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LATEST QUATERNARY HISTORY OF THE SOUTHERN STRETCH OF THE TISZA VALLEY

by

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Summary: The possibilities for the discrimination of Pleistocene and Holocene sediments of different facies and their geological history in the alluvial area of the southern Tisza valley are shown by the use of various lithological methods.

During the detailed investigations and geological surveying of the Quaternary sediments of the Great Hungarian Plain, a research programme launched in 1950 by the Hungarian Geological Institute, several monographs were published on this subject (I. Miháltz 1953, J. Sümeghy 1953). The results of part- researches, however, have been published just in a very small number, despite the great help they may provide for the better understanding and the geological reambulation of single areas (T. Ungar 1956).

In his paper „The hydrology of the southern part of the Tisza valley" I. Miháltz (1966) already dealt with the near-surface sediments of the vicinity of Szeged during the preliminary geological investigations connected with the Szeged Barrage Project. In the present paper his conclusions have been adopted extensively as a basis to rely upon.

I. Miháltz considers the southern Tisza valley to comprise the old flood-plain of 20 to 30 km width to the south of Csongrád. According to him, the Tisza valley can be split up into two parts. The Tisza valley s. str. comprises the Holocene erosion-carved depressions of the river and the zone filled up by its alluvium. The Tisza valley s. l. consists of the deep-seated zone of the valley filled up by Pleistocene detrital material, of the margin of the Danube-Tisza Interfluve and of the part of the Trans-Tisza Region sloping towards the river.

The southern part of the southern Tisza valley is accordingly rather well known, while its northern one is not, even though the understanding of the geohistorical evolution of the Tisza valley would require the proper knowledge of this part, too. Therefore, large-scale geological surveying was carried out in the norther part of the valley.

The agriculturally cultivated alluvial area has been feeling an urgent need for the introduction of farming under irrigation, requiring to dig new canals. A continuously increasing number of industries have been located on alluvial soils along the banks of the Tisza. These facts also justify the more detailed geological investigations of the Tisza alluvium.

The area of larger-scale investigations has been selected to the east of Pusztaszer village in the northern part of the southern Tisza valley, at the junction of the Danube-Tisza Interfluve and the Tisza valley. (Fig. 1).

In the west the Tisza valley is bounded by the Danube-Tisza Interfluve Ridge. The Ridge is constituted in a thickness of 20 to 150 m by Pleistocene eolian sediments. Its surface is patterned by sanddune ranges separated from one another by „szik"-soil surfaces and chalky shallow sloughs, periodically waterlogged.

In the Tisza valley the sediments are represented on the surface by clayey infusion-loess and Holocene lacustrine sediments. These last-mentioned deposits happen to attain their widest extension in the area under consideration, i. e. in the vicinity of Lake Dongér and of Lake Csáj lying to the NE of the former.

DESCRIPTION OF THE SEDIMENTS

The authors have sought to explore the territory by field observations: by analyzing samples taken from the surface in the geologically most critical part, the vicinity of Lake Dongér: by 10-m-deep boreholes: by detailed, laboratory granulometric analyses of 136 samples: by determining the carbonate content of 125 samples and measuring the pH of 125 samples.

Within the uncovered thickness three formations could be distinguished:

1. Alluvial sediments in the lower part.
2. Loess in the middle part.
3. Alluvial and lacustrine sediments and eolian sands in the upper part.

1. The lower half of the uncovered sequence is constituted in 5 m thickness by fine-grained sediments (fine silts and its variants) (Fig. 2. and 3).

It is only Borehole 5 of Section I and Borehole 14 of Section II that have reached into fine sands instead of silts. In several places, slightly peaty lenses, indicating the one-time proliferous vegetation, are intercalated. The lenticular mode of occurrence is characteristic of the sequence as a whole. The curves 2, 4, 5, 8, 9 of Fig. 4 illustrate examples of the types of sediments occuring here.

As shown by their heavy minerals composition, the sands are of Tisza river origin (B. Molnár 1961, 1964, 1966, 1967). As determined by the grain-shape method developed by I. Miháltz —T. Ungár—P. Dávid (1954, 1955), the sand grains belong for the most part to the sharp-edged, angular types 1 and 2, i. e. to the fluviatile type (Table 1).

The carbonate content of this 5-m-thick sequence is commonly below 5 % or between 5 and 10%, its pH being about 8. o.

2. The afore-mentioned sequence is overlain in 2 to 5 m thickness by infusion-loess, clayey or alkalized („szik"-soil-coated) in many outcrops (Fig. 1, 2, 3). In the broader outskirts this same formation was also described by I. Miháltz (1953, (1967) and T. Ungár (1956).

