Optically stimulated luminescence dating of the Đurđevac sands (N. Croatia): First results

Beerten, Koen; Galović, Lidija; Kordić, Branko; Šorša, Ajka

OPTICALLY STIMULATED LUMINESCENCE (OSL) DATING OF THE ĐURĐEVAC SANDS (NORTHERN CROATIA): FIRST RESULTS

Koen Beerten[1], Lidija Galović[2], Branko Kordić[2], Ajka Šorša[2]

[1]Engineered and Geosystems Analysis, SCK CEN, Belgium
[2]Croatian Geological Survey, Croatia

Corresponding author: Koen Beerten (kbeerten@sckcen.be)

The Đurđevac Sands are named after its informal type-locality near the town of Đurđevac, where they form a unique terrestrial dune landscape that covers Late Pleistocene loess deposits and Holocene river Drava fluvial and associated marshy deposits (Galović and Posilović, submitted). Based on the superposition principle, Hećimović (1989) concluded that the Đurđevac Sands must be Holocene in age. However, recent ^{14}C dating results of charcoal found in palaeosoils within the dune sands suggest that they were, at least partially, deposited during the Late Pleistocene (Galović and Posilović, submitted). The aim of the current study is to verify those recent findings using optically stimulated luminescence (OSL) dating of the aeolian sands that are covered by and covering the palaeosoils. OSL dating is proven to be a reliable technique to determine the burial ages of Late Pleistocene and Holocene aeolian sands in similar landscapes in northwestern Europe (Vandenberghe et al., 2013).

Samples were taken in an abandonned sand quarry, Draganci, in the town of Kalinovac (Figure 1a). The quarry is carved out into what seems to have been a massive (hummocky) dune, bordering a partially degraded large-scale parabolic dune created by northern winds (Figure 1b). Samples were taken after clearing the excavation wall, turning it partially into a staircase. Stainless steel cylinders were hammered into each of the steps. After removing the steel cylinders and taping the caps until fixed, surrounding sediment was sampled for determining the radioactivity concentrations. After removing the outer material from the cylinders (dark room lab), a portion of each sample was subjected to a 10% HCl, a 15% H_2O_2 treatment, a 2.8 g/cm³ polytungstate treatment, and, finally, a 45% HF treatment in order to purify the quartz. Equivalent doses were determined on individual aliquots using the 100-200 µm quartz fraction fixed onto disks with a 4 mm mask. A single aliquot regenerative (SAR) dose procedure (Murray and Wintle, 2003) was used, stimulating the samples for 40s with blue light diodes. A preheat of 240°C was used, and early background subtraction was applied to isolate the fast component. In addition, after drying, 500 g of surrounding sediment was analysed using high-resolution gamma-spectrometry. Dose rates were calculated taking into account beta and gamma contributions from all relevant radionuclides, a fixed internal dose and a depth-dependent cosmic dose contribution.

The preheat plateau test, applied on one sample only, did not show any significant dose dependency on preheat, even though the individual data points showed significant scattering. The dose recovery test for the a cutheat/preheat combination of 200°C/240°C yielded a recovery ratio of 1.00 ± 0.02 (23 aliquots) and an overdispersion of 9.0% (± 0.4%).

The resulting OSL ages are shown in Figure 1c-d. Overdispersion ranged from 42% for the second lowermost sample to 10% for the uppermost sample. However, given the fact that the distributions are rather symmetrical, and there is no reason to assume significant incomplete bleaching in this depositional setting, the ages are simply based on a central age model. The two lowermost samples yield OSL ages of around 14.5 ka, with a rather large uncertainty, and seem to be in agreement, within error limits, with the radiocarbon age

of charcoal from the lower palaeosoil (LPS), i.e., 15147 ± 265 cal yr BP. Furthermore, the two uppermost samples seem to place the position of the Pleistocene-Holocene boundary in this sediment-soil archive on top of the uppermost palaeosoil (UPS). A more detailed OSL sampling scheme will be set out in the near future, in the framework of the ACCENT project (Galović et al., submitted), in conjuction with (palaeo)pedological, geomorphological and geophysical techniques to elucidate the evolution of the Đurđevac landscape during the later Pleistocene and the Holocene, against a background of climate, land use and socio-economic change.

