Studies on paleoenvironmental change using a method of sedimentological assessment

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Abstract

There are only few loess exposures in Hungary where red clays and very ancient „pink" loesses can be studied not only in deep boreholes but where they are found in uplifted position subsurface. Szulimán section studied in detail belongs to them. The same method was applied for the investigations of similar sequences in elevated position at Hévízgyörk. In this way Quaternary deposits in different regions of the country can be parallelized.

The investigations were aimed at disclosing changes in paleogeographic conditions during Pleistocene in the environs of the studied exposures with the involvement of new analytical methods of Quaternary sedimentology. An important requirement was that a rapid and exact information be obtained directly from the stratigraphic diagrams and the summary tables containing the parameter values for the individual layers.

Our primary aim was to present diagrams and tables with information for the reader about the layers to be found at different depths.

Keywords: granulometric parameters, demarcation of the layers, warming and cooling peaks, erosional gaps

Introduction

The 6 *granulometric parameters* involved in the method are conceived as environmental indicators. They characterise Quaternary deposits and dynamics in rate of sedimentation, allowing the local correlation between the similar layers. To specify our knowledge two newly introduced indices of environmental discrimination (Kis, É. 1995): *fineness grade* (F_G) and *degree of weathering* (K_d) were applied together with four traditional granulometric parameters: *sorting, kurtosis, asymmetry, median* (S_o K, S_k, M_d respectively), $CaCO_3$ content, and

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variations in grain size composition (percentage of clay, silt, loess and sand). The method applied enables vertical correlation of sequences.

Description of the Szulimán profile

The studied section is located near the village of Szulimán, Hungary, in the southern part of Zselic region, in the valley of the stream Almás. Based on the parameter values 9 layers could be identified *(Figure 1, Photos 1* and *2, Table 1):*

I. 2 fossil soils
II. 3 loess layers
  – 1 old loess layer
  – 2 silty loess layers
III. 1 level of slope sediments
IV. 1 level of Pannonian clay
V. 1 level of mottled clay
VI. 1 level of silty sand

Fig. 1. The Szulimán and Hévízgyörk sections on the map of Hungary

Photo 1. Eastern part of the Szulimán loess section (Photo by Kɪs, É.)

Photo 2. Western part of the Szulimán loess section (Photo by Sᴄʜᴡᴇɪᴛᴢᴇʀ, F.)

Table1. Szulimán section: granulometric parameter values by horizons and their interpretation (Kis, É.). (Granulometric analyses in 9 grain size categories: di Gléria, M.)

Depth, m	Fineness grade, F_G		Degree of weathering, K_d		Sorting, S_o		Kurtosis, K		Asymmetry, S_k		Remark
	value	sediment	value	sediment	value	grade	value	boundary of layers	value	energy of transport	
0.00–0.60	71.78	Slope sediment (greyish-yellow, with reddish-brown soil crumbles)	0.94	slope sediment (greyish-yellow, with reddish-brown soil crumbles)	2.21	very poor	0.28	–	0.01	average	–
0.60–1.30	74.04–75.50	paleosol (reddish-brown)	1.25–1.47	paleosol (reddish-brown)	2.45–2.61	very poor	0.28–0.31	At 1 m: boundary of layer in the middle part of the upper soil	0.01–0.02	average	–
1.30–2.20	67.34–75.50	Old loess (with loess dolls and 3 cm loess concretions, red krotovinas)	1.25–1.57	old loess (with loess dolls and 3 cm loess concretions, red krotovinas)	2.61–2.77	extremely poor	0.13–0.23	At 1,80 m: boundary between two layers within the apparently uniform old loess	0,24–0.32	low and very low	At 1.9 m: soil hiatus
2.20–5.30	69.93–75.25	paleosol	0.60–079	paleosol	3.21–4.53	extremely poor	0.15–0.29	At 5 m: boundary of layers in the lower third of red paleosol	0.04–0.19	average and low	At 5.0 m: soil hiatus
5.60–5.80	Carbonate bench										
6.00–7.00	75.62	Pannonian clay (grey)	1.0	Pannonian clay (grey)	2.13	very poor	0.21	At 6.5 m: boundary within Pannonian clay	0.02	average	–
7.00–8.50	65.43	silty loess	2.12	silty loess	2.45	very poor	0.27	–	0.04	–	–
8.50–8.55	Carbonate bench										
8.55–9.50	65.43	silty loess	2.12	silty loess	2.45	very poor	0.27	–	0.04	average	–
9.50–10.10	56.57	mottled clay (greyish-yellow)	2.43	mottled clay (greyish-yellow)	2.41	very poor	0.28	At 9.8 m: boundary between mottled clay and Pannonian silty sand	0,03	average	–
11.90–12.10	50.29	silty sand (Pannonian)	3.64	silty sand (Pannonian)	1.96	poor	0.30	–	-0.22	high	Intense surge of waves in the coastal zone

