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OSL DATES AND HEAVY MINERAL ANALYSIS OF UPPER QUATERNARY SEDIMENTS FROM THE VALLEYS OF THE ÉR AND BERETTYÓ RIVERS

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Abstract: The study of the evolution of the river network in the Great Hungarian Plain has been based on sedimentological, neotectonical, morphological investigations, heavy mineral analysis and complementary OSL dating. The study area extends from the Körös sub-basin into the Ér and Berettyó river valleys which are situated northeast from the subsiding basin and northwest from the uplifting Apuseni Mountains.

The OSL ages provide evidence that a large river run in the Ér-valley at least from 46±4 to 39±4 ka. It deposited garnet and magnetite-ilmenite-rich sediments, similar to the recent Berettyó, Ér and Sebes-Körös rivers and less intensive the modern Tisza river. These sediments originated from the nearly located metamorphic and Neogene volcanic rocks and contain some reworked older clastic sedimentary rocks from the northern part of the Apuseni Mountains. These OSL ages fit the active tectonic phase of the Érmellék depression. Loess is 49-47, 44, 39 and 25 ka old and aeolian sands 10 to 9 ka were dated. Their heavy mineral composition and that of fluvial sands is similar.

Keywords: OSL dating on quartz, heavy mineral analysis, river network, Érmellék, Great Hungarian Plain.

1. INTRODUCTION

To study the evolution of the river network of the Great Hungarian Plain we analysed Upper Quaternary sediments in the Érmellék region. The main areas were the valleys of the Ér- and Berettyó rivers, which are located east from the Great Hungarian Plain and northwest from the Apuseni Mountains (**Fig. 1**). These rivers carry sediments into the Körös sub-basin. High-resolution cyclostratigraphical and palaeoclimate analyses indicated that the 420-460 m thick Pleistocene fluvial succession in the Körös sub-basin was continuously deposited under net subsiding conditions during the Pleistocene, controlled by the climate and tectonic movements (Thamó-Bozsó *et al.*, 2002; Nádor *et al.*, 2003 and 2007). The evolution of the river network of this sub-basin during the Late Pleistocene was investigated by sedimentological, morphological, tectonic methods, and heavy mineral analysis. A detailed chronological framework (Nádor *et al.*, 2007; Thamó-Bozsó *et al.*, 2007) was elaborated applying optically stimulated luminescence (OSL) dating on quartz. The interpretation of seismic profiles, the field measurements of the neotectonic activity, and the variability of the thickness of sediments in the Körös sub-basin revealed that the river development was largely controlled by the subsidence along the Érmellék depression until 14 to 16 ka, and by uplift of the southeastern part of the catchment area (Nádor *et al.*, 2007). In order to extend these studies to the development of the margin of the basin we studied the sediments in the valleys of Ér and Berettyó rivers, northeast from the Körös sub-basin. There, natural outcrops allow to analyse Upper Quaternary sediments, neotectonic features and morphological elements.

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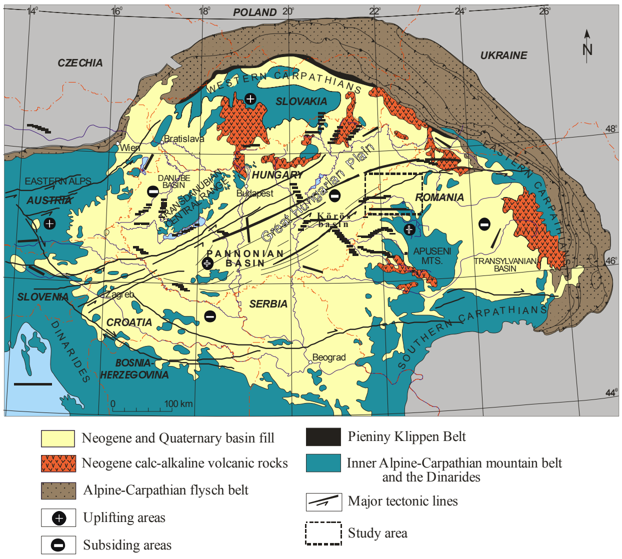