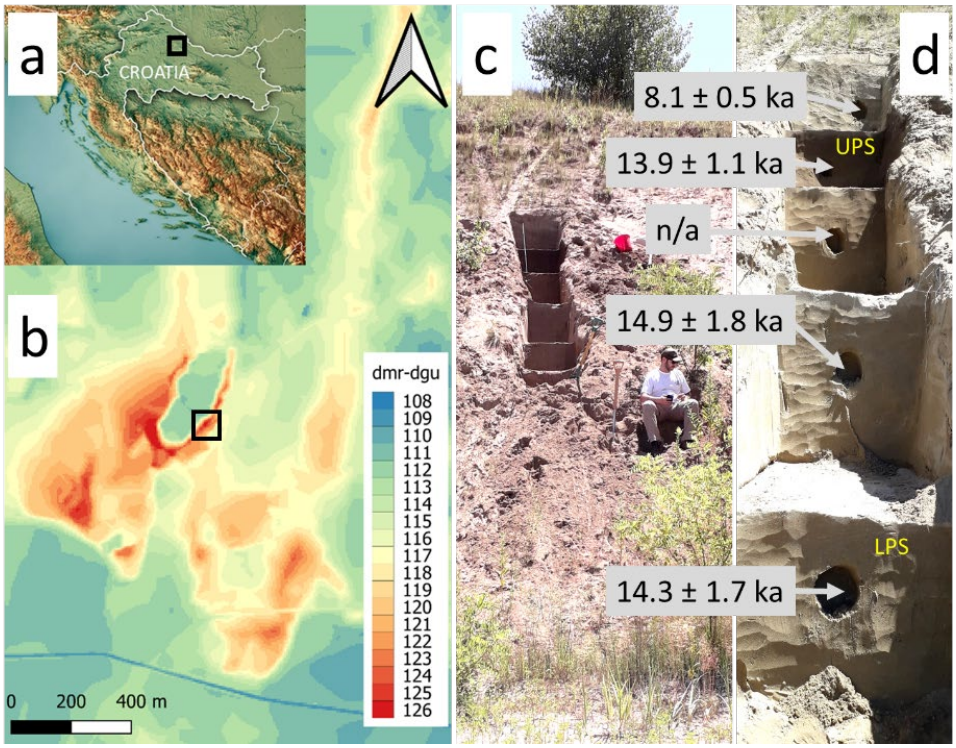

Figure 1: (a) Location of the sampling site in Croatia as indicated by the black rectangle. (b) Digital Elevation Model of the Draganci sand pit and surroundings; black rectangle indicates the position of the stepped profile shown in (c); note the parabolic dune to the east of the sampling location, with a very long right arm. (c) View of the sampled cross-section. (d) Detailed photograph of the profile sampled for OSL dating; OSL ages are given in grey boxes. The approximate position of the upper palaeosoil (UPS) and lower palaeosoil (LPS) is indicated.

REFERENCES

Galović, L., Posilović, H., submitted. The age of the Đurđevac Sands (Podravina, N Croatia). Proceedings of the 3rd Euro-Meditteranean Conference on Environmental Integration (Tunisia, 2021), Springer.

Galović, L., Beerten, K., Šorša, A., Poch, R.M., Stejić, P., Gajić, R., Pandurov, M., Husnjak, S., submitted. Incoming research project: Abrupt climate changes – Evidence from Quaternary sedimentological sequences in Croatia (ACCENT). Proceedings of the 3rd Euro-Meditteranean Conference on Environmental Integration (Tunisia, 2021), Springer.

Hećimović, I., 1987. Basic geological map of SFRY, scale 1:100.000, Guidebook of the geological map for the Đurđevac sheet – in Croatian. Federal Geological Survey, Belgrade.

Murray, A.S., Wintle, A.G., 2003. The single aliquot regenerative dose protocol: potential for improvements in reliability. Radiation Measurements 37, 377-381.

Vandenberghe, D.A.G., Derese, C., Kasse, C., Van den haute, P., 2013. Late Weichselian (fluvio-)aeolian sediments and Holocene drift-sands of the classic type locality in Twente (E Netherlands): a high-resolution dating study using optically stimulated luminescence. Quaternary Science Reviews 68, 96-113.