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EROSION SURFACES AND FACIES CHANGES IN THE DANUBE TECTONIC TRENCH

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INTRODUCTION

Having explored the Pliocene and Quaternary formations of the Great Plain along the profile of nearly N—S direction lying in the line of the river Tisza, the Hungarian State Geological Institute initiated to drill new boreholes in a profile of W—E direction. For the time being the profile includes the boreholes of Kunadacs, of the Kecskemét environs and of Nyárlőrinc. Under the guidance of the Department for Flatlands of the Hungarian State Geological Institute the core samples of the boreholes were investigated by many-sided sedimentological and paleontological methods. Within this complex processing this paper tries to give a report on the micromineralogical and grain-size analysis of sand strata from the borehole of Nyárlőrinc.

Nyárlőrinc is situated 19 km east of Kecskemét, at the side of the Danube—Tisza Interfluve inclining towards the river Tisza, about 13 km west of the river. The borehole Nyárlőrinc Ny-1 was drilled in 1975 in the axis of the "Danube tectonic trench" demonstrated by SÜMEGHY, J. [1953].

In the borehole profile of 800 metres of Nyárlőrinc from down topwards Upper Pannonian strata to 688 m, Uppermost Pliocene, Levantine strata between 273 and 688 m [after FRANYO, F.] or as suggested recently by BARTHA, F. [1971, 1975] and by JÁMBOR, Á., KORPÁS—HÓDI, M. [1971] Uppermost Upper Pannonian strata are found. The latter author regard the Uppermost Pliocene sequence to be a part of the Upper Pannonian. Finally, between 0 and 273 m the Pleistocene sequence is found. Holocene is absent.

In the "Danube tectonic trench" the Pliocene and Quaternary strata become thicker towards Szentes, Mindszent and Szeged and their lower boundary gets deeper than determined in the profile of Nyárlőrinc indicating a more intense subsidence as compared to its environment. E.g. at Mindszent the Upper Pannonian — Levantine resp. the Levantine — Pleistocene boundaries occurred in a depth of 1210 resp. 690 m, i.e. much deeper than at Nyárlőrinc.

The micromineralogical analysis of 103 samples deriving from the interval between 0 and 800 m of the Nyárlőrinc profile was carried out. In favour of micromineralogical analysis the samples were first divided into fractions, then the minerals of the fraction of 0.1 to 0.2 mm were separated to light and heavy minerals by means of bromoform, the boundary between them lying at a specific weight of 2.8.

Based on the previous investigations it was expected that at Nyárlőrinc in addition to the fluviatile facies the aeolian ones will also occur within the Pleistocene sediments, thus the shape of the quartz grains of these samples were also determined by means of the grain-shape method of CAILLEUX [CAILLEUX, A., 1952; MOLNÁR, B., 1961]. Grain-shape investigations were carried out in the grains of more than 0.2 mm diameter if possible, in case of finer-grained material the grains of 0.1 to 0.2 mm diameter were used.

In case of the clastic sediments of the Great Plain the change in grain-size composition strongly affects the heavy-mineral composition, thus in favour of right conclusions the compositional analyses of grains were also carried out [MOLNÁR, B., 1969].

The investigation results are comprehended in Tables and the data were demonstrated in profiles, respectively (Tables 1—2, *Figs. 1—2*). When grouping the results according to ages the following statements can be concluded.

INVESTIGATION RESULTS OF THE UPPER PANNONIAN FORMATIONS

The Upper Pannonian formation were explored between 688 and 800 metres, i.e. in a length of 112.0 m. On the basis of the profile of FRANYÓ, F. [1976] showing the sedimentary evolution the Upper Pannonian sequence of Nyárlőrinc is characterized by the predominance of the pelitic clastic sediments. Consequently, this strata sequence is less suitable to micromineralogical investigations, thus the analyses of only eight samples were carried out. The grain composition of the investigated samples did not exceed the fine-grained sand either investigating the coarsest strata of the sequence. It can be read off from Table 1, resp., from the column III of *Fig. 1* that the prevailing grain size varied between 0.04 and 0.12 mm.

It is characteristic of the heavy-mineral composition of the sedimentary sequence that it is poor in heavy minerals (Table 1). In all samples chlorite predominates, the quantity of which varies between 68.8 and 84.2 percent. Nevertheless, when summing up the 10.2 percent biotite and 13.2 percent chlorite content of the sample of least; i.e. 68.8 percent chlorite content, it is obvious that phyllosilicates predominate also in this sample.

Garnet and weathered minerals (0.6 to 6.3 and 1.8 to 5.9 percent, respectively) occurred in much smaller quantities, but in all samples. In order of better review these minerals were framed in Table 1. Other minerals, e.g. hypersthene, other orthorhombic pyroxenes, augite and diopside which are demonstrated together in *Fig. 1*, did not occur in a quantity which proved to have been suitable to demonstration. The stereomicroscopic photos of Plate I reflect also this rather monotonous mineral composition consisting mostly of chlorite.