Its colour and structure alone are enough for one to identify the sediment with loess recognizable even to the naked eye. The physical conditions of its occurrence suggest, unlike the commonly lenticular development of the fluviatile sediments, a sedimentation in a non-agitated environment. Its granulometric composition shows the predominance of the 0,02—0,05 m ∅ fraction characteristic of the loess (curves 12, 13, 15, 16, 18 and 19 of Fig. 4), though the 〉0,02 mm fraction is also significant (about 20—40%), which is due to deposition in a humid environment and to subsequent alcalization. Its carbonate content, 20 to 30%, is striking in every lithological log, while its pH, 8 to 9, is somewhat higher than that of the previous sequence. The poor gastropod and pollen contents are different from those of both the under- and overlying sequences, being similar to those of the infusionloesses described from other localities.

In correspondance with the humid environment of deposition, the sequence un-

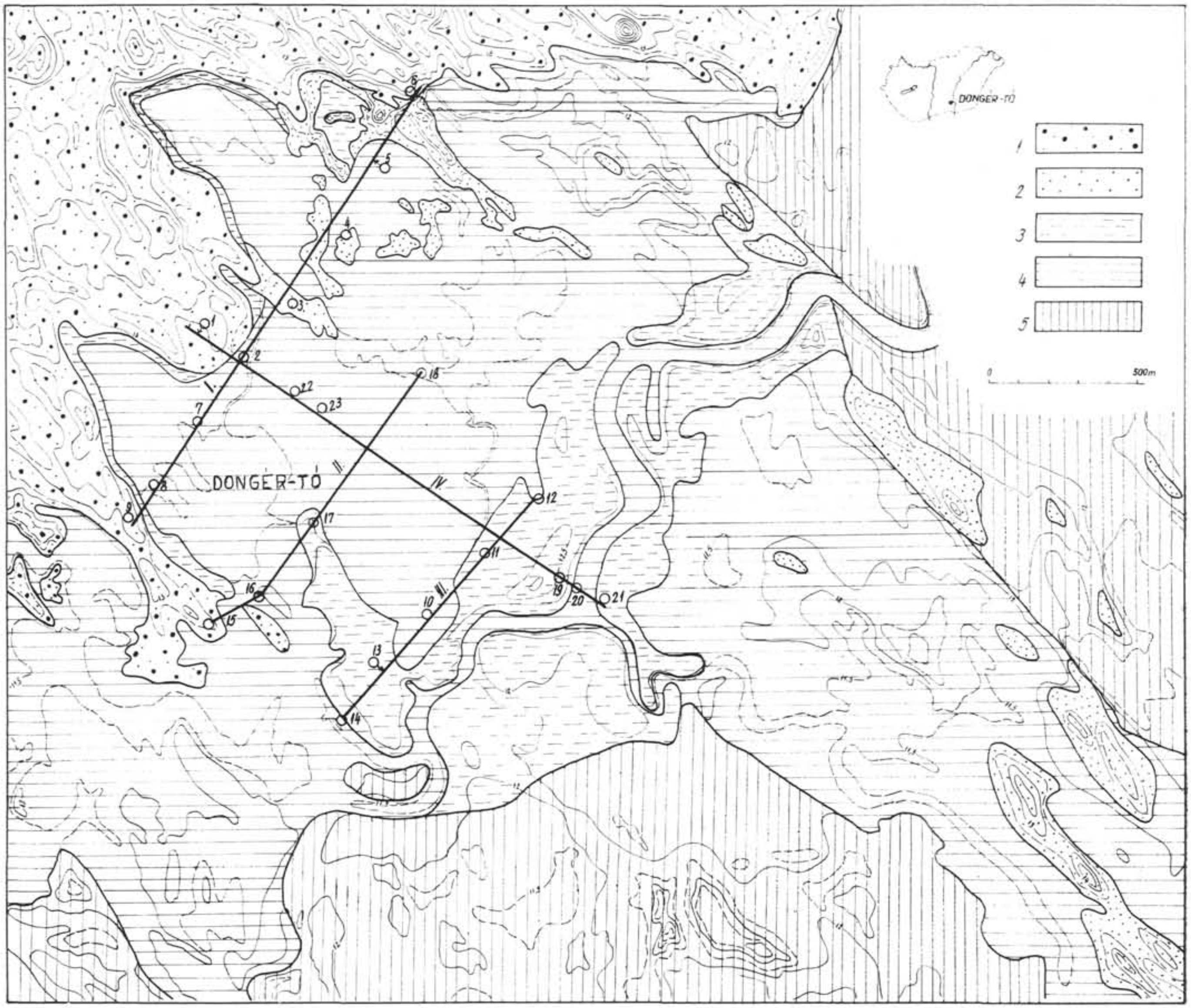

Fig. 1.: Geology of the territory of Lake Dongér.
1. Small sand. — 2. Fine sand. — 3. Fine silt. — 4. Clay. — (1—4. Holocene). — 5. Alcalized infusion-loess. (Pleistocene)

