Doctoral School of Geosciences

THE ACCUMULATION HISTORY OF THE PÉCEL LOESS-PALEOSOL PROFILE

A PÉCELI LÖSZ-PALEOTALAJ SZELVÉNY AKKUMULÁCIÓS TÖRTÉNETE

Theses of the Ph.D. Dissertation

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Introduction and aims

The primary goal of this research was the complete investigation of the loess-paleosol sequence of Pécel, located in the Gödöllő hills. During several sampling sessions, a 25.72-meter-high section was constructed, the upper 24.56 meters of which is a series of loess-paleosols, 0.51 meters of fluvial sand sediments are located below it, and the lower 0.65 meters, the Ostracoda fauna found in it based on, clay sediment of Pannonian age. During the investigations, 6 loess and 5 paleosol layers were isolated. From the layer thicknesses of the sand sediment, we can conclude that it may be the sediment of the former bed of the Rákos stream, which flows a few hundred meters from the section.

The entire research covers the examination of 5 loess-paleosol sequences, with different locations: foothill (Bodrogkeresztúr, Pécel) and lowland (Kisdorog-kelet, Kisdorog-west, Bonyhádvarasd). With the exception of the Bodrogkeresztúr section, all the other newly excavated sections, whose results are compared with each other, contain a lot of information.

During my research, different loess-paleosol sequences were investigated, including some new sequences, which were not described before. The first aim was to (I) compare different chronometric methods (radiocarbon, OSL) in one sequence. The next one (II) was to investigate the Pécel site weathering degree after the first sampling period with geochemical indices. These geochemical measurements also showed that (III) there is a change in the source of the dust. After the weathering degree has been identified, the whole 26 meters high sequence was sampled and the whole grain size distribution was revealed.

There were 20 radiocarbon measurements were made and the whole sequence was measured with magnetic susceptibility. It occurred from all these relative and absolute ages that the Pécel sequence started to accumulate (IV) at least in the Middle Pleistocene (between 300-400 ka.). After all, three more sequences were sampled in the Tolna hills of the Transdanubian region. These sequences were smaller, between 6-12 meters, so there were no preliminary weathering investigations. During the results processing, it occurred that there is a dominant difference between the north-eastern and the south-western sequences grain size distribution. With all the five sequences data (V) the difference in wind directions became apparent. The prevailing wind direction in the Carpathian Basin is western-northwestern, but the coarser grains in some sequences shows that there was a period when this direction was opposite, south-southeast. In the Bodrogkeresztúr and

Pécel sequences there were no well-developed paleosol layers, but in the Transdanubian sequences 1-3 meters thick paleosols were described which (VI) can be explained by the regionality of hilly areas.

Methods applied

All the self-investigated sequences were sampled in 4 cm interval to the loss on ignition (LOI; Dean, 1974), grain size composition, geochemical, magnetic susceptibility investigations. To collect the Molluscs from the sediment, the sampling was less dense, 8 or 12 cm, depends on the hight of the wall. From the Molluscs, radiocarbon age can be measured, which can be used to make the age-depth models and the accumulation rate diagrams from them.

Dean's Loss on Ignition method (Dean, 1974) was used to determine the organic matter and carbonate content of the samples. This method is based on the measurement of the loss on ignition weight of the powdered sediment samples. The previously air-dried samples are first ignited at 550 °C, at which temperature the organic matter is being burnt, and then, at 900 °C, in order to detect the carbonate content. The 900 °C temperature value was chosen based on the study of Heiri et al. (2001).

The determination of grain size composition was based on Bokhorst et al. (2011). Air dried samples were pre-treated in hydrogen peroxide (30% H_2O_2) and hydrochloric acid (10% HCl) bath to remove organic materials and carbonate from the sediment. Then, 30 mL of Calgon ($Na_2P_6O_{18}$) solution was added to 0.7 g of the sample to separate the individual granules. Immediately before the measurement, the samples were treated in an ultrasonic cleaner for 20 min to prevent the adhesion of the particles. The grain size composition was carried out with an Easysizer 20 laser sedigraph at the Department of Geology and Paleontology, University of Szeged. The source used is a 2 MW of energy, 0.6328 μm wavelength He-Ne laser (Sümegi et al., 2019). The laser sedigraph measured 42 particle size ranges between 0.0001 and 0.5 mm using 54 built-in detectors based on the Mie scattering theory. Frequency and cumulative values were calculated by using the measured values. The results were arranged into particle size ranges based on the Wentworth scale (Wentworth, 1922) and plotted on separated line diagrams.