The mineral composition of the Upper Pannonian sequence of Nyárlőrinc shows good agreement with that the Upper Pannonian sequences of Szentes, Mindszent, Szeged and of that of the South Great Plain, in general [MOLNÁR, B., 1963, 1965*a*, 1965*b*, 1966*a*, 1966*b*, 1966*c*; GEDEON—RAJETZKY, M., 1975].

As to our recent knowledge, this part of the Upper Pannonian sedimentary sequence is a lacustrine sediment both in the Great Plain and thus also at Nyárlőrinc. The homogeneous lacustrine sedimentation conditions and the selective weathering may be the reasons of this poorish mineral composition.

The CAILLEUX's grain-shape method showed predominantly sharp splintery quartz grains in the Upper Pannonian section of the borehole, profile. Lightsurfaced, slightly rounded quartz grains occurred only in 6.0 to 17.0 percent (*Fig. 1*, column II). The stereomicroscopic photo of Plate V (4) fairly shows that quartz grains are really sharp a splintery. According to CAILLEUX, A. this composition relates to fluviatile transport and deposition in water.

TABLE 1

Heavy mineral composition of bore-profile of Nyárlőrinc

Number	Depth m	Dominantly magmatic minerals: Hypersthene	Other rhombic pyroxenes	Augite	Diopside	Basaltic—Hornblende	Magnetite—Ilmenite	Apatite	Zircon	Biotite	Chloritized Biotite	Dominantly metamorphic minerals: Chlorite	Tourmaline	Epidote	Clinosoisite	Zoisite	Rutile	Hornblende	Actinolite—Tremolite	Anthophyllite	Garnet	Other minerals: Staurolite	Kyanite	Calcite-dolomite	Limonite	Pyrite	Other micas	Weathered minerals	Total quantity minerals in the examined fraction	Dominant grain diameter mm	AGE	FACIES
52	398.0 I.	5.2	7.3	3.8	3.5	0.6	11.1	1.4	—	—	—	2.1	1.0	1.0	0.7	—	—	6.2	0.3	1.0	32.4	—	0.3	0.3	—	0.7	—	21.1	5.5	1.00	LEVANTINE	LACUSTRINE — FLUVIATILE
53	398.0 II.	3.8	3.8	2.7	2.7	0.3	8.9	1.0	0.3	—	—	4.1	1.0	2.4	2.4	0.7	—	9.2	1.0	0.3	26.0	0.3	1.4	1.0	—	1.4	—	25.3	50.4	1.20		
54	399.4 —400.0	—	2.6	0.9	—	0.9	1.3	0.9	—	0.4	—	52.2	0.9	1.3	0.9	—	—	4.8	0.9	0.9	2.2	—	0.9	4.4	—	—	9.6	14.0	0.8	0.15		
55	433.20—433.8	0.3	3.5	1.0	3.5	0.3	4.5	0.3	—	—	—	42.4	0.7	1.4	1.7	—	—	4.9	0.3	0.3	8.4	—	0.7	4.9	—	—	3.8	17.1	3.0	0.14		
56	439.19—440.01	0.6	2.9	0.9	4.1	0.6	2.9	1.6	—	0.3	—	14.8	—	0.9	1.9	0.6	—	6.4	0.9	0.3	26.0	0.6	0.3	7.3	—	5.4	3.8	16.9	7.3	0.24		
57	447.2 —448.3	—	1.6	—	0.5	—	0.5	2.1	—	—	—	65.8	—	1.1	0.5	—	—	1.6	1.1	—	2.7	—	0.5	2.7	—	1.1	6.4	11.8	1.8	0.11		
58	456.70—457.32	0.3	4.4	2.3	3.7	0.3	4.7	2.3	—	—	—	20.9	1.0	0.3	2.0	—	—	4.7	1.3	0.3	10.1	—	0.7	4.4	—	—	3.0	33.3	2.3	0.14		
59	460.16—461.4	2.0	2.6	3.2	1.2	—	8.1	0.9	0.3	—	—	23.5	0.6	0.6	1.5	—	—	7.0	—	—	28.7	0.3	0.6	0.6	0.3	1.7	0.6	15.7	1.6	0.09		