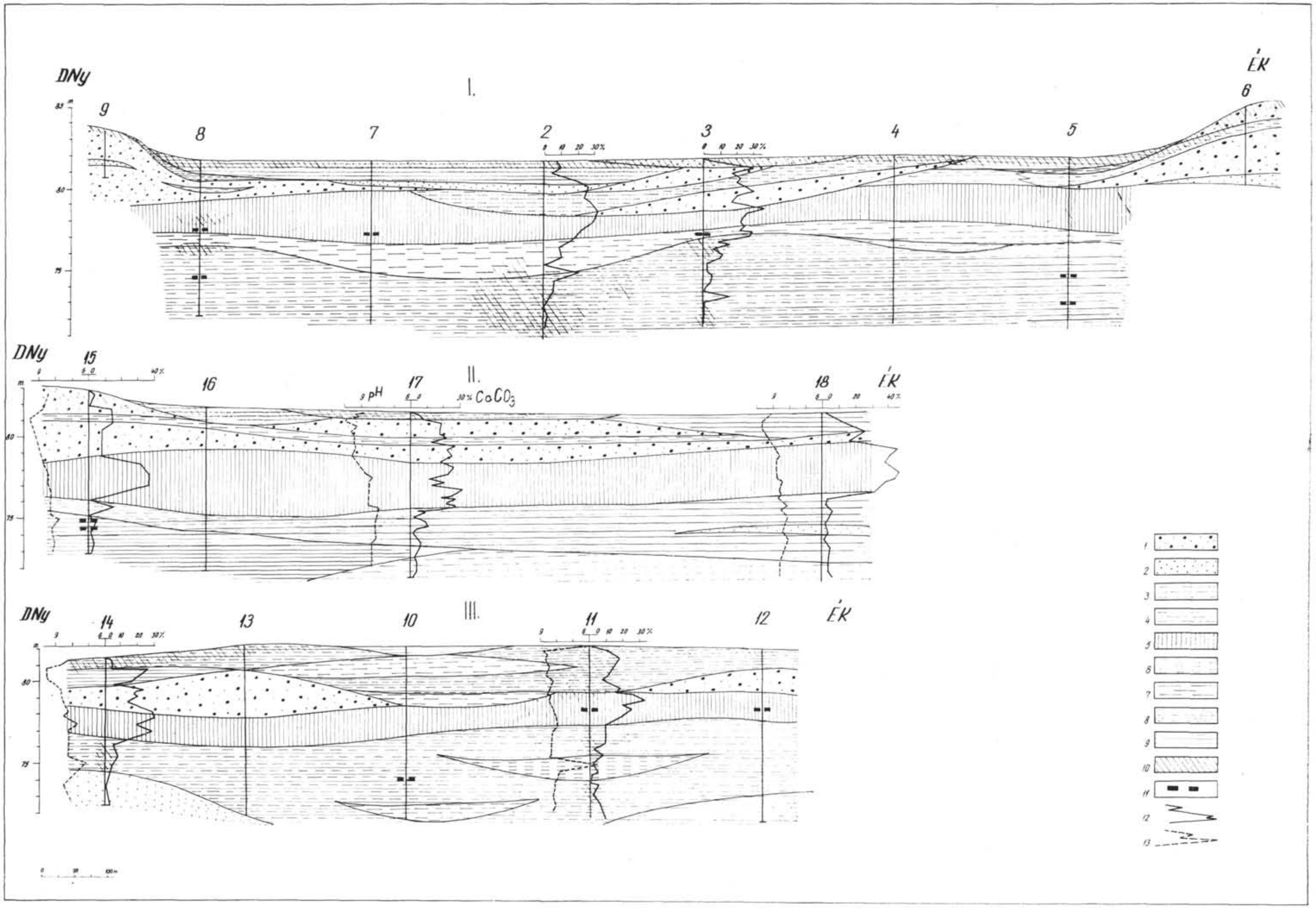

Fig. 2: Profile I—III.