The U-ratio defines the ratio of the coarse silt and the medium + fine silt fractions. This ratio can be applied to distinguish the cold, dry glacial periods with significant eolian transport and high wind velocity (high U-ratio), and the warm, wet interglacial periods with weak wind intensity (low U-ratio). This distinction approach is based on the observation that the

predominant grain size fraction of eolic sedimentation is <16 μm in warmer interglacial periods, while it is >16 μm in colder glacial periods (Vandenberghe et al., 1997; Nugteren et al., 2004). Clay fraction (<5.5 μm) and grain size fractions coarser than 44 μm are not taken into account for the calculation of the U-ratio, thus, no information can be obtained about clay minerals formed by secondary pedogenetic processes or about fine sand particles transported in saltation (Vandenberghe et al., 1997; Vandenberghe, 2013).

The Grain Size Index (GSI) introduced by Rousseau et al. (2002) is similar to the U-ratio. The most significant difference is that the clay fraction is also taken into account for its calculation. Based on this index, the efficiency of sedimentation, transport and accumulation processes can be determined which are closely related to the changes in wind velocity (Rousseau et al., 2002). High GSI values indicate an increased frequency and intensity of dust storms, as well as a higher sedimentation rate (Rousseau et al., 2002, 2007).

The magnetic susceptibility (Zhou et al., 1990; An et al., 1991; Rousseau and Kukla, 1994; Dearing et al., 1996; Sun and Liu, 2000; Zhu et al., 2004; Hlavatskyi and Bakhmutov, 2021; Chen et al., 2006) measurements were carried out by using a Bartington MS2K surface sensor instrument at the Department of Geology and Paleontology, University of Szeged. The air-dried, powdered samples were measured three times in different directions.

New scientific results

T1 There was a possibility in the Bogrogkeresztúr sequence to investigate the radiocarbon and the OSL dating methods through age-depth and accumulation rates models. The results show that, due to their small uncertainty, radiocarbon age data produce more reliable models compared to the results obtained from luminescence tests. However, the measurement limit of the radiocarbon test is low (0-70 thousand years), so it can only be used uniformly in very young layers or in archaeological research. In the case of large, older sections, the mixed use of dating methods is unavoidable, however, when creating age-depth models, it is important to accurately determine the input parameters.

T2 For a new study, weathering degree must be investigated before the whole research, to be certain, that the sequence, we would like to investigate, is not a redeposited sediment. In the case of Pécel, the preliminary sedimentological and geochemical investigations have shown that the profile merits conducting further research, as no significant erosion or intensive weathering could be

detected. It carries a wealth of data, which can perfectly complement the results of the surrounding profiles investigated so far and could provide data for the study of the climate changes in the Quaternary.

T3 Through geochemical data, there is a significant change in the upper part of the Pécel sequence. At least two source areas can be presumed based on geochemical indices (CIA, CIW, Rb/Sr, Zr/Rb). Based on the characteristics of the chemical composition of sulphide minerals (P, S, Pb, Ni, As sulphides), the lower 10 m of the profile was supposed to be transported from the NW direction (Buda Thermal Karst, Börzsöny, Cserhát). Sufficient information is not yet available in order to determine the source area of the upper 10 m.

T4 Magnetic susceptibility measurement and 20 radiocarbon ages are available from the Pécel sequence. With the relative and absolute ages, it is assumed that the development of the sediment started at least in the Middle Pleistocene (between 300-400 ka). Beneath the loess, there are river sediments, which means, the older loess sediments may be eroded and redeposited.

T5 With the investigations of the 5 sequences, there is a significant change can be identified in the prevailing wind direction, both the grain size composition results and the geochemical element changes in Pécel support this.

T6 Through the 5 sequences data, we can identify a regionality effect in the Transdanubian development history. Both in Bodrogkeresztúr or Pécel, there are no thick, well-developed paleosol layers, but in the Transdanubian sequences, where the paleosols are 1 to 3 meters thick and can be divided into 3 different parts.

Összefoglalás

Kutatásom elsődleges célja a Gödöllői-dombság területén elhelyezkedő péceli lösz-paleotalaj szelvény teljes megkutatása volt. Több mintázási alkalom során egy 25,72 méter magas szelvény került kiakalításra, melynek a fölső 24,56 métere egy lösz-paleotalaj sorozat, alatta 0,51 méternyi folyóvízi homoküledék helyezkedik el, az alsó 0,65 méter pedig, a benne talált Ostracoda fauna alapján, Pannon korú agyagüledék. A vizsgálatok során 6 lösz és 5 paleotalaj réteg került elkülönítésre. A homoküledék rétegvastagságaiból arra következtethetünk, hogy az a szelvénytől párszáz méterre folyó Rákos patak egykori medrének üledéke lehet.