60	472.00—473.05	0.3	1.5	1.2	2.8	0.3	3.1	0.3	—	—	—	19.5	0.6	0.6	0.9	—	—	4.6	0.9	—	15.8	—	0.6	26.0	—	0.9	5.6	14.5	8.5	0.22		
61	475.40—479.00	—	3.6	2.3	3.9	—	3.2	1.3	0.3	—	—	24.1	—	1.3	1.0	—	—	9.10	0.6	—	25.6	—	0.3	5.2	—	1.0	3.2	14.0	4.5	0.19		
62	489.12—489.83	0.3	2.3	1.7	1.7	0.3	6.7	2.3	0.3	—	—	24.8	0.7	1.0	1.3	—	—	4.4	1.3	0.3	22.8	—	—	6.0	—	0.7	3.3	17.8	2.7	0.16		
63	492.00—495.14	—	2.0	1.6	3.2	—	2.4	0.8	—	0.8	—	47.4	0.4	0.4	1.2	—	—	4.9	0.4	0.8	6.9	—	0.4	3.6	—	—	4.9	17.9	2.3	0.20		
64	496.69—500.00	—	3.3	0.3	1.2	—	5.5	1.5	—	0.6	—	34.4	0.3	0.9	2.7	—	—	3.9	1.5	0.3	15.2	—	1.2	4.0	—	0.3	4.0	18.9	3.3	0.20		
65	501.15—503.20	—	5.1	2.0	1.3	—	7.8	1.7	—	—	—	15.2	—	0.3	3.0	—	0.3	2.0	0.3	—	35.7	—	1.0	4.4	—	1.3	—	18.6	3.2	0.7		
66	508.00—510.80	—	4.9	0.4	2.4	—	1.2	0.4	—	0.8	—	47.8	0.4	1.6	0.8	0.4	—	4.5	1.6	—	8.5	—	0.4	2.4	—	—	6.9	14.6	3.7	0.14		
67	510.80—516.0	0.4	2.9	0.8	2.9	—	6.1	0.4	—	—	—	47.8	0.4	0.4	2.0	0.4	0.4	4.1	1.2	—	11.1	—	—	5.7	—	—	2.0	11.0	1.00	0.19		
68	522.00—527.80	0.6	3.1	1.5	4.0	—	7.4	0.6	—	0.3	—	11.8	—	0.9	2.8	—	—	2.2	1.2	—	35.9	—	1.5	3.4	—	0.9	1.5	20.4	4.7	0.24		
69	539.30—545.60	—	3.2	0.5	3.2	—	2.3	0.5	—	—	—	52.1	0.5	0.9	1.4	0.5	—	3.2	—	0.9	11.5	—	0.5	4.6	—	0.9	1.8	11.5	2.7	0.20		
70	545.60—550.10	0.4	3.0	1.1	1.9	—	4.2	0.8	—	—	—	35.7	0.4	0.4	0.8	—	0.4	2.3	0.8		12.9	—	1.5	4.2	—	0.4	1.5	27.3	3.9	0.21		
71	550.48—550.98	—	6.1	1.8	2.5	—	8.7	2.2	—	—	—	16.2	—	1.1	2.2	—	—	4.3	0.7	0.4	20.6	—	0.7	2.2	—	—	0.4	29.9	3.8	0.18		
72	561.80—565.92	0.3	3.4	1.9	3.4	—	6.2	0.9	—	—	—	16.8	0.9	1.2	1.2	—	0.3	1.5	1.2	—	23.9	—	0.9	6.2	0.3	—	2.2	27.3	4.1	0.21		
73	570.80—577.10/b	—	1.0	1.0	1.7	—	6.8	1.4	—	0.3	—	35.5	—	1.0	1.0	—	—	0.3	0.7	0.3	14.3	—	1.0	3.1	—	—	2.7	27.9	4.2	0.22		
74	577.10—579.95	—	2.1	3.1	2.1	—	8.6	—	—	0.3	—	28.7	0.7	0.3	1.0	—	—	0.3	1.0	0.3	16.5	—	0.3	5.5	—	—	1.0	28.2	3.3	0.23		
75	580.50—585.10/b	0.5	0.5	0.9	0.9	—	5.1	0.9	—	3.2	—	43.6	—	1.4	1.8	—	—	0.5	0.9	0.5	9.7	—	0.9	0.5	0.9	1.4	4.6	21.3	0.3	0.16		
76	585.10—591.40/b	—	3.3	1.7	3.0	—	4.7	2.0	—	0.6	—	34.0	0.6	0.6	2.6	0.3	—	0.3	0.3	0.3	11.7	0.3	0.3	2.7	—	1.0	2.7	27.0	2.7	0.14		
77	591.40—595.25	0.6	7.4	1.3	1.6	—	2.6	0.6	—	2.2	—	38.7	0.3	1.0	1.9	0.6	—	—	0.3	0.3	13.1	—	1.0	5.1	—	0.3	2.2	18.9	4.1	0.15		
78	595.31—596.30	—	0.8	0.4	1.2	—	5.2	—	—	—	—	33.5	—	0.8	1.6	—	—	1.6	—	—	5.9	—	0.4	4.8	—	3.2	1.6	39.0	7.4	0.31		
79	598.02—600.98	0.7	2.8	1.1	2.8	—	3.6	0.3	—	1.1	—	35.3	—	1.4	1.4	0.3	—	1.1	—	0.3	6.1	—	0.7	0.3	—	0.3	1.4	39.0	5.0	0.24		
80	604.40—605.55	0.4	2.9	1.8	2.6	—	5.1	1.8	—	0.7	—	11.8	0.7	1.8	2.0	—	0.4	—	0.7	0.4	25.0	—	0.7	0.4	—	0.7	1.1	39.0	3.8	0.30		