1. Fine-sandy small sand. — 2. Small-sandy fine sand. — 3. Fine sand with coarse silt. — 4. Coarse silt with fine sand. — Alcalized infusion-loess. — 6. Fine-silty coarse silt. — 7. Coarse-silty fine silt. — 8. Clayey fine silt. — 9. Fine silty clay. — 10. Humic sediment. — 11. Slightly peaty layers with plant remains. — 12. Carbonate content. — 13. pH value

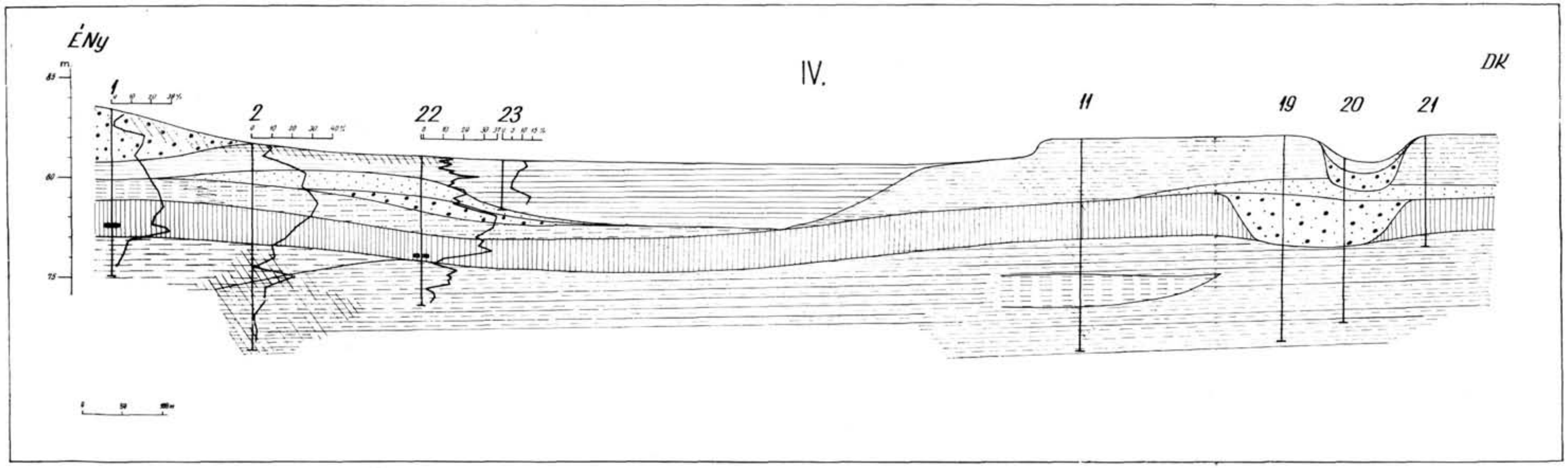

Fig. 3: Profile IV (For legend, see Fig. 2)

