natural dose rate (Gy/ka or Gy/a), which dose reached the sample during a year or ka. Equivalent dose (Gy) / dose rate (Gy/a) gives the age (a) of the sample.

Sampling and sample preparation

The studied samples were taken from fluvial and eolian sands and silts on the Hungarian Plain and Transdanubian Hills. They were collected in opaque PVC tubes from outcrops and boreholes. The sample preparation was performed in subdued red light. Quartz was extracted from grain size fraction of 80–200 μm using H_2O_2 to remove organic material, 10% HCl to dissolve carbonates, SPT for density separation, 40% HF for 60 minutes to remove feldspars and the outer ~10 μm layer from the quartz grains, which has absorbed a dose from alpha radiation. The clean quartz grains were mounted as monolayer on stainless steel discs (aliquots).

OSL measurements and age calculation

OSL measurements were made in the Geological Institute of Hungary, using Risø TL/OSL automatic reader with a calibrated $^{90}Sr/^{90}Y$ beta source. After checking the luminescence purity of the quartz extracts by infra-red stimulation, blue LEDs were used for the optical stimulation of quartz. A single-aliquot regenerative-dose (SAR) protocol was used to estimate equivalent doses. In this procedure the equivalent dose is determined on a single aliquot by making repeated measurements of its OSL signal intensity, all light-sensitive trapped charge is removed during OSL measurements, and the data are automatically corrected. Preheat plateau tests, dose recovery tests, dose-response growth curves and thermal transfer tests were measured too. Equivalent doses (D_e) are based on between 18-23 aliquots per sample. The dose rates were calculated on the basis of high-resolution gamma spectrometry measurements of the surrounding sediments performed in the laboratory of Eötvös Loránd Geophysical Institute.

Results

On the Hungarian Plain OSL ages of the studied 25 sand samples from the upper 2–8 m of fluvial units vary between 10–47 ka. In this area the OSL age data were used to reconstruct the evolution of Late Quaternary river network complemented with heavy mineral analysis and interpretation of aerial photographs. We have two very young samples from recent flood deposits of the Tisza and Körös rivers.

The studied 12 fluvial and eolian sand and silt samples from the Transdanubian Hills are 11 to 42 ka old in from a depth 1,5-7 m. These age data provide the chronostratigraphic framework for timing neotectonic movements in this area.

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