81	609.13—609.47	—	2.6	1.3	3.3	—	4.6	1.0	0.3	4.0	—	32.6	0.3	1.3	0.3	0.3	—	—	0.3	—	12.2	—	0.3	3.0	—	—	6.9	25.4	2.5	0.14		
82	610.22—611.50	—	4.8	1.5	5.2	—	7.4	0.7	—	—	—	7.1	0.7	3.0	1.9	0.4	—	0.4	0.8	—	37.1	—	1.1	2.2	—	1.5	0.4	23.8	6.1	0.22		
83	613.5 —615.00	1.4	2.0	0.7	2.0	—	3.8	1.7	—	2.0	—	31.8	0.3	1.0	1.0	—	—	0.3	0.7	—	10.0	—	1.0	2.7	—	1.4	2.0	34.2	2.0	0.12		
84	623.60—624.23	—	5.2	0.7	4.5	—	4.2	1.4	—	0.3	—	7.6	0.7	3.8	5.5	2.1	—	0.3	0.7	—	32.9	—	1.4	—	—	0.7	1.7	26.3	5.7	0.19		
85	627.40—630.00	—	3.8	3.0	3.0	—	10.9	2.3	—	1.1	—	11.7	—	2.6	2.6	0.4	—	—	0.4	—	28.3	0.4	1.5	2.3	—	0.8	0.4	24.5	2.3	0.16		
86	635.00—635.75	—	2.8	0.7	1.0	—	7.3	1.7	0.3	0.3	—	12.8	—	1.7	1.7	—	—	—	0.7	0.7	18.3	—	1.0	9.7	—	1.7	4.8	32.8	3.4	0.42		
87	637.05—640.00	—	1.3	—	—	—	—	1.3	—	2.7	—	76.2	—	1.3	—	—	—	—	—	—	4.7	—	0.6	6.0	—	0.6	1.3	4.0	0.8	0.10		
88	650.41—651.09	0.7	2.3	1.0	2.0	—	7.3	1.0	—	0.3	—	12.9	0.7	2.3	2.0	0.3	—	—	0.7	—	36.5	0.3	2.6	0.3	—	—	0.7	26.1	8.2	0.26		
89	657.00—657.53	0.3	2.8	0.6	2.8	—	10.0	2.2	—	1.2	—	20.9	1.2	1.5	1.2	—	—	0.6	—	—	25.1	0.3	0.6	1.6	—	6.2	0.3	20.6	2.1	0.90		
90	659.59—661.70	0.3	4.5	0.6	2.1	—	8.2	2.1	—	0.6	—	16.4	1.2	4.5	1.5	—	—	—	—	0.3	26.3	—	0.9	2.4	—	4.5	0.3	23.3	4.2	0.70		
91	663.25—664.20	—	1.2	0.8	0.8	—	2.4	1.2	—	0.8	—	13.0	0.8	1.2	0.8	0.4	—	—	0.4	1.2	4.0	—	0.8	35.8	—	3.2	1.2	30.0	1.3	0.21		
92	667.80—668.61	—	3.0	0.7	3.0	—	7.7	1.0	—	0.7	—	37.3	—	1.7	1.0	—	—	—	—	0.3	16.5	—	1.3	1.3	—	1.3	1.0	22.2	3.6	0.38		
93	675.53—676.42	—	1.5	—	1.9	0.4	5.4	1.5	—	—	—	17.2	0.8	1.5	2.7	—	—	—	—	0.4	35.1	—	0.8	7.7	—	1.2	1.5	20.4	2.3	0.20		
94	678.70—681.41/a	—	2.1	0.5	3.7	—	9.0	1.8	—	0.3	—	12.7	0.5	2.9	3.2	—	—	—	0.3	—	28.2	—	1.6	9.2	—	0.5	0.8	22.7	5.8	0.14		
95	682.91—684.20	—	3.2	1.0	2.5	—	6.1	2.2	0.3	0.3	—	17.3	1.0	1.0	3.0	—	—	—	0.3	—	34.9	—	1.3	1.3	—	0.3	1.0	23.0	5.3	0.27		
96	690.48—690.59	—	—	0.7	—	—	—	—	—	6.2	—	84,2	—	0.7	—	—	—	—	—	—	1.4	—	0.7	—	—	—	0.7	5.4	3.80	0.04	UPPER PANNONIAN	LACUSTRINE
97	692.67—694.60	—	—	—	1.3	—	0.6	1.9	—	—	—	73.5	—	5.1	0.6	0.6	—	—	—	—	6.3	—	1.3	1.9	—	0.6	2.5	3.8	2.3	0.10		
98	695.01—695.32	—	—	—	0.7	—	—	2.0	—	1.3	—	80.6	0.7	2.0	—	—	—	—	—	—	2.7	—	0.7	1.3	—	2.0	—	6.0	4.7	0.05		
99	700.90—701.24	—	—	—	—	—	—	0.8	—	3.1	—	89.0	—	—	—	—	—	—	0.8	—	1.5	—	—	—	—	0.8	—	4.0	3.7	0.06		
100	705.18—705.47	—	0.7	—	—	—	—	—	—	—	—	87.5	—	1.5	—	—	—	—	—	—	0.7	—	—	—	—	—	3.7	5.9	0.5	0.06		
101	763.57—769.02/a	—	—	0.6	—	—	—	—	—	10.2	13.2	68.8	—	1.2	—	—	—	0.6	—	—	0.6	—	—	—	—	—	3.0	1.8	2.9	0.12		
102	763.57—769.02/b	0.7	—	—	0.7	—	0.7	1.4	—	—	—	77.3	—	—	2.1	—	—	—	1.4	—	2.1	—	0.7	3.6	—	0.7	3.6	5.0	3.3	0.12		
103	769.30—775.08/a	—	—	0.7	2.0	—	0.7	0.7	—	1.4	—	80.1	0.7	0.7	1.4	0.7	—	0.7	—	—	2.0	—	0.7	0.7	—	—	2.0	4.8	2.6	0.12		