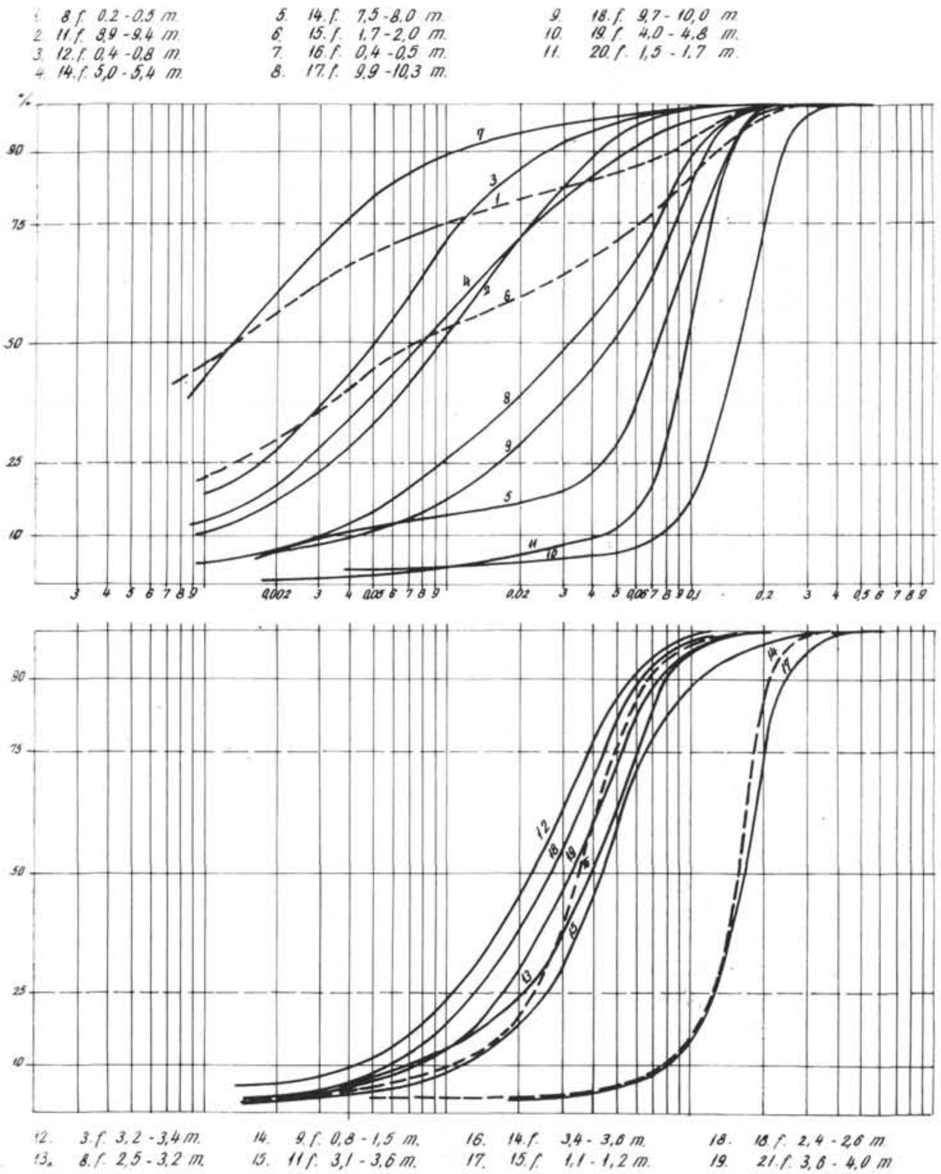

Fig. 4: Examples of the granulometric curves of the sediment types occuring in the Lake Dongér area (top: alluvial and lacustrine sediments; bottm: eolian sediments)

der consideration locally includes (e. g. in boreholes 7, 11, and 12) slightly peaty lenses with fossil plant remains. (The new approach to the genetics of the infusion-loesses has not been tackled (see M. Pécsi 1967).

The differences in the thickness of the loesses can be ascribed to erosion. The greatest thickness may have been stripped of in those places, where the loess in no longer exposed to the surface. For instance, in the line of boreholes 19 and 20 the loess layer has been entirely worn away by fluvial erosion. In this zone there is still a depression on the surface, which has not ceased attracting surface drainage (Fig. 1 and 3).

3. The loess is in many places overlain by 3 to 5 m of lenticular, though never peaty, sediments which often pinch out and vary in granulometric composition between clay and small sand (curves 1, 3, 6, 7, 10, 14, 15 of Fig. 4). The finest clay sediment ever observed in the territory also appears here and it always occurs near the surface or is totally exposed to it (curves 1, 3, 7, of Fig. 4).

The heavy minerals composition of the loess-covering sands showed in all of the cases a mixture of sources (Danube-and-Tisza origin), whereas the underlying ones did always suggest an origin from the Tisza river. (B. Molnár, 1964, 1966, 1967). The Danube-derived fraction of the heavy minerals is always more rounded, because of the greater distance of transportation, as compared to the fraction deriving from the Tisza flood-plain.

There are differences in the shape of the quartz grains, too. The loess-covering sands show the predominance of grains belonging to the 3rd type of attrition. The most essential differences in the precentage distribution and the grain shape of the minerals have been indicated by encircling the respective figures in Table 1.

The loess-covering layers differ from the loess-underlying ones in both carbonate content (15—22%) and—immediately under the surface—pH (8,5—9,2) (Fig. 2 and 3). On account of the physical conditions of occurrence it seems to be evident that the loess is overlain by fine-grained alluvial and lacustrine sediments and wind-blown sands of mixed, Danube-and-Tisza, origin. The wind-blown sands at the junction of the Danube-Tisza Interfluve and the Tisza valley directly overly the loess, being exposed to the surface in many places (Fig. 2, Section I, Borehole 6—9). In other places, closer to the Tisza river (these cases being more frequent), they pinch out between alluvial and lacustrine deposits.

On the geological map, scale 1:10 000, made on the basis of the results of investigations (Fig. 1), the coarsest sediments small-grained wind-blown sands) are shown to occur in the highest morphological position in the NW part of the territory. The wind-blown sands covering the surface end with SE-trending tongues whose direction coincides with the predominant wind direction of the Danube-Tisza Interfluve (R. Wagner 1931).

To the SE of the contiguous wind-blown sand area there are isolated occurrences of fine wind-blown sands which either crop out from below alluvial or lacustrine sediments, of overlie the loess formation.

These too form minor dunes rising some 40 to 50 cm above their background and coinciding in direction with the afore-mentioned wind-blown sand tongues.

Heavily alkalized in most of its outcrops, the loess formation occurs in the NE and S parts of the territory. The depressions between loess and wind-blown sand are occupied by Lake Dongér and minor abandoned river channels blanketed by clay and fine silt. The age of the formations.

