Multi-methods luminescence dating of Batajnica loess section (Serbia)

Daniela Constantin (1), Anca Avram (1,2), Daniel Veres (3), Szabolcs Kelemen (1,2), Igor Obreht (4), Ulrich Hambach (5), Slobodan Marković (6), Alida Timar-Gabor (1,2)

(1) Interdisciplinary Research Institute on Bio-Nano-Sciences, Babes-Bolyai University, Cluj-Napoca, Romania, (2) Faculty of Environmental Sciences and Engineering, Babes-Bolyai University, Cluj-Napoca, Romania, (3) Institute of Speleology, Romanian Academy, Cluj-Napoca, Romania, (4) Organic Geochemistry Group, MARUM-Center for Marine Environmental Sciences and Department of Geosciences, University of Bremen, Bremen, Germany, (5) BayCEER & Chair of Geomorphology, University of Bayreuth, Bayreuth, Germany, (6) Chair of Physical Geography, Faculty of Sciences, University of Novi Sad, Novi Sad, Serbia

The loess-paleosol sequences in the Middle and Lower Danube Basin are amongst the thickest and most complete available in Europe. At the site of Batajnica in the southern Carpathian (Middle Danube) Basin, Northern Serbia, previous stratigraphy, geochemistry and magnetic susceptibility investigations identified 5 loess-paleosol alternations, the lowermost being correlated to MIS 15. Thermoluminescence ages have been reported but in depth state of the art absolute dating is lacking.

In order to establish a luminescence chronology for this site, 23 samples have been collected at high resolution from the uppermost loess layer and Holocene soil, as well as from the boundaries of the three uppermost paleosols. The Single Aliquot Regenerative (SAR) protocol has been applied to 4-11 μm and 63-90 μm quartz grains. Feldspar infrared stimulated luminescence (IRSL) emitted by 4-11 μm polymineral grain was measured using the post IR-IRSL$_{225}$ and post IR-IRSL$_{290}$ techniques. Quartz yielded reliable OSL ages for the samples with equivalent doses up to 220 Gy ($\sim$80 ka). Overall, the luminescence dating results obtained for Batajnica section further confirm the grain-size dependent discrepancy previously reported for ages as well as equivalent doses for loess samples of different origins. The quartz and polymineral fine grains ages were found in agreement for equivalent doses up to 300 Gy ($\sim$70 ka; post IR-IRSL$_{225}$) and up to 160 Gy ($\sim$30 ka; post IR-IRSL$_{290}$). Ages of 39 $\pm$ 3 ka (116 Gy, 63-90 μm quartz), 44 $\pm$ 4 ka (180 Gy, pfg post IR-IRSL$_{225}$) and 53 $\pm$ 6 ka (220 Gy, pfg post IR-IRSL$_{290}$) were obtained for the loess sample collected just above a potential tephra layer in the uppermost loess unit (L1), that very likely correlates with the Campanian Ignimbrite/Y5-ash layer (^{40}Ar/^{39}Ar dated elsewhere to 39.3 $\pm$ 0.1 ka), with a widespread occurrence in the Danube Basin.

Based on the multi-methods approach for dating samples with age control provided by the major paleosols, we are discussing the validity of each dating protocol in the high dose range. At this site, for equivalent doses beyond 220 Gy, the post-IR IRSL$_{290}$ protocol overestimates systematically the expected depositional moment. The natural signal emitted by polymineral fine grains (post-IR IRSL$_{290}$) and 63-90 μm quartz SAR-OSL approaches saturation for samples immediately below the Eemian palaeosol, while the 4-11 μm quartz SAR-OSL and post-IR IRSL$_{225}$ signals continue to grow. For the loess sample collected from the S2 paleosol (magnetic susceptibility data correlated to MIS 7 $\sim$ 190-240 ka) the natural luminescence signal measured with the post-IR IRSL$_{290}$ protocol is found in saturation. The natural signals emitted by 4-11 μm quartz and polymineral fine grains (post-IR IRSL$_{225}$) interpolate below the saturation level of the dose response curves but underestimate with 50 % and 30 % respectively the expected equivalent doses.