A teljes kutatás 5 lösz-paleotalaj szelvény vizsgálatát fedi le, különböző, hegylábi (Bodrogkeresztúr, Pécel), valamint síksági (Kisdorog-

kelet, Kisdorog-nyugat, Bonyhádvarasd) fekvéssel. A bodrogkeresztúri szelvény kivételével az összes többi újonnan feltárt szelvény, melyek eredményeinek egymással való összehasonlítása számos információt hordoz magában.

Az elsődleges vizsgálatok az izzításos tömegveszteségen alapuló szervesanyag-, és karbonáttartalom (LOI - Dean, 1974), valamint a szemcseösszetétel meghatározás voltak. Miután a terepi leírás és a fenti eredmények alapján pontosan elkülönítettem a lösz és paleotalaj rétegeket, geokémiai (XRF) eredményekkel és az azokból nyert geokémiai indexekkel a szelvény anyagát adó porüledék összetételét és mállottsági foka került meghatározásra. A továbbiakban mágneses szuszceptibilitás (MS) vizsgálattal relatív-, 20 radiokarbon koradattal pedig abszolút kort rendeltem a szelvényhez. A radiokarbon adatok felhasználásával kor-mélység modell készült, melyből üledékfelhalmozódási ráta került számításra, a poranyag hullás intenzitásának feltárása érdekében. A legidősebb rendelkezésre álló koradat 7.56-7.68 méter mélységből 42.508 cal. BP, mely a relatív koradatokkal összevetve alátámasztja a szelvény feltételezhető 300-400.000 éves korát, tehát MIS 9/10 szintben kezdődött meg a felhalmozódás a folyóvízi üledékre.

A kor-mélység modellekhez a koradatok felhasználhatóságát a 2. fejezetben található publikációban dolgoztam fel a bodrogkeresztúri szelvényen, ahol rendelkezésre állt egy szelvényből radiokarbon és optikailag stimulált lumineszcens (OSL) adat is. Az eredményekből kirajzolódik, hogy a radiokarbon koradatok a kis bizonytalanságuk miatt megbízhatóbb modelleket produkálnak a lumineszcens vizsgálatokból nyert eredményekkel szemben. A radiokarbon vizsgálat mérési határa azonban alacsony (0-70 ezer év), így csak nagyon fiatal rétegekben, vagy régészeti kutatásokban használható egyöntetűen. Nagy kiterjedésű, idősebb szelvények esetében a korolási módszerek vegyes használata elkerülhetetlen, azonban a kor-mélység modellek készítsekor a bevitt paraméterek pontos meghatározása fontos.

A péceli mellett 3 dunántúli szelvény került kialakításra, Kisdorog-kelet (6,40 méter), Kisdorog-nyugat (5,60 méter) és Bonyhádvarasd (8,16 méter). Mindhárom szelvény síksági helyzetű, a Tolnai-dombvidék területén helyezkedik el. A kisdorogi szelvények egymástól 500 méterre helyezkednek el, egy domb keleti, valamint nyugati oldalán. Ez a kettős mintázás lehetővé tette a lösz-paleotalaj szelvények fejlődésének lokális és regionális összehasonlítását. Mindkét szelvény esetében csupán egy, azonban nagyon fejlett paleotalaj réteg került feltárásra. A bonyhádvarasdi, egy Kisdorogtól 4

km-re elhelyezkedő, déli fekvésű, szintén jól fejlett paleotalaj réteggel rendelkező szelvény.

A három déli (Bodrogkeresztúr, Pécel, Bonyhádvarasd), egy keleti (Kisdorog-kelet) és egy nyugati (Kisdorog-nyugat) szelvények szemcseösszetételi eredményeiből kirajzolódik egy uralkodó szélirány változás (Észak-Északnyugati - Dél-Délkeleti változás). Az uralkodó porhordás változását a péceli geokémiai eredmények is alátámasztják, ahol 10 méteres mélységben elemtartalom változás rajzolódik ki.

A szelvényekből kinyert Mollusca fauna feldolgozása a jövőben pontosabb képet fog adni, mind a klimatikus, mind a vegetációs változások tekintében.