Fig. 1. *Study area and geological surroundings (after Bada and Horváth, 2001).*

2. STUDY AREA

The valleys of the Ér and Berettyó rivers are situated in the norteastern part of the Pannonian Basin (**Fig. 1**). The large intermountain Pannonian Basin, surrounded by the Alps, Carpathians and Dinarides, formed during the Early and Middle Miocene by back-arc style rifting, coeval with the late stages of thrusting of the Carpathian belt (Royden and Horváth, 1988). From the Late Miocene onwards post-rift thermal subsidences initiated the isolation of the Pannonian Basin from the Paratethys and the depression was occupied by the Lake Pannon. The lake was filled up by large fluvial-dominated delta systems prograded from NW to NE during the Late Miocene-Pliocene and filled up with alluvial sediments (Royden and Horváth, 1988; Juhász, 1994; Magyar *et al.*, 1999). About 6 Ma ago NW–SE and N–S compression started and caused the uplift of the marginal Carpathian Belt, Apuseni Mountains, North Hungarian Range and Transdanubia, and subsidence of the basins which were progressively filled up mainly by sediments transported by the ancestors of the Danube and Tisza rivers and their tributaries. The differential uplift and subsidence rates in the basin caused a complex evolution of the drainage network.

The study area is located northeast from the subsiding Körös sub-basin and northwest from the uplifting Apuseni Mountains (**Fig. 1**). It has a ENE-WSW striking hilly morphology about 110-210 m above sea level (**Fig. 2**). The NW part of it with the Érmellék region is at a lower position; the SE section with the Szilágyság region is more elevated. The Ér River is only 40 km long, 4-7 m wide, joins the Berettyó River, which is 203 km long and has a drainage area of about 6100 km². The Berettyó River flows along the southern part of the Érmellék depression and further into the Sebes Körös River in Hungary. The latter is 209 km long and has a catchment area of about 2800 km², it merges with the Körös rivers and continue as Hármas-Körös River, the tributary of Tisza River (**Fig. 1**). The Ér, Berettyó and Sebes-Körös rivers originate in the northern part of the Apuseni Mountains.

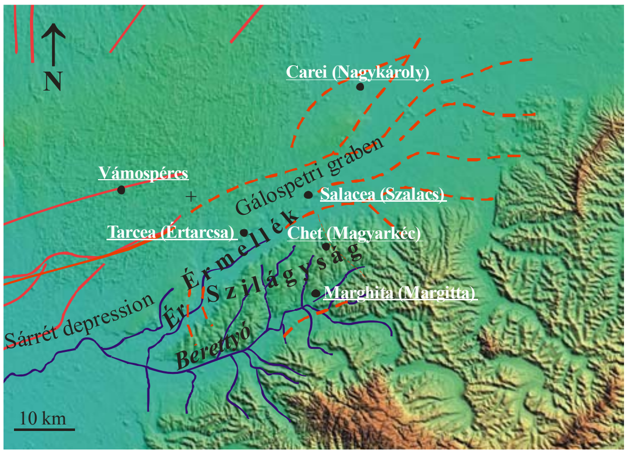

Fig. 2. *Location of the studied sections and the main Quaternary faults (cut from DEM map of Timár et al., 2003).*

Érmellék is a seismoactive region. The last two earthquakes occurred in 1829 and 1834 with estimated magnitude of 5.5 and 7.1, respectively (Réthly, 1952; Szeidovitz, 2000). There is a tectonic zone between the hilly region of Szilágyság and the Great Hungarian Plain in the Sárrét depression and the Gálospetri graben (**Fig. 2**)

According to the sedimentological and paleontological data, the Quaternary sediments are 150-300 m thick on the eastern part of the Great Hungrian Plain. They are gradually thinning towards the east (Franyó, 1992; Rónai, 1985; Ţenu, 1981). In the Érmellék region 15-20 m thick Pleistocene sections containing fluvial sand and gravel, loess and paleosoils are present. In the loess sections brown forest type paleosoils occur in the lower position and forest steppe or chernozem type paleosoils in the higher position. The loess is intercalated with alluvial sand and flood plain silty clay. Pleistocene sediments are overlain by a few meters thick Holocene re-deposited loess, silty sand, silty clay, aeolian sand, peat and a recent soil of the forest steppe type. On the modern surface of the study area fluvial and aeolian sands dominate on the lower horizon (near the rivers and their neighbourhood), and loess on the more elevated places.