An important evidence for the understanding of the geohistorical evolution of the territory is provided by the loess layer which is present throughout the territory and represents the last glaciation of the Pleistocene.

In the beds underlying the loess Mrs. Miháltz found and identified Betula, Salix and Alnus pollen grains accompanying Pinus silvestris constituting about 50% of the pollen spectrum. Of the fossil remains of plants other than trees the pollen

Table 1.

Examples of the results of the analysis for heavy minerals and grain shape of sand sampler from the borholes in the Lake Dongér area
(Fraction anlized: (0,1—0,2 m/m)

Name of mineral	No of borehole and interval of sampling				
	Sands of mixed, Danube-Tisza, origin			Sands of Tisza origin	
	6. 0,6—0,9 m	15. 0,5—0,85 m	13. 1,9—2,0 m	18. 7,0—7,35 m	14. 8,5—9,0 m
Hypersthene	6,7	5,1	1,3	$\boxed{11,8}$	$\boxed{18,7}$
Other ortho-rhombic pyroxenes	1,8	2,8	3,1	1,1	1,3
Augite	10,9	11,3	8,8	$\boxed{24,0}$	$\boxed{19,3}$
Diopside	$\boxed{3,0}$	$\boxed{2,3}$	$\boxed{2,5}$	1,1	0,7
Bazaltic hornblende	0,6	0,6	1,3	$\boxed{9,7}$	$\boxed{14,7}$
Magnetite	4,2	5,6	5,0	$\boxed{7,0}$	$\boxed{12,0}$
Biotite	3,0	0,6	1,9	2,7	1,3
Apatite	0,6		3,1	1,1	1,3
Zirkon	—	0,6	—	—	—
Chlorite	0,6	1,1	0,6	2,2	3,3
Turmaline	1,8	—	3,1	1,6	—
Zoisite	—	—	0,6	—	0,7
Rutile	—	—	0,6	0,5	—
Hornblende	4,2	3,4	10,7	5,4	3,3
Actinolite-tremolite	2,4	—	1,9	0,5	—
Garnet	29,8	41,8	37,2	9,7	12,7
Staurolite	1,2	1,7	1,3	0,5	—
Kyanite	0,6	1,1	—	0,5	2,0
Calcite-dolomite	—	—	—	2,2	0,7
Limonite	1,8	1,1	1,3	2,7	—
Weathered minerals	26,8	20,9	15,7	15,7	6,7
Total heavy minerals weight % of the analyzed fraction	3,46	2,8	2,35	2,32	2,02
Grain shape analyses 1.	—	—	—	0,8	2,5
(% of grain types) 2.	32	28	30,5	$\boxed{57,6}$	$\boxed{61,0}$
3.	$\boxed{65}$	$\boxed{70}$	$\boxed{68,0}$	41,2	36,0
4.	3	2	1,5	0,4	0,5

grains of Carex, Typha and Sagittaria and of Botryococcus algae, forms indicating a stagnant-water environment (flood-plain), were encountered.

According to Mrs. Miháltz, the above pollen assemblage is indicative of a humid climatic phase tending to coolness. This is confirmed by the presence of peaty lenses. On account of their physical conditions of occurrence and pollen spectrum, these strata may have been deposited during the W_2—W_3 interstadial which preceded the last glaciation.

The overlying loess contains few pollen grains: mainly Pinus silvestris. This loess layer was deposited in the last stadial: in W_3. The slightly peaty lenses with fossil plant remains occurring in its lower part may correspond to the transition from the W_2—W_3 interstadial to the W_3 stadial, i. e. to an enviromment which may have been temporarily warmer and wetter.

Because of frequent dessication the loess-covering wind-blown sands and alluvial and lacustrine sediments have yielded just a few pollen grains. These include hardly any Conifersae, and it is the non-tree pollen that predominates (Chenopodiaceae, Artemisia and Compositae). According to Mrs. Miháltz, the representatives of Chenopodiaceae confined to the uppermost 20 cm may be connected with the alcalization of the soil. The drying trend of the climate is also evidenced by the lack of peaty lenses in this sequence and by the higher pH observed in all of the samples analyzed. On the basis of their superposition to the loess and of their pollen spectrum these strata can be referred to the Holocene.

GEOLOGICAL HISTORY

The history of the territory has been sketched in Fig. 5 and Fig. 6.

During the last stadial (W_3) the amount of precipitations decreased under the cooler climate. Thus fluviatile sedimentation was replaced by loess deposition. Both the alluvium and the loess formation extend beyond the contemporary eastern boundary of the Danube-Tisza Interfluve. To the west they continue under the wind-blown sands.