TABLE 2

Heavy mineral composition of bore-profile of Nyárlőrinc

Number	Depth m	Dominantly magmatic minerals										Dominantly metamorphic minerals												Other minerals					Total quantity minerals in the examined fraction	Dominant grain diameter mm	*AGE*	*FACIES*
		Hypersthene	Other rhombic pyroxenes	Augite	Diopside	Basaltic—Hornblende	Magnetite—Ilmenite	Apatite	Zircon	Biotite	Chloritized Biotite	Chlorite	Tourmaline	Epidote	Clinosoisite	Zoisite	Rutile	Hornblende	Actinolite—Tremolite	Anthophyllite	Garnet	Staurolite	Kyanite	Calcite-dolomite	Limonite	Pyrite	Other micas	Weathered minerals				
1	2.0 — 3.0 m	3.2	1.9	1.3	3.5	—	5.7	0.9	—	0.3	—	3.8	1.3	1.3	2.5	—	—	8.8	0.6	0.9	30.0	0.3	0.6	3.8	—	1.6	—	27.7	4.2	0.21	PLEISTOCENE	EOLIAN
2	6.63— 7.20 m	2.4	4.0	3.4	2.7	0.7	7.4	0.3	0.3	0.3	—	2.7	1.3	1.3	2.4	—	—	8.5	0.7	1.3	36.9	0.3	0.7	—	—	0.7	—	21.7	4.2	0.16		
3	8.5 m	1.9	0.5	1.9	1.9	—	5.6	—	—	—	—	4.2	2.3	2.3	2.8	—	—	2.3	0.5	0.5	44.8	0.5	0.5	2.3	—	—	—	25.2	1.04	0.14		
4	15.69—15.93 m	1.9	3.1	3.5	3.1	—	7.4	1.2	—	0.4	—	1.9	0.4	1.2	2.3	—	—	5.4	0.4	0.8	29.2	—	0.4	0.4	—	1.2	—	35.8	3.2	0.14		
5	19 m	1.3	—	0.4	1.8	—	6.7	1.8	—	0.4	—	5.4	0.4	3.6	3.6	—	—	9.4	0.4	—	38.0	—	—	10.2	—	—	—	16.6	0.5	0.12		
6	21.5 m	4.5	0.8	1.6	1.6	—	7.3	—	0.4	—	—	—	0.4	2.4	2.4	—	—	7.7	—	—	32.9	—	1.2	—	0.8	—	—	36.0	6.0	0.20		
7	31.0 m	4.1	2.5	4.1	0.8	—	7.5	0.4	—	—	—	7.9	—	1.6	3.3	—	—	5.4	—	0.8	26.6	0.8	0.4	0.4	—	—	—	33.4	2.1	0.11		
8	36.0 m	2.5	2.0	1.5	0.5	—	5.0	1.0	0.5	—	—	6.8	2.5	3.0	3.9	—	—	2.0	—	—	31.8	0.5	0.5	2.5	1.0	—	—	32.5	4.5	0.13		
9	38.20—38.66 m	2.1	3.5	4.8	3.5	0.3	4.8	0.3	—	0.3	—	2.4	1.4	0.7	1.7	—	—	16.6	1.7	0.7	24.3	0.3	0.3	0.3	—	1.7	1.4	26.9	2.3	0.20		
10	51.5 m	3.5	2.3	2.3	3.5	—	4.6	0.8	—	—	—	5.8	1.5	0.4	3.1	—	—	7.7	—	0.8	27.8	0.4	1.5	—	0.4	—	—	33.6	2.1	0.13		
11	58.0 m	0.7	1.5	0.7	1.8	—	5.2	0.4	—	—	—	10.4	1.1	1.1	2.6	0.7	—	13.3	—	0.4	33.0	—	1.5	0.4	—	—	—	25.2	3.6	0.19		
12	62.5 m	1.1	1.1	2.6	1.1	0.8	11.3	1.1	—	0.4	—	11.3	1.1	3.4	2.2	0.4	—	10.5	0.8	1.1	24.5	0.4	1.1	—	—	—	0.4	23.3	1.9	0.17		
13	64.5 m	2.2	1.5	1.5	2.6	—	7.7	1.8	—	—	—	4.8	0.4	0.7	2.9	—	—	11.4	—	0.4	23.5	0.4	1.5	7.7	—	—	1.1	27.9	7.6	0.16		
14	70.0 m	1.6	5.7	3.3	2.0	—	8.6	—	—	—	—	2.5	—	0.8	1.6	—	—	8.6	1.6	0.4	43.7	—	0.4	—	—	0.8	0.8	17.6	2.8	0.12		