3. SAMPLES AND STUDY METHODS

Based on sedimentological and tectonic field observations, samples of loess, fluvial and aeolian sand were collected from 1.2 to 4.5 m below the recent surface from six outcrops for optically stimulated luminescence (OSL) dating and heavy mineral analysis (**Figs 2 and 3**). Quartz was extracted from the grain size fraction 100-160 µm using H_2O_2 to remove the organic constituents, and 10% HCl to dissolve carbonates. The samples contained very small amounts of organic material, and only the loess samples contained some carbonate. An aqueous solution of sodium polytungstate was used for density separation of the quartz-rich fraction. Then it was etched with 40% HF for 60 minutes to remove any remaining feldspars and

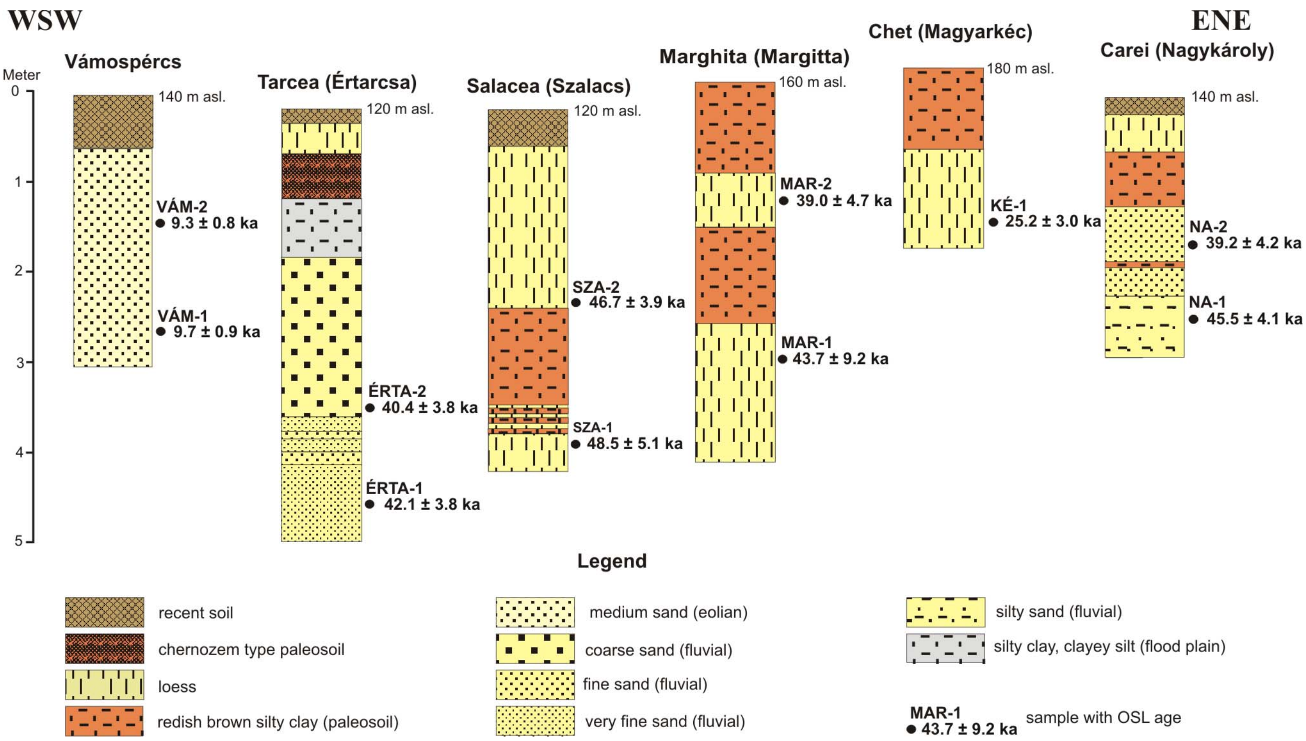

Fig. 3. *Lithology of the studied sections and OSL ages (Hungarian names of the villages are given in brackets).*