References

An, Z.; Kukla, G.J.; Porter, S.C.; Xiao, J. 1991. Magnetic Susceptibility Evidence of Monsoon Variation on the Loess Plateau of Central China during the last 130,000 Years. Quaternary Research, 36, pp. 29–36.

Bokhorst, M.P.; Vandenberghe, J.; Sümegi, P.; Łanczont, M.; Gerasimeno, N.P.; Matviishina, Z.N.; Marković, S.B.; Frechen, M. 2011. Atmospheric circulation patterns in central and eastern Europe during the Weichselian Pleniglacial inferred from loess grain-size records, Quarternary International 234, pp. 62-74.

Chen, J.; Chen, Y.; Liu, L.; Ji, J.; Balsam, W.; Sun, Y.; Lu, H. 2006. Zr/Rb ratio in the Chinese loess sequences and its implication for changes in the East Asian winter monsoon strength. Geochimica et Cosmochimica Acta, 70, pp. 1471–1482.

Dean, W.E. 1974. Determination of carbonate and organic matter in calcareous sediments and sedimentary rocks by loss on ignition: comparison with other methods, Journal of Sedimentary Petrology, 44, pp. 242-248.

Dearing, J.A.; Hay, K.L.; Baban, S.M.J.; Huddleston, A.S.; Wellington, E.M.H.; Loveland, P.J. 1996. Magnetic susceptibility of soil: An evaluation of conflicting theories using a national data set. Geophysical Journal International, 127, pp. 728–734.

Heiri, O.; Lotter, A.F.; Lemcke, G. 2001. Loss on ignition as a method for estimating organic and carbonate content in sediments: Reproducibility and comparability of results. Journal of Paleolimnology, 25, pp. 101–110.

Hlavatskyi, D.; Bakhmutov, V. 2021. Early-Middle Pleistocene Magnetostratigraphic and Rock Magnetic Records of the Dolynske Section (Lower Danube, Ukraine) and Their Applications to the Correlation of Loess-Palaeosol Sequences in Eastern and South-Eastern Europe. Quaternary, 4, 43.

Nugteren, G.; Vandenberghe, J.; van Huissteden, K.; An, Z.S. 2004. A Quaternary climate record based on grain size analysis from the Luochuan loess section on the Central Loess Plateau, China. Global and Planetary Change, 41, pp. 167–183.

Rousseau, D.; Antoine, P.; Hatté, C.; Lang, A.; Zöller, L.; Fontugne, M.; Othman, D.; Luck, J.; Moine, O.; Labonne, M.; Bentaleb, I.; Jolly, D. 2002. Abrupt millennial climatic changes from Nussloch (Germany) Upper

Weichselian eolian records during the Last Glaciation. Quaternary Science Reviews, 21, pp. 1577–1582.

Rousseau, D.D.; Kukla, G. 1994. Late Pleistocene Climate Record in the Eustis Loess Section, Nebraska, Based on Land Snail As-semblages and Magnetic Susceptibility. Quaternary Research, 42, pp. 176–187.

Rousseau, D.-D.; Sima, A.; Antoine, P.; Hatté, C.; Lang, A.; Zöller, L. 2007. Link between European and North Atlantic abrupt climate changes over the last glaciation. Geophysical Research Letters, 34, 22713.

Sun, J.; Liu, T. 2000. Multiple origins and interpretations of the magnetic susceptibility signal in Chinese wind-blown sediments. Earth Planetary Science Letters, 180, pp. 287–296.

Sümegi, P.; Molnár, D.; Gulyás, S.; Náfrádi, K.; Sümegi, B.P.; Törőcsik, T.; Persaits, G.; Molnár, M.; Vandenberghe, J.; Zhou, L. 2019. High-resolution proxy record of the environmental response to climatic variations during transition MIS3/MIS2 and MIS2 in Central Europe: The loess-paleosol sequence of Katymár brickyard (Hungary). Quaternary International, 504, pp. 40–55.

Wentworth, C.K. 1922. A scale of grade and class terms for clastic sediments, The Journal of Geology 30, pp. 377-392.

Vandenberghe, J. 2013. Grazin size of fine-grained windblown sediment: A powerful proxy for process identification. Earth-Science Reviews, 121, pp. 18–30.

Vandenberghe, J.; An, Z.S.; Nugteren, G.; Lu, H.; van Huissteden, K. 1997. New absolute time scale for Quaternary climate in the Chinese Loess region by grain-size analysis. Geology, 25, pp. 35–38.