15	74.3 m	0.9	0.4	1.7	—	—	3.4	0.4	—	8.1	—	14.0	0.4	1.3	0.4	—	—	1.3	—	0.4	19.6	—	—	21.3	0.4	—	—	26.0	5.1	0.06		
16	77.5 m	1.8	1.3	0.4	0.9	—	3.9	1.3	—	0.4	—	11.8	—	0.9	1.8	—	—	17.1	0.9	1.3	17.1	1.8	0.4	5.7	0.4	—	—	30.8	3.7	0.11		
17	81.0 m	1.5	0.8	2.3	1.9	—	3.9	0.8		1.2	—	9.6	0.4	2.3	1.2	0.4	—	12.0	0.8	0.8	10.0	0.8	0.8	25.0	1.5	—	1.2	20.8	5.1	0.11		
18	89.60—90.81 m	2.1	5.9	4.2	3.4	1.4	8.3	—	—	—	—	2.7	0.7	1.4	2.4	0.3	—	10.3	0.7	0.7	16.2	—	2.0	—	—	—	1.0	36.3	3.4	0.14		
19	97.3 m	2.0	2.4	2.4	4.5	0.4	6.6	0.8	—	0.4	—	5.8	0.4	4.1	5.8	—	—	9.5	0.4	1.6	16.0	0.4	0.4	6.2	—	—	1.2	28.7	3.2	0.15		
20	99.3 m	0.7	4.0	1.4	4.3	—	3.6	0.4	0.4	—	—	6.9	1.8	4.7	0.7	—	—	6.5	0.4	1.4	22.4	0.4	0.7	4.0	—	—	0.4	34.9	3.4	0.14		
21	101.0 m	2.0	2.8	2.4	3.2	—	5.6	0.4	—	—	—	15.1	0.4	1.6	2.8	—	—	8.0	1.6	1.2	23.9	—	1.2	1.6	—	—	—	26.2	3.2	0.22		
22	112.0 m	1.0	2.3	0.6	3.3	—	5.5	0.6	—	0.6	—	4.6	1.6	0.6	1.0	0.3	—	5.2	0.3	0.3	10.8	—	1.0	17.6	2.0	—	0.3	40.5	4.7	0.12		
23	113.20 m	2.4	3.7	2.0	1.0	—	7.1	1.3	—	1.7	—	6.8	1.3	1.0	2.7	—	—	9.8	1.0	0.7	13.9	0.3	0.7	11.2	—	—	0.3	31.1	1.0	0.08		
24	123.0 m	0.9	—	—	—	—	—	—	—	7.3	—	35.2	—	—	—	—	—	1.4	—	0.4	—	—	—	7.8	—	—	44.3	2.7	5.3	0.07		FLUVIATILE
25	124.0 m	—	0.7	1.1	0.4	—	1.1	—	—	4.5	—	22.1	0.4	0.7	0.4	—	—	1.5	0.7	—	5.6	0.4	0.4	29.6	—	—	19.5	10.9	6.5	0.09		
26	134.0 m	1.8	1.4	3.2	3.9	1.4	5.3	1.0	—	0.4	0.4	12.0	0.4	1.4	1.4	0.4	—	15.8	1.4	—	19.4	—	1.0	—	—	0.7	4.9	22.4	2.8	0.31		
27	139.74—140.87 m	0.4	—	0.8	2.1	—	2.6	0.4	—	2.3	—	24.3	0.4	0.8	—	—	—	19.1	2.1	0.4	2.6	—	—	3.0	—	5.1	5.9	27.7	3.4	0.13		
28	154.7 m	0.5	1.3	1.3	1.8	1.3	0.9	2.2	—	1.3	—	21.3	0.5	0.5	0.5	0.5	—	21.7	4.0	0.5	4.8	—	0.5	0.9	—	6.2	6.2	21.3	3.3	0.11		
29	158.0 m	0.4	0.4	1.3	—	0.4	1.7	—	—	1.7	—	16.0	0.9	0.9	1.3	0.4	—	6.9	1.7	0.4	2.2	—	0.4	43.1	—	—	6.1	13.8	3.5	0.12		
30	161.5 m	1.5	1.5	4.4	2.2	—	2.6	0.4	—	1.1	—	7.3	0.4	0.7	1.8	—	—	7.0	0.4	0.4	14.7	—	0.7	14.7	—	—	1.8	36.4	16.3	0.25		
31	164.0 m	1.5	2.2	3.3	2.9	0.4	8.4	0.4	—	1.1	—	7.3	0.7	1.8	2.2	—	—	9.5	0.7	1.1	17.0	0.4	1.5	4.4	—	—	4.0	29.2	16.0	0.28		
32	167.4 m	0.9	0.9	1.8	0.9	—	—	—	—	0.9	—	30.7	—	—	0.4	0.4	—	5.9	1.3	—	0.4	0.4	0.4	29.4	—	—	10.8	14.5	9.2	0.12		
33	169.3 m	1.0	1.4	1.0	1.7	—	2.8	0.7	—	4.2	—	39.9	0.3	0.7	0.7	—	—	10.2	1.4	—	0.3	—	—	8.1	—	0.7	12.3	12.6	3.5	0.09		