the outer ~10 µm layer from the quartz grains, which absorbed a dose from alpha radiation (Aitken, 1985 and 1998). High mica content of the quartz fraction of some loess samples was successfully separated by rolling the grains on paper. A monolayer of clean quartz grains were mounted on stainless-steel discs with 8 mm diameter using silicone spray.

OSL measurements were made using a Risø TL/OSL DA-15C/D automated reader with a calibrated $^{90}Sr/^{90}Y$ beta source, delivering about 0.124 Gy/s to the disk. The luminescence purity of the quartz extracts was checked using infra-red stimulation. To empty the shallow traps, which may be unstable during the burial period of the sediment, a 260ºC preheat temperature was applied. Optical stimulation was performed by blue light-emitting diodes (LEDs) for 40 s at 125ºC. Equivalent doses were estimated using the Single-Aliquot Regenerative-dose (SAR) protocol (Murray and Wintle, 2000 and 2003; Murray and Olley, 2002; Wintley and Murray, 2006). Dose recovery tests, the dose response grow curve and the thermal transfer test were carried out for each sample. A preheat plateau test was done on one sample from each outcrop. In most cases, the equivalent dose (D_e) was derived from 23-29 aliquots per sample. In the case of three loess samples only 6, 9 and 16 aliquots per sample were available due to the low quartz fraction. The dose rates were calculated using the conversion factors by Adamiec and Aitken (1998) based on laboratory high-resolution gamma spectrometry analyses (Canberra GC3020) of about 0.7-1.0 kg bulk sediment which surrounded the OSL samples.

Microscopic study was applied to trace the origin of the sediments. It was performed on the same samples as were subject of OSL measurements using a stereo and polarising microscope. Heavy minerals were separated from the 100-200 µm grain size fraction by bromoform using centrifuge.

4. RESULTS

Sedimentological and tectonic field observations

In the studied sections sandy sediments dominate at Vámospércs, Tarcea (Értarcsa), and Carei (Nagykároly) (**Fig. 3**). There are at least 2-3 m thick coarse or fine grained fluvial sand bodies, which are partly cross laminated. At Carei (Nagykároly) the sand is covered by 0.6 m thick brown or reddish bown clay (paleosoil), which forms a thin layer also in the sand, and several decimeters thick loess. At Tarcea (Értarcsa) the fluvial sand is overlain by about 1.5 m thick silty clay and clayey silt floodplain sediments, a chernozem type paleosoil and some loess. Far from the hills, at Vámospércs, there is aeolian reworked fluvial sand which is partly cross laminated.

Southeast in the hilly part of the Érmellék region 1.0-3.7 m thick pale yellow or brownish yellow loess bodies outcrop in sections at Salacea (Szalacs), Chet (Magyarkécz) and Marghita (Margitta). They are alternated with, or are covered by 0.1-1.0 m reddish brown silty clay layers (paleosoils), which frequently contain MnO pizolites and limonite concretions.

The micro- and morphotectonic measurements in the Szilágyság region provide evidence for two phases of deformations. The older was generated by a NE-SW compression, which caused left lateral strike slips. The younger was generated by the WNW-ESE compression and caused right lateral strike slips (transpression), which seem to be active till now. The network of the tectonic lines is very similar to those, analysed from seismic sections of the Körös sub-basin. More details are given by Magyari *et al.* (in press).

OSL dating

Various tests have confirmed that the quartz samples are suitable for OSL age determination. Applying the SAR protocol a known laboratory dose administered to these samples were accurately measured. Dose response growth curves showed that measurements are possible up to the applied 320 Gy. Quartz in the loess samples is more saturated than in the sands, except the loess at Chet (Magyarkécz). Based on the results of the preheat plateau tests, 260ºC preheat temperature was used. It was also found that thermal transfer was negligible in the measured samples. Most samples have delivered symmetric and narrow frequency histograms of the equivalent doses apart of the MAR-1 and MAR-2 loess samples.