Zhou, L.P.; Oldfield, F.; Wintle, A.G.; Robinson, S.G.; Wang, J.T. 1990. Partly pedogenic origin of magnetic variations in Chinese loess. Nature, 346, pp. 737–739.

Zhu, R.; Liu, Q.; Jackson, M.J. 2004. Paleoenvironmental significance of the magnetic fabrics in Chinese loess-paleosols since the last interglacial (<130 ka). Earth Planetary Science Letters, 221, pp. 55–69.

Lists of publications related to the Ph.D. dissertation

Makó, L.; Cseh, P.; Nagy, B.; Sümegi, P.; Molnár, D. 2023. Development History of the Loess-Paleosol Profiles of Pécel, Kisdorog and Bonyhádvarasd, Hungary. Quaternary, 6 (3), 38.

Makó, L.; Molnár, D.; Runa, B.; Bozsó, G.; Cseh, P.; Nagy, B.; Sümegi, P. 2021. Selected Grain-Size and Geochemical Analyses of the Loess-Paleosol Sequence of Pécel (Northern Hungary): An Attempt to Determine Sediment Accumulation Conditions and the Source Area Location. Quaternary, 4 (2), 17.

Makó, L.; Molnár, D.; Cseh, P.; Sümegi, P. MAR comparisons between different chronometric methods for two profiles in the Bodrogkeresztúr area. Studia Quaternaria, 38 (1), pp. 67-73.

List of other publications

Eltijani, A.; Molnár, D.; **Makó, L**.; Geiger, J.; Sümegi, P. 2022. Applying grain-size and compositional data analysis for interpretation of the Quaternary oxbow lake sedimentation processes: Eastern Great Hungarian Plain. Studia Quaternaria, 39 (2), pp. 83-93.

Cseh, P.; Molnár, D.; **Makó, L**.; Sümegi, P. 2022. Geoarchaeological Analyses of a Late-Copper-Age Kurgan on the Great Hungarian Plain. Quaternary, 5 (2), 20.

Eltijani, A.; Molnár, D.; **Makó, L**.; Geiger, J.; Sümegi, P. Application of Parameterized Grain-Size Endmember Modelling in the Study of Quaternary Oxbow Lake Sedimentation: A Case Study of Tövises Bed Sediments in the Eastern Great Hungarian Plain. Quaternary, 5 (4), 44.

Sümegi, P.; Molnár, D.; Gulyás, S.; Stevens, T.; **Makó, L**.; Cseh, P.; Molnár, M.; Fitzsimmons, K.; Nett, J.J.; Hlavatskyi, D.; Lehmkuhl, F. 2022. Comparison of High-Resolution 14C and Lumincescence-Based Chronologies of the MIS 2 Madaras Loess/Paleosol Sequence, Hungary: Implications for Chronological Studies. Quaternary, 5 (4), 47.

Sümegi, P.; Molnár, D.; Náfrádi, K.; **Makó, L**.; Cseh, P.; Törőcsik, T.; Molnár, M.; Zhou, L. 2022. Vegetation and land snail-based reconstruction of the palaeocological changes in the forest steppe eco-region of the Carpathian Basin during last glacial warming. Global Ecology and Conservation, 33, e01976, 28.

Molnár, D.; Sümegi, P.; **Makó, L**.; Cseh, P.; Zeeden, C.; Nett, J.; Lehmkuhl, F.; Törőcsik, T.; Sümegi, B.P. 2021. Palaeoecological background of the Upper Palaeolithic site of Ságvár, Hungary: radiocarbon-dated malacological and sedimentological studies on the Late Pleistocene environment. Journal of Quaternary Science, 36 (8), pp. 1353-1363.

Molnár, D.; **Makó, L**.; Cseh, P.; Sümegi, P.; Fekete, I.; Galović, L. 2021. Middle and Late Pleistocene loess-palaeosol archives in East Croatia: multi-proxy palaeoecological studies on Zmajevac and Šarengrad II sequences. Studia Quaternaria, 38 (1), pp. 3-17.

Sümegi, P.; Gulyás, S.; Molnár, D.; Bozsó, G.; Fekete, I.; **Makó, L**.; Cseh, P.; Molnár, M.; Sümegi, B.P.; Almond, P.; Zeeden, C.; Törőcsik, T.; Nett, J.J.; Markó, A.; Lehmkuhl, F. 2021. New chronology and extended palaeoenvironmental data to the 1975 loess profile of Madaras brickyard, South Hungary. Journal of Quaternary Science, 36 (8), pp. 1364-1381.