34	188.7 m	0.3	1.4	1.4	0.7	0.3	2.8	—	—	—	—	13.7	0.3	0.7	—	0.3	—	7.0	0.3	0.3	1.0	0.3	0.3	23.6	0.7	—	7.0	37.6	4.5	0.20		
35	202.5 m	1.7	1.7	3.5	1.4	0.7	6.3	1.0	—	1.0	—	21.9	0.3	1.4	1.7	0.3	—	13.2	0.3	0.7	7.3	—	1.0	3.1	—	—	3.1	28.4	3.5	0.19		
36	205.8 m	0.6	3.2	0.6	2.8	0.6	8.2	0.9	—	0.3	—	13.5	1.3	0.9	0.6	0.6	0.3	10.1	0.6	—	6.3	0.3	0.6	13.0	—	0.3	3.8	30.6	4.2	0.22		
37	209.0 m	—	1.3	0.3	0.6	0.3	3.3	2.9	—	—	—	20.2	0.6	1.6	1.0	0.3	—	6.6	0.6	—	3.0	—	1.0	16.4	—	—	12.5	27.5	6.7	0.25		
38	212.7 m	0.3	3.5	2.9	0.6	—	8.0	1.6	—	—	—	5.7	1.3	2.5	1.6	0.6	0.3	10.2	0.3	0.3	8.6	0.6	1.0	19.5	—	—	1.0	29.6	8.0	0.18		
39	215.5 m	0.7	2.4	1.7	0.7	0.3	3.1	0.7	—	2.0	—	36.2	—	1.7	0.3	—	0.3	3.7	0.3	0.3	4.4	0.3	0.3	4.7	—	—	22.0	13.9	9.0	0.34		
40	217.5 m	0.8	1.6	2.7	2.4	1.6	10.6	0.4	—	—	—	6.3	—	1.6	0.4	1.2	—	9.8	0.4	0.4	16.1	0.4	1.6	2.7	—	—	1.2	37.8	6.2	0.36		
41	238.87—241.80 m	—	6.1	3.5	6.1	0.9	3.0	0.9	—	—	—	20.0	1.8	1.3	0.9	—	—	9.6	3.0	—	9.1	—	0.4	0.9	—	2.6	0.9	29.0	4.1	0.21		
42	257.6 m	—	3.8	2.6	4.0	1.5	3.3	0.7	—	—	—	29.9	1.8	1.5	0.7	0.4	—	7.4	1.1	—	9.6	—	0.7	0.4	—	—	5.5	25.1	3.5	0.18		
43	272.6 m	—	1.6	3.1	5.2	1.0	3.1	0.5	—	—	—	21.9	0.5	2.1	0.5	—	—	6.8	1.0	0.5	6.2	—	1.6	2.1	—	—	4.2	38.1	2.7	0.14		
44	289.9 m	—	2.1	—	0.7	—	1.4	0.7	—	—	—	73.2	—	—	—	—	—	2.1	1.4	—	0.7	—	—	5.7	—	—	7.8	4.2	4.4	0.08	LEVANTINE	LACUSTRINE —FLUVIATILE
45	301.5 m	1.2	4.7	2.4	3.9	2.0	11.5	1.2	—	—	—	15.8	0.4	0.8	1.6	—	—	5.9	0.4	—	24.9	—	1.2	0.8	—	0.8	2.8	17.7	1.2	0.28		
46	307.7 m	—	3.2	1.1	2.8	—	3.9	—	—	—	—	36.9	1.4	0.7	0.7	—	—	8.5	0.3	—	3.5	0.3	—	2.1	—	0.3	6.8	27.5	3.3	0.11		
47	315.0 m	1.6	4.0	—	1.2	5.7	11.3	0.4	0.8	—	—	10.1	0.8	1.6	0.8	—	—	6.5	0.4	—	20.7	0.4	0.4	3.6	—	0.4	2.4	26.9	5.5	0.36		
48	335.0 m	0.7	5.0	2.0	2.8	3.2	3.6	1.1	—	—	—	18.3	0.7	1.1	0.3	—	—	13.6	1.1	0.7	12.5	—	0.3	1.1	—	1.8	2.1	28.0	7.3	0.26		
49	365.5 m	—	3.4	0.4	3.0	0.4	5.3	0.4	0.4	—	—	30.2	1.1	3.0	1.9	—	0.4	6.4	1.9	—	6.4	—	1.1	3.0	—	—	10.6	20.7	4.9	0.18		
50	382.6—384.0 m	—	1.4	1.4	2.8	0.5	1.4	0.5	—	0.5	—	57.9	0.9	0.9	—	—	—	8.0	1.4	—	4.2	—	0.9	0.9	—	2.3	1.9	12.2	2.1	0.13		
51	396.0 m	2.6	4.5	2.6	4.1	—	6.0	0.8	—	0.4	—	6.0	0.8	2.3	1.1	—	—	8.3	2.3	—	37.8	—	0.4	0.4	—	0.4	1.1	18.1	35.8	0.17		