The equivalent doses (D_e) of the samples have wide range between 8 and 103 Gy (**Table 1**). The loess samples were more radioactive (14.5 ppm Th; 3.2 ppm U; 0.6 % K in average) compared to the sands (3.8 ppm Th; 1.0 ppm U; 0.3 % K). Hence, the loess samples have higher dose rates (1.9-2.3 Gy/ka) than the sands (0.8-1.3 Gy/ka).

The water content of the sediments at the time of sampling was in the range of 2 to 23 dry weight%. The laboratory saturated water content ranged from 20 and 43 % dry weight. Samples were collected above the recent ground water level. The assumed water content for the time span of burial was taken as mean of the current and the saturated water content. The estimated OSL ages range from 9 to 49 ka (**Table 1**). The ages of KÉ and MAR loess samples are less reliable than those of the other sediments (age of MAR-1 has large standard deviation) due to the smaller number of the measured aliquots.

The new OSL ages are stratigraphically consistent within their sections. Loess and aeolian sands are usually well bleached during the aeolian transport and before deposition resetting the OSL signal (e.g. Duller, 2004). Although the optical bleaching of fluvial sediments depends on the fluvial transport distance (Stokes *et al.*, 2001) the transport lengths of 20-40 km was sufficient as confirmed by the symmetric and narrow frequency histograms of the equivalent doses of these fluvial samples.

Microscopic study

The largest detrital grains in the studied sediments are 1 mm. Quartz dominates among the grains of >0.2 mm, which contain some quartzite and rock fragments originating from metamorphic, volcanic, and older sedimentary rocks (e.g. red sandstone). Feldspar, amphibole, pyroxene and opaque minerals are very rare. Limonite and manganese-oxide concretions, rhizoconcretions and cemented grains are more frequent in the loess samples than in the sands.

In the 0.1 to 0.2 mm fine-grained sand fraction of the samples usually quartz is the most frequent mineral. Muscovite and altered biotite dominate in the MAR and SZA loess samples. There are a few multiple-twinned acidic-neutral plagioclases (MAR, VÁM), orthoclase and cross-hatched twinning grains of microcline (SZA), several rock fragments and altered minerals, too.

Quartz grains are usually subrounded, some of them are well-rounded and have polished surface showing the effect of aeolian reworking. The most well rounded grains are found in the VÁM, ÉRTA (and SZA) samples.

The heavy mineral content in the fine grained sand fraction ranges from 0.3 to 2.8 weight% (**Table 2**). Most of the loess samples contain less heavy minerals (0.3-0.9 weight%) than sands (1.0-2.8 weight%). Usually garnet and magnetite-ilmenite are the most frequent detrital heavy minerals in the samples. Amphibole and pyroxene are also common. Sometimes biotite (MAR-1), sometimes amphibole dominates (MAR-2). Chlorite, tourmaline (shorl), and staurolite are less frequent. Rutile, zircon, apatite, monazite, epidote, kainite, sillimanite, andalusite and zoisite are rare. Secondary minerals are limonite, manganese-oxide, leucoxene and altered minerals. Garnets are mainly pale pink or colourless, chlorite is usually pale green, biotite is partly altered to chlorite. Amphiboles as hornblende presents in each sample, oxihornblende and actinolite-tremolite are rare. Hornblende sometimes has rugged termination. Ortho- and/or clinopyroxenes, first of all hypersthene, ferrohypersthene and augite were also identified in most of the sediments. There are hypersthene and augite grains with „hacksaw" terminations too.