At the beginning of the Holocene the climate became again more humid and the flood-plain of the Tisza grew again wider. The loess of the W_3 stadial was dissected, and its upper part eroded in many places, by the river. The loess-covering sediment also continues a little farther westwards in to the Danube-Tisza Interfluve, below and within the wind-blown sand sequence (Fig. 3, Profile I, borehole 1, 2; Fig. 5, 2/b). In the profile of Fig. 6 the Holocene fluviatile sediment, overlying the loess elsewhere, is absent, However, a few kilometres to the N of the profile, in the vicinity of Lake Fehér, it does occur already.

In the dry hazel-nut stage of the Holocene during which the wind-blown sand movement was common in the Danube-Tisza Interfluve, the sands were migrated southeastwards here too, in correspondance with the predominant wind direction. As a result of this process a part of the early Holocene alluvium was buried (Fig. 3, Profile I: boreholes 1 and 2, Fig. 5: 2/a). Where only the loess is present, the wind-blown sands rest directly on the loess layer (e. g. in the section of Fig. 6).

Under the slightly more humid climate that followed the hazel-nut stage, the stagnant waters left over by the frequent floods evaporated in the summer seasons and led to alcalization. In the waters of already low energy farther off the Tisza, just finegrained sediments could settle and thus accumulation slowed down. In the areas close to the river bed, however, the accumulative power of the river was greater. Therefore the absolute height of the more distant areas decreased with the passing of time (i. e. these areas became relatively deeper) and the stagnant waters accumulated in intermittent natron lakes. Lake Dongér, Lake Csáj and Lake Fehér belong among these. Under natural conditions their waters are not recharged by anything else than the precipitations and the ground-waters migrasting from the Danube-Tisza Interfluve towards the local depressions.

The eastern side of the southern Tisza valley shows a similar structure. However, the eastern boundary is not marked by the wind-blown sands, unlike in the west, so that the Tisza valley passes more gradually into the Trans-Tisza Plain (to the east of the river).

Within the above-outlined area the Tisza valley s. str., the contemporary erosional depression of the river and its accumulation zone lie a few metres deeper (Fig. 6). The last-mentioned zone extends in general to the east of the river.

