

LUMINESCENCE CHARACTERISTICS OF QUARTZ SEPARATED FROM LATE PLEISTOCENE-HOLOCENE SEDIMENTS OF THE CARPATHIAN BASIN

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Quartz is a frequently used mineral in the luminescence age dating, first of all in the optically stimulated luminescence (OSL) dating method. OSL age of the sediment gives the date of its last exposure to sunlight. After deposition and burial the ionizing radiation of the surrounding sediments and the cosmic radiation generate free electrons, some of which become trapped in impurities and structural defects within quartz grains, and they store the absorbed energy. Initially the number of the trapped electrons is proportional to the dose of absorbed ionizing radiation. During heating or light exposure, the excited electrons escape from the traps, and the stored energy is released as luminescence light, TL or OSL signal respectively. There is a linear relationship between the absorbed dose and the luminescence signal for low doses. However, in the period of burial, the traps gradually become saturated, and the further ionizing radiation does not cause growth in the luminescence, limiting the age dating usually about 100 ka at the case of quartz. The higher values of the environmental dose rate cause earlier saturation. Usually only a small percentage of grains emit luminescence light, and the weak OSL signals give rise to problems in dating.

Late Pleistocene and Holocene sediments from different parts of the Carpathian Basin were studied, e.g. fluvial sediments near the Danube, Tisza, Körös, Lápos and Ér rivers, from the Transdanubian Hills, and South Transdanubia; eolian dune sands from the Transdanubian Central Range, and Transtisza Region; loess and loess-like sediments from Transdanubia, and valley of Ér River. Most of the fluvial sediments are medium or fine sands, and there are only a few sandy clay and gravel samples among them. Samples were collected by opaque PVC tubes. Sample preparation was done under subdued red light in dark room. Quartz was extracted mainly from within the grain size fraction 90–160, or 100–200 μm using H_2O_2 to remove the organic material, and 10% HCl to dissolve carbonates. Aqueous solution of sodium polytungstate was used for density separation of the quartz-rich fraction, which was then etched with 40% HF for 60 or 90 min to remove any remaining feldspars and the outer layer from the quartz grains (AITKEN, 1998). The clean quartz grains were mounted on stainless-steel discs in an 8 mm diameter (large aliquot) monolayer using silicone spray. OSL measurements were made using a Riso TL/OSL DA-

15C/D reader with a calibrated $^{90}\text{Sr}/^{90}\text{Y}$ beta source. Blue light-emitting diodes (LEDs) were used for the optical stimulation of quartz for 40 s, at 125 °C. Preheat temperature was 220, 240, or 260 °C according to the results of preheat plateau tests. A single-aliquot regenerative-dose (SAR) protocol (WINTLE & MURRAY, 2006) was applied during the measurements. Environmental dose rates were calculated based on laboratory high-resolution gamma spectrometry analyses (Canberra GC3020, Eötvös Loránd Geophysical Institute of Hungary) of about 0.7–1 kg bulk samples from the sediments surrounding the OSL samples. To characterise the luminescence of the separated quartz fractions their growth curves, saturation doses, and luminescence intensity were compared.

Growth curves show the growth of luminescence response to increased doses of ionizing radiation up to 240 Gy in this study. Samples with fast-growing OSL reach the saturation level earlier, at about 80–100 Gy, e.g. some sediments from Transdanubia. Meanwhile samples with slowly growing luminescence become saturated later, above 200 or 240 Gy, e.g. fluvial sediments of Lápos, Tisza, Danube, Körös, and Ér rivers.

Comparing the luminescence intensity, quartz fractions separated from some sediment of Ér Valley, Transdanubia, and near Tisza River exhibit the brightest OSL signals. But sediments of the Danube which were collected in the Vienna Basin have very dim OSL signal with consequent difficulties in age estimation. Some sands in the Transdanubian Central Range also show quite dim luminescence. Environmental dose rates of the studied sediments range between 0.7 and 3.8 Gy/ka. Due to the high radioactive Th, U, and K content the sediments of the Lápos River and loess samples from different areas have higher dose rates (above 2 Gy/ka) than the sands do.

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References

- AITKEN, M.J. (1998): An introduction to optical dating. The dating of Quaternary sediments by the use of photon-stimulated luminescence. Oxford University Press, Oxford, etc., p. 280.
WINTLE, A.G. & MURRAY, A.S. (2006): Radiation Measurements, 41: 369–391.