Comparing the different samples, loess sediments contain more mica and altered minerals than sands, while the fluvial sands have higher garnet content. SZA and KÉ loess samples have a similar magnetite-ilmenite and

Table 1. *Results of quartz OSL dating (n – number of measured aliquots, w.c. – assumed water content).*

	Sapmle	Depth (cm)	Sediment	n	Equivalent dose (Gy)	Dose rate (Gy/ka)	w. c. (w%)	OSL age (ka)
SZA-2	Salacea (Szalacs)	200	loess	23	102.60±4.30	2.20±0.15	23.5	**46.70 ± 3.87**
SZA-1	Salacea (Szalacs)	380	loess	23	90.32±6.96	1.86±0.13	29.6	**48.47 ± 5.09**
KÉ-1	Chet (Magyarkéc)	160	loess	9	51.65±4.89	2.05±0.14	32.8	**25.20 ± 2.97**
ÉRTA-2	Tarcea (Értarcsa)	320	coarse-medium grained sand	25	35.16±2.21	0.87±0.06	11.6	**40.36 ± 3.84**
ÉRTA-1	Tarcea (Értarcsa)	450	medium grained sand	24	39.93±2.16	0.95±0.07	13.3	**42.09 ± 3.80**
MAR-2	Marghita (Margitta)	120	loess	16	78.03±7.56	2.00±0.14	25.2	**38.95 ± 4.66**
MAR-1	Marghita (Margitta)	280	loess	6	99.80±19.64	2.28±0.16	24.7	**43.74 ± 9.17**
VÁM-2	Vámospércs	140	medium grained sand	24	7.93±0.45	0.86±0.06	12.7	**9.27 ± 0.82**
VÁM-1	Vámospércs	260	medium grained sand	27	7.82±0.44	0.81±0.06	11.1	**9.67 ± 0.87**
NA-2	Carei (Nagykároly)	160	medium grained sand	25	49.652±4.056	1.27±0.08	14.5	**39.20 ± 4.20**
NA-1	Carei (Nagykároly)	250	medium grained sand	29	36.365±2.031	0.80±0.05	12.1	**45.48 ± 4.10**

Table 2. *Results of heavy mineral analysis (% data based on point counting, x – less than 0.5 %).*

Sample	SZA-2	SZA-1	KÉ-1	ÉRTA-2	ÉRTA-1	MAR-2	MAR-1	VÁM-2	VÁM-1	NA-2	NA-1
heavy mineral content (w%)	0.55	0.92	2.12	1.29	1.81	0.57	0.26	1.66	1.92	1.01	2.82
hornblende	12.9	11.6	3.7	12.4	9.1	24.5	5.9	17.6	9.9	10.8	18.2
oxi-hornblende	1.6	1.5	x	0.6	1.9			1.5	x		
actinolite-tremolite	1.6	x	x		x	x	x				
other amphibole	3.2	2.9		1.1		2.0			1.8		
augite	4.0	2.9	2.5	3.2	4.7	x	x	2.9		0.5	6.3
hypersthene		1.5	3.7	3.2	1.9	7.1	x	5.2	7.1	1.4	11.9
ferrohyperstene	1.6	x	1.2	0.6	1.9	2.0		2.2	0.9	3.7	2.1
magnetite-ilmenite	30.6	14.9	21.0	18.5	28.3	16.3	12.9	29.1	41.1	29.4	10.5
biotite		x	1.2				15.8				
altered biotite			3.8	1.7		2.0	22.8	x	x		
garnet	24.2	23.6	14.8	49.5	34.0	17.3	8.9	25.4	20.5	40.7	33.6
staurolite	1.6	1.5		0.6	2.5	1.7	2.0	3.7	x	x	0.7
epidote	x				0.6						
kyanite	1.6		x			x	x			x	x
sillimanite	x					x	x		x	x	1.4
andalusite	0.8	x								x	
chlorite	2.4	15.0	x	x		x	x	x	x	x	0.7
zoisite		2.9			x	x	x	2.6			
apatite				x						2.3	x
zircon		x	x	0.6				x			x
rutile	2.4	x		1.1	1.9		x	x	0.9	0.5	1.4
tourmaline (shorl)	3.2		x		0.6	x	2.0	0.8	1.8	x	0.7
monazite	1.6	2.9	x	x	1.3		1.0	x	1.5	1.4	1.4
rock fragment	3.2				1.9	6.1		x	6.3	1.4	5.2
limonite	x	2.9	14.8	x		10.2	19.8		2.7		
leukoxene	0.8	5.8	2.5	1.1	5.0	4.5	8.9	4.1	2.0	5.6	6.1
altered minerals	2.4	10.1	30.8	6.0	4.4	6.1		5.2	3.6	2.0	
summa	100.0	99.8	100.0	100.0	100.0	99.9	100.0	100.4	99.9	99.6	100.1

garnet-rich heavy mineral composition as the sand samples in the other sections. But the MAR loess is very different, containing much amphibole or biotite. Sands contain more well-rounded, polished grains than the loess, first of all the VÁM and ÉRTA samples.