The field works conducted and a combined assessment of granulometric parameters led to a conclusion that the sequences of the section contain part of the “Dunaföldvár series” according to the Hungarian loess terminology. This sequence is represented by alternating “pink loesses” or “pink silts” and red soils. Downward the profile grey Pannonian clay and mottled clay also occur. Previously – based on paleomagnetic measurements by M. Pevzner – the formation of “pink loesses” was put by M. Pécsi (1993) to the period between Jaramillo and Olduvai events. More sophisticated dating methods might suggest that the formation of these sediments could have started even earlier, from the Gauss/Matuyama paleomagnetic boundary.

The upper layers of the section must have been eroded, including the former marker horizons: tephras, solifluctional and pseudogley levels and younger chernozem soils with the superimposing “marker loess” and “crumbling clayey sand”.

The uppermost layer of the profile is greyish yellow slope sediment of ca 60 cm thickness with reddish brown soil crumbles. Below that there is a ca 70 cm thick reddish brown paleosol, superimposing a ca 1 m thick loess layer. The latter is rich in loess dolls and contains a level of loess concretions of ca 3 cm and red krotovinas.

This loess is underlain by a paleosol of ca 3 m thickness. This fossil soil is separated from the underlying grey Pannonian clay by a “bench of carbonate debris” of 20 cm thickness. Downward there is a silty loess layer of 1.5 m thickness (with an interbedding of a 5 cm thick “debris limestone bench” in the middle part), superimposing mottled clay. A silty sand horizon lies at the bottom of the profile.

Method

*A*n exact demarcation of the layers *(Figure 2, Table 1)* is facilitated by F_G and K_d values obtained. A joint evaluation of these parameter values makes it possible a clear distinction between young and old loesses, an exact stratigraphic subdivision, drawing conclusions concerning the environmental conditions during the deposition of sediments, identification of sedimentation gaps.

All information concerning the individual layers can be read from the diagram constructed. Parameter values are related to the corresponding depths. Boundaries of layers otherwise not discernible can be recognised including variations within the given layers. For example, peaks of and K_d values indicate a boundary in about the middle of old loess. This is corroborated by K and S_k peaks. F_G peaks are extremely high (68.00–70.00) being typical of old loess, whereas those of K_d are very low (1.4–2.0, with the prevalence value of 1.5) suggesting “pink loess”, i.e. sediments having formed earlier than old loess.