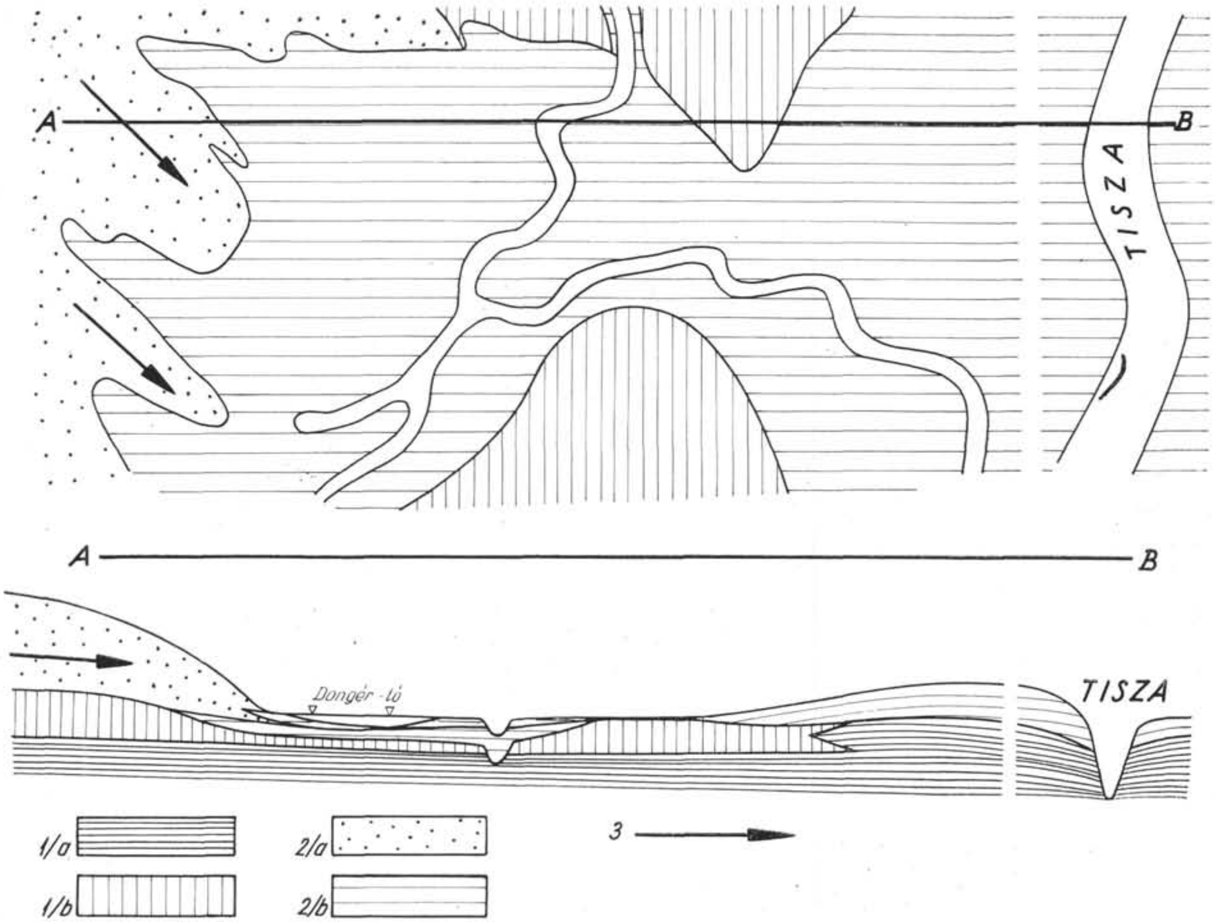

Fig. 5: Idealized sketch of the junction of the Danube-Tisza Interfluve and the Tisza valley la. Fluvial alluvium. *1b*. Alcalized in fusion-loess. — 1*a*—1*b*. Pleistocene. 2*a*: Wind-blown sand — 2*b*: Alluvial and lacustrine sediment. 2*a*—2*b*: Holocene. — 3. Direction of sand movement

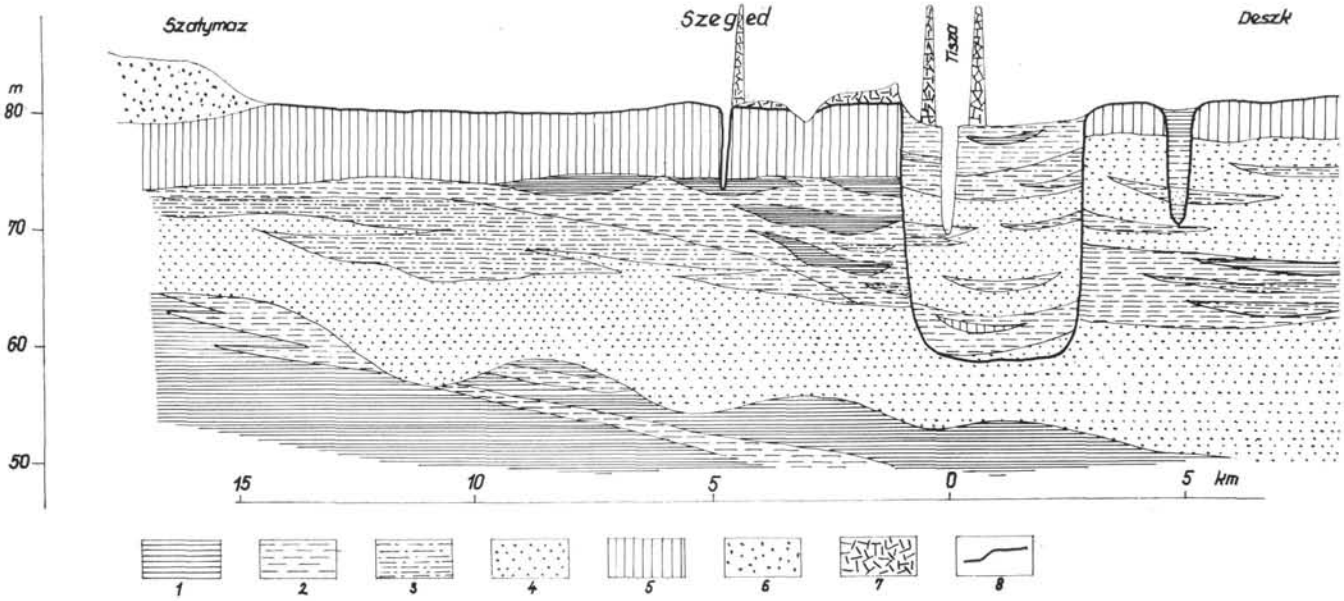

Fig. 6:Profil across the southern par of the Tisza valley, according to I. Mihâltz (1966) 1. Clayey silt and clay. — 2. Silt. — 3. Silty fine sand. — 4. Sand. — 5. Loess. — 6. Wind-blown sand. — 7. Zone of accumulation. — Pleistocene-Holocene boundary

After the Tisza's regulation the deposition of sediments within the levees has changed, the grain size of the sediments has grown coarser and the rate of accumulation has been speeded up.

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