Tapody, R.O.; Sümegi, P.; Molnár, D.; Karlik, M.; Törőcsik, T.; Cseh, P.; **Makó, L**. 2021. Sedimentological-Geochemical Data Based Reconstruction of Climate Changes and Human Impacts from the Peat Sequence of Round Lake in the Western Foothill Area of the Eastern Carpathians, Romania. Quaternary, 4 (2), 18.

Molnár, D.; **Makó, L**.; Sümegi, P.; Sümegi, B.P.; Törőcsik, T. 2019. Revisiting the palaeolithic site at Szeged-Öthalom: attempt for appoint the palaeolithic horizon. Studia Quaternaria, 36 (1), pp. 45-53.

Molnár, D.; Sümegi, P.; Fekete, I.; **Makó, L**.; Sümegi, B.P. 2019. Radiocarbon dated malacological records of two Late Pleistocene loess-paleosol sequences from SW-Hungary: Paleoecological inferences. Quaternary International, 504, pp. 108-117.

Conferences, abstracts and book chapters

Eltijani, A.; Molnár, D.; Sümegi, P.; Geiger, J.; **Makó, L**. 2021. Grain size and compositional data analysis for interpretation of Quaternary oxbow lake sedimentation processes: a case study from the SE Great Hungarian Plain

Makó, L. 2021. Előzetes szemcseméret és geokémiai adatközlés a péceli lösz-paleotalaj szelvényről. 24. Magyar Őslénytani Vándorgyűlés, pp. 21-21.

Makó, L.; Molnár, D.; Sümegi, P. 2020. A bodrogkeresztúri lösz-paleotalaj szelvény környezettörténeti és üledékföldtani vizsgálata. Magyarok a Kárpát-medencében 4, pp. 131-140.

Molnár, D.; **Makó, L**.; Sümegi, P. 2020. A Szeged-Öthalom területén feltárt felső-paleolit telep környezettörténeti rekonstrukciója üledéktani és malakológiai adatok alapján. Környezettörténet: Tanulmányok Sümegi Pál professzor 60 éves születésnapi köszöntésére, pp. 273-280.

Cseh, P.; Molnár, D.; **Makó, L**.; Sümegi, P. 2020. Geoarcaeological analyses of the Császárné-halom (mound) at Pusztaszer. 26th EAA Virtual Annual Meeting: Abstract Book, pp. 553-553.

Makó, L.; Molnár, D.; Sümegi, P. 2019. A Szeged-Öthalom területén található Gravetti megtelepedés környezetrekonstrukciója malakológiai és üledéktani adatok alapján. 22. Magyar Őslénytani Vándorgyűlés, pp. 26-27.

Co-author statements

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was decisive that I have not used it to obtain a scientific degree and will not do so in the future.

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Balázs Nagy

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MAKÓ, L.; CSEH, P.; NAGY, B.; SÜMEGI, P.; MOLNÁR, D. 2023: Development History of the Loess-Paleosol Profiles of Pécel, Kisdorog and Bonyhádvarasd, Hungary. — *Quaternary* 6(3), 38.

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Szeged, 11.07.2023

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CO-AUTHOR STATEMENTS

I, Pál Sümegi, hereby declare that the role of the doctoral candidate in the publication of

MAKÓ, L., MOLNÁR, D.; CSEH, P.; SÜMEGI, P. 2021: MAR comparisons between different chronometric methods for two profiles in the Bodrogkeresztúr area. — *Studia Quaternaria* 38(1), 67-73.

MAKÓ, L.; MOLNÁR, D.; RUNA, B.; BOZSÓ, G.; CSEH, P.; NAGY, B.; SÜMEGI, P. 2021: Selected Grain-Size and Geochemical Analyses of the Loess-Paleosol Sequence of Pécel (Northern Hungary): An Attempt to Determine Sediment Accumulation Conditions and the Source Area Location. — *Quaternary* 4(2), 17.

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MAKÓ, L.; MOLNÁR, D.; RUNA, B.; BOZSÓ, G.; CSEH, P.; NAGY, B.; SÜMEGI, P. 2021: Selected Grain-Size and Geochemical Analyses of the Loess-Paleosol Sequence of Pécel (Northern Hungary): An Attempt to Determine Sediment Accumulation Conditions and the Source Area Location. — *Quaternary* 4(2), 17.

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Boglárka Runa