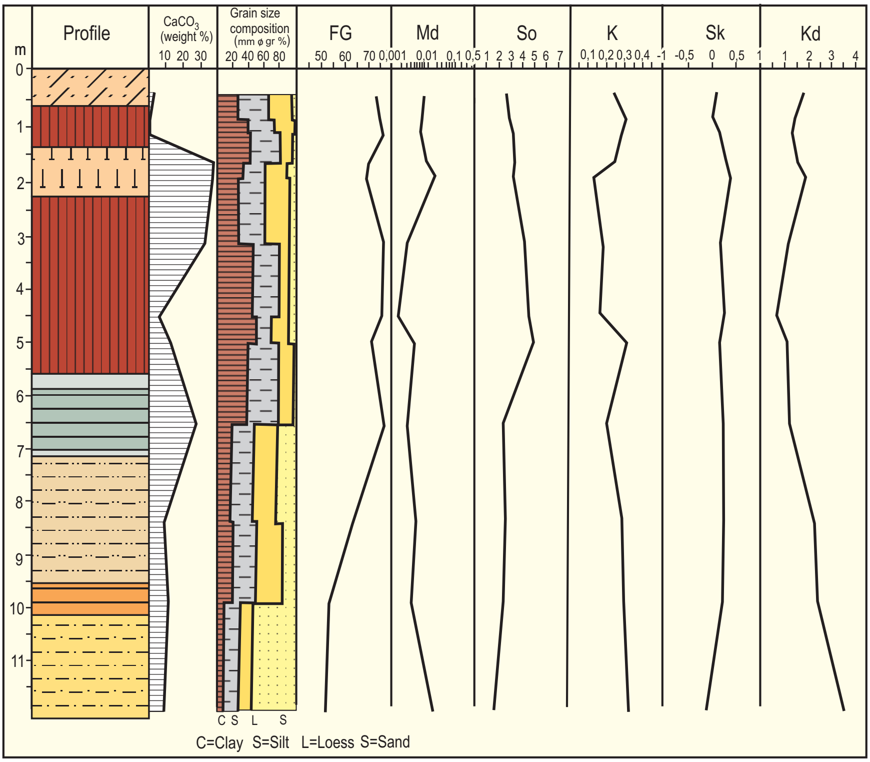


Fig. 2. Granulometric parameter values by samples from the Szulimán section (Kis, É.). Stratigraphical analysis: Schweitzer, F., Kis, É., Balogh, J. and di Gléria, M.

Within the apparently uniform second paleosol (at a depth of 5 m) a boundary is suspected: F_G values drop from 75 to 70, M_d indicates granulometry turning coarser rapidly and S_o – an explicitly coarse sediment. These values suggest redeposition in the lower horizon of the soil. These assumptions are supported by K and S_k values substantially differing from the average.

Warming and cooling peaks can be established with the help of K_d through the delimitation of different types of sediments. A genuine *warming maximum* could not be found within the old loess where K_d reaches values around 2, whereas these peaks generally fluctuate between 3 and 4 within the loess.

The highest warming maxima were found at a depth of 4.5 m within the second paleosol (0.5). Such a low parameter value was not established even in the borehole part of the Paks section. Brownish red soils there showed values above 1. Consequently, climate must have been much warmer at Szulimán. Similarly, warm climate is suggested by the soils of the Hévízgyörk section (*Figure 3, Photo 3*). Second paleosol at Szulimán (with the warming maximum mentioned) is overlying Pannonian sediments.