The quantitative detrital heavy mineral composition of the samples was compared to each other and to that of the recent rivers sediments in the area using cluster analysis (Thamó-Bozsó *et al.* 2007, Thamó-Bozsó and Ó-Kovács, 2007). The results provide evidence, that the samples ÉRTA-1, ÉRTA-2 and NA-2 of fluvial sands are very similar to each other because of their high garnet content. The samples SZA-1, SZA-2, and KÉ of loess and the samples VÁM-1 and VÁM-2 of aeolian sands are also very similar due to the high magnetite-ilmenite and garnet content. These samples are related with the samples NA-1 of fluvial sand and MAR-2 of loess, which contain more amphibole than the other samples. The lower MAR-1 loess sample is different because of a high biotite content. Despite the differencies, the studied sediments are most similar to the sediments of recent Berettyó, Ér and Sebes-Körös rivers. The three samples NA-1, SZA-1 and MAR-2 also show similarities to the Tisza River sediments.

5. DISCUSSION

It was recognised at the beginning of the 19th century, that the ancestral river network in the Hungarian Plain was different from the present one. This was concluded from the abandoned fluvial channels and alluvial fans (Somogyi, 1961 and references therein). Based on sedimentological and hydrogeological studies, palaeo-river network reconstructions were drawn (e.g. Sümeghy, 1951; Urbancsek, 1960; Somogyi, 1961; Borsy, 1989; Borsy *et al.*, 1989; Mike, 1991; Gábris, 1994; Neppel *et al.*, 1999). Recently ancient river patterns of the Great Hungarian Plain were studied also by morphological and tectonic methods, radiocarbon and OSL age dating (e.g. Gábris and Nagy, 2005; Timár *et al.*, 2005; Thamó-Bozsó *et al.*, 2007; Nádor *et al.* 2007; Gábris and Nádor, in press).

Reconstructions provide evidence that the palaeo-Tisza flowed south of its present course, most probable in the valley of the modern Ér River. It collected waters of rivers approaching from the north, east and southeast (Sümeghy, 1951; Urbancsek, 1960; Borsy, 1989). Somogyi (1961) supposed that the Tisza River and its tributaries formed their recent course during the Holocene as result of tectonic movements. Borsy *et al.* (1989) argued that this happened only 4500 years ago. In contrary Molnár (1997) suggested that the Tisza River gradually shifted his course towards the west already in the Günz-Mindel interglacial. Gábris (1998 and 2002) claims that the much larger palaeo-Tisza River run in the southwestern part of the Érmellék depression, where the modern Berettyó River flows. Based on the study of Late Quaternary dynamics of the Tisza River, Timár *et al.* (2005) suggest that its major avulsion event happened about 16-18 ka ago. Our OSL ages show that the modern rivers in the Körös sub-basin formed their present courses only during the last 10 ka (Thamó-Bozsó *et al.*, 2007). The river development in Körös sub-basin was largely controlled by the subsidence in the Érmellék depression until 14 to 16 ka along the Dévaványa-Szarvas fault zone, and by the uplift of the southeastern part of the catchment area (Nádor *et al.*, 2007). Our new data in this study provide further information on the development of the Ér- and Berettyó river valleys and the neotectonic control.

The palaeochannel of a large river in the Ér valley can be seen on the Digital Elevation Model (DEM) and satellite maps (e.g. GoogleErth) and on airborne fotographs. It is an at least 10 km wide NE-SW straight and bend valley. The sedimentological characteristics of the fluvial sands in the study area (thickness, stratification, grain size) suggests that in the past a much larger river was in the Ér River valley than today.