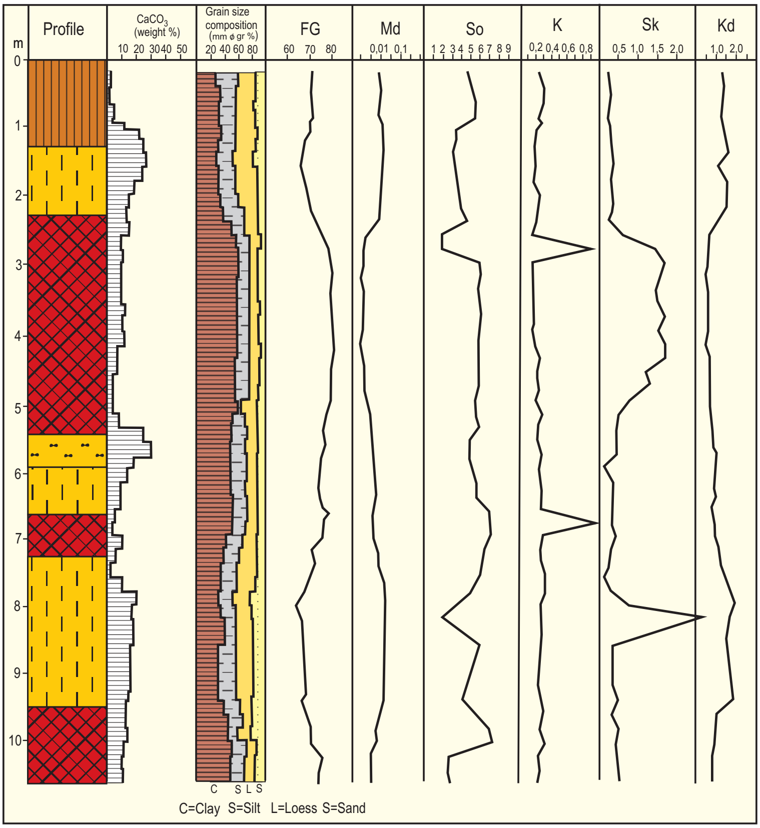


Fig. 3. Granulometric parameter values by samples from the Hévízgyörk section (KIS, É.). Stratigraphical analysis: PÉCSI, M., HAHN, GY., SCHWEITZER, F. and SZEBÉNYI, É.

Photo 3. Hévízgyörk loess section (Photo by KIS, É.)

Extreme values of F_G and K_d indices (when they occur within deposits of entirely different typical values) refer to erosional gaps (eroded horizons), e.g.:

– at a depth of 5 m: soil hiatus,
– at a depth of 6.5 m: Pannonian clay hiatus,
– at a depth of 8.5 m: silty loess hiatus,
– in the silty sand at the bottom (Kd = 3.5): silty loess hiatus.

Asymmetry (S_k) values may differentiate between the redeposited and *in situ* character of layers. Redeposited layers within the section are:

– at a depth of 3.5 m: in the uppermost third of the upper paleosol,
– at depths of 4.5 and 5.0 m: in the same paleosol,
– at a depth of 8.4 m: in the middle part of pink silty loess.

Silty sand occurring in the lowermost part of the profile has a negative asymmetry value. This is an indication of surf in the coastal zone.

Granulometric curves with double or triple maxima also testify to redeposited sediments. E.g. triple maxima could be observed in the curve of sample N7, 4.4–4.6 m *(Figure 4)* from the paleosol superimposing grey Pannonian clay and also in that of sample N4, 1.5–1.7 m, from old loess with red krotovinas below the upper paleosol, whereas double maxima occur in sample N8, 4.9–5.1 m *(Figure 5)* from the paleosol below the old loess. Triple peaks refer to multiple redeposition, double peaks indicate double redeposition.

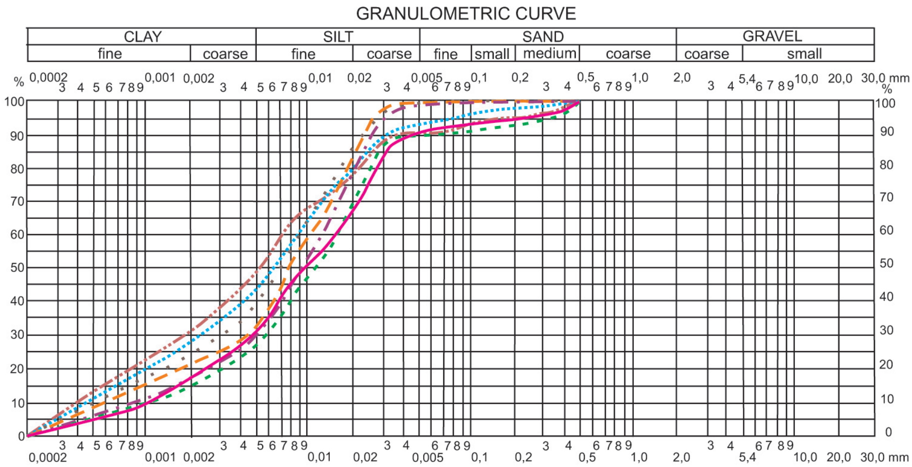
Exact boundaries of layers can be deduced from *kurtosis (K)* index values. They coincide with the extreme values of F_G and K_d; e.g. at the boundary of Pannonian clay at a depth of 6.7 m K=0.2; F_G=78; K_d=1.0. Also using these values variations in grain size become detected not visible to the naked eye.

Sorting (S_o) provides information about the origin of sediments. Sorting values by layers of the Szulimán exposure are the following: slope deposit: 2.21, upper paleosol: 2.45–2.61, old loess: 2.61–2.77, lower paleosol: 3.21–4.53, Pannonian clay: 2.13, silty loess: 2.45, mottled clay: 2.41, silty sand: 1.96.

Granulometric parameter values concerning all samples collected from the Szulimán exposure can be read immediately from the diagram constructed along with the profile, and their interpretation – from the table. By correlation of diagrams related to other key sections changes in environmental conditions of the surrounding loess regions can be compared. Through these comparisons new proofs can be found for the correlation heretofore based upon the description of the profiles, sampling and subsequent laboratory analyses.

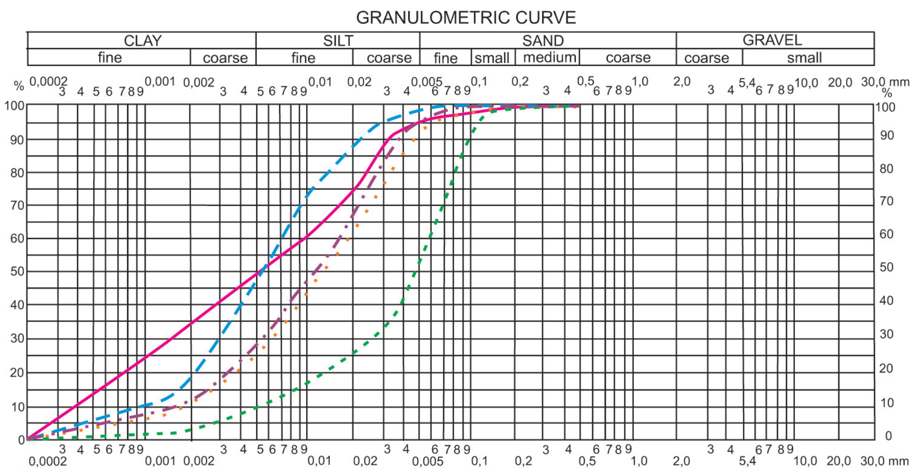
Conclusions

Characteristic features of the Szulimán section (boundary and thickness of layers, and variations within them) strongly resemble those of the Hévízgyörk section elaborated using the same analysis of environmental indication.



Legend							
1	0,0008	0,0037	0,0091	0,018	0,0265	0,0004	0,03
2	0,0006	0,00275	0,0077	0,0165	0,023	0,00033	0,026
3	0,00052	0,0022	0,007	0,015	0,023	0,000315	0,0285
4	0,0008	0,0034	0,0094	0,026	0,05	0,0005	0,026
5	0,00098	0,0045	0,0125	0,023	0,07	0,0005	0,034
6	0,00043	0,00165	0,0063	0,017	0,047	0,00029	0,05
7	0,00038	0,0125	0,0052	0,0185	0,06	0,00026	0,2
	10%	25%	50%	75%	90%	5%	95%

Fig. 4. Granulometric curve with triple maxima at the Szulimán section *(sample N7: 4.40–4.60 m)* in the paleosol superimposing grey Pannonian clay and in old loess underlying upper paleosol, interwoven with red krotovinas (Kıs, É.)



Legend							
1	0,0008	0,001	0,005	0,0205	0,034	0,00027	0,06
2	0,001	0,00265	0,00535	0,012	0,0235	0,00043	0,03
3	0,002	0,005	0,0135	0,03	0,048	0,0008	0,0665
4	0,00175	0,0044	0,0125	0,0255	0,04	0,0005	0,05
5	0,0058	0,02	0,048	0,077	0,1	0,003	0,125
	10%	25%	50%	75%	90%	5%	95%

Fig. 5. Granulometric curve with double maxima at the Szulimán section *(sample N8: 4.90–5.10 m)* in the paleosol underlying old loess (Kıs, É.)