The OSL ages of the loess samples are 47-49, 44, 39, and 25 ka. Fluvial sands deposited between 46 and 39 ka, aeolian sands about 9-10 ka. According to earlier determined OSL and TL ages, similar 37-50 ka old loess-paleosoil successions were found on the Transdanubian area of Hungary (e.g. Novothny *et al.*, 2002; Novothny *et al.*, in press). 37 or 45 ka old fluvial sands also occur in the Körös sub-basin (Thamó-Bozsó *et al.*, 2007). The aeolian sand formation at 9-10 ka is confirmed by luminescence ages e.g. near the Danube (Újházy, 2002; Újházy *et al.*, 2003) providing evidence for a sand movement preferentially during the early Holocene.

The fluvial sands in the study area are the sediments of a large river, which occupied the Ér Valley at least from 46±4 to 39±4 ka. These ages date an active tectonic phase of the Érmellék region, which belongs to the older neotectonic movements (NE-SW compression) identified by micro- and morphotectonic measurements.

Heavy mineral studies of the Quaternary sediments in the Great Hungarian Plain also helped to reconstruct the ancient river network. According to the lithology of the catchment areas of the recent rivers which probably drained the study area we conclude that minerals of Neogene andesites, rhyolites and tuffs of the Inner Carpathian Volcanics are characteristic in the sediments of the Bodrog and Szamos river and of the upper section of the Tisza River. These sediments also contain more pyroxenes and hornblende than others. Low-, medium- and high-grade metamorphic rocks dominate in the catchment area of the Sebes-Körös, Berettyó and Ér rivers, which have a high garnet and magnetite content.

The garnet and magnetite-ilmenite-rich heavy mineral composition of the fluvial sands at the Carei (Nagykároly) and Tarcea (Értarcsa) indicate, that they originated from nearby metamorphic and Neogene volcanic rocks and recycled old clastic sedimentary rocks, similar to sediments of recent rivers on the northern part of the Apuseni Mountains. Fluvial sands are present in the Great Hungarian Plain with similar ages and more or less similar heavy mineral composition. The aeolian sands at Vámospércs and the loess samples at Salacea (Szalacs) and Chet (Magyarkéc) have a similar mineral composition than the fluvial sands. This indicates that they probably were reworked from the adjacent fluvial sediments and blown out from river flood plains by winds. The different biotite or amphibole-rich loess samples at Marghita (Margitta) reflect that they derived from other valley, the Berettyó river valley, where the mineral composition of the fluvial sediments was different.

6. CONCLUSIONS

Our study on the evolution of the river network in the Great Hungarian Plain extended the already investigated area of the Körös sub-basin with the Ér and Berettyó rivers valley, which is situated northeast from the subsiding basin and northwest from the uplifting Apuseni Mountains.

The new OSL ages indicate that loess deposited at Salacea (Szalacs) in the central part of the Érmellék region about 47-49 ka ago. Some younger fluvial sands with ages of 46 and 42 to 39 ka were found at Carei (Nagykároly) and Tarcea (Értarcsa). At the same time between 44 and 39 ka loess deposited at Marghita (Margitta) and at 25 ka in Chet (Magyarkéc). Far from the hilly area at Vámospércs aeolian sand from reworked fluvial sediments of the Érmellék region accumulated 9-10 ka ago.

Our results provided evidence that the river which flowed in the Érmellék region at least from 46±4 to 39±4 ka was much larger than the present Ér River. Its garnet and magnetite-ilmenite-rich sediments originated from adjacent metamorphic and Neogene volcanic rocks and reworked old clastic sedimentary rocks. This large river drained the northern part of the Apuseni Mountains, because it has a similar heavy mineral composition than the recent Berettyó, Ér and Sebes-Körös rivers, and partly the modern Tisza River. The aeolian sands and the loesses are probably reworked adjacent fluvial sediments, blown out from river flood plains by winds.

The ages of the fluvial sands of a large river in the study area date the active tectonic phase of the Érmellék depression.

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