It is probably the uplifted position of the Pannonian basement that contributed to lower horizons of considerable thickness occurring on the surface. In both exposures a great amount of sandy sediments is observed; they originate from Pannonian deposits. On the bottom of the section sand and silty sand occur. Series of mottled clay found at Szulimán is of lacustric origin. The superimposing horizon is silty loess with carbonate concretions.

The real key to correlate between the different profiles is presented by marker horizons of "calcareous debris" with a thickness of some decimetres which can hardly be visualised when drawing profiles. They are horizons of Ca accumulation of red clay soils formed upon sand. The superimposing red clay has been eroded and sandy carbonate occurs in many places. The same horizons – or the red clay instead – can be found at Hévízgyörk section.

These "benches of carbonate debris" enable conclusions e.g. on a hiatus of red paleosol at a depth of 7 m. Here is a similar carbonate bench as Ca horizon of a red paleosol has been eroded. The same red soil occurs in the section at 6.6–7.2 m *(Figure 3).* There is the bottom of the upper red paleosol within both exposures at 5.5 m below surface, with the "bench of carbonate debris" at Szulimán, whereas the same formation only occurs in some places at Hévízgyörk. The two red paleosols can be correlated, and their identity proven using granulometric parameter values. The latter show striking similarity in fossil soil horizons: F_G at Szulimán: 70.0–75.0 and at Hévízgyörk: 70.0–76.0; K_d at Szulimán: 0.5–1.2 and at Hévízgyörk: 0.4–1.0. The paleosols must have developed under warming maximum, the highest in the profiles studied so far (K_d = 0.5); they are very old red soils. Parameter values for the rest of the sequences also can be deduced and permit similar correlation.

By comparison of granulometric curves the differences and disparities between the profiles (elaborated by the same method) can be traced rapidly and it is possible to obtain information concerning variations within the layers.

The results produced enable conclusions which contribute to our knowledge about the environs of the given profile; at the same time earlier concepts might be verified i.e. corroborated or corrected.

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Ukraine in Maps

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Since the disintegration of the USSR, the Western world has shown an ever-growing interest in Ukraine, its people and its economy. As the second-largest country in Europe, Ukraine has a strategic geographical position at the crossroads between Europe and Asia. It is a key country for the transit of energy resources from Russia and Central Asia to the European Union, which is one reason why Ukraine has become a priority partner in the neighbourhood policy of the EU. Ukraine has pursued a path towards the democratic consolidation of statehood, which encompasses vigorous economic changes, the development of institutions and integration into European and global political and economic structures. In a complex and controversial world, Ukraine is building collaboration with other countries upon the principles of mutual understanding and trust, and is establishing initiatives aimed at the creation of a system that bestows international security.

This recognition has prompted the Institute of Geography of the National Academy of Sciences of Ukraine (Kyiv) and the Geographical Research Institute of the Hungarian Academy of Sciences (Budapest) to initiate cooperation, and the volume entitled "Ukraine in Maps" is the outcome of their joint effort. The intention of this publication is to make available the results of research conducted by Ukrainian and Hungarian geographers, to the English-speaking public. This atlas follows in the footsteps of previous publications from the Geographical Research Institute of the Hungarian Academy of Sciences. Similar to the work entitled South Eastern Europe in Maps (2005, 2007), it includes 64 maps, dozens of figures and tables accompanied by an explanatory text, written in a popular, scientific manner. The book is an attempt to outline the geographical setting and geopolitical context of Ukraine, as well as its history, natural environment, population, settlements and economy. The authors greatly hope that this joint venture will bring Ukraine closer to the reader and make this neighbouring country to the European Union more familiar, and consequently, more appealing.