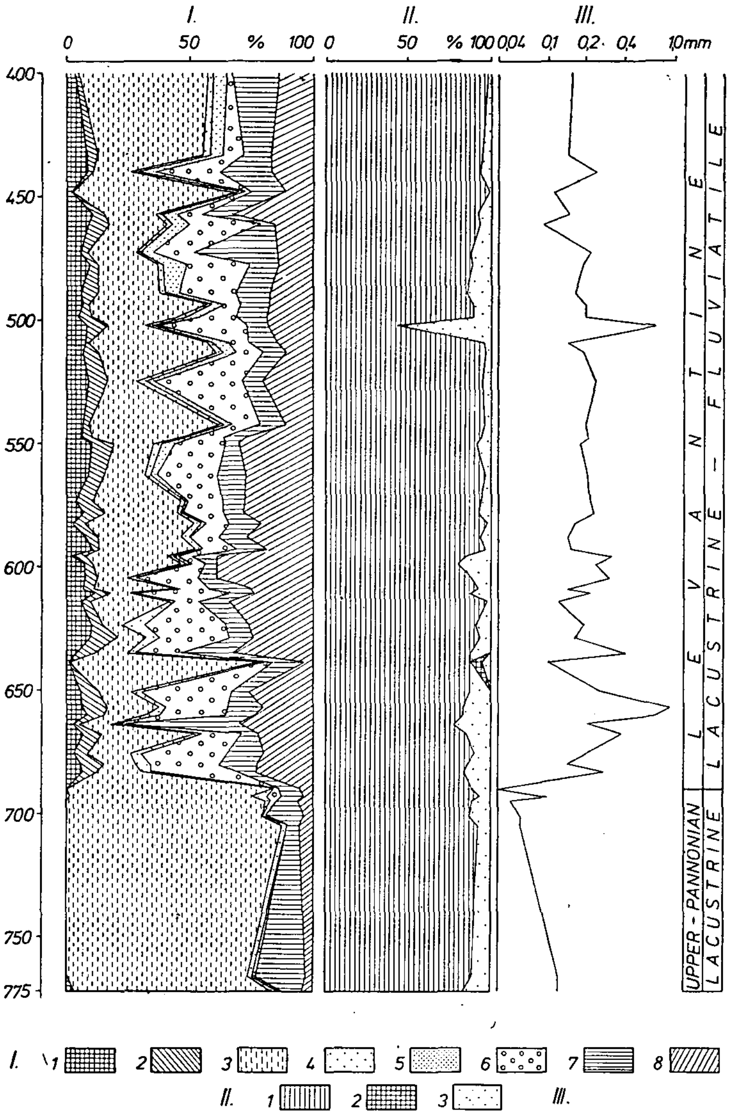

Fig. 1. Results of heavy mineral, grain-shape and grain-size analyses of the section between 400 and 775.8 m of the borehole at Nyárlőrinc

I. 1. hypersthene, other orthorhombic pyroxenes, augite and diopside, 2. magnetite-ilmenite, 3. chlorite, 4. epidote, 5. hornblende and actinolite-tremolite, 6. garnet, 7. other minerals together, 8. weathered mineral.

II. 1. sharp, splintery, 2. rounded, mat, 3. rounded bright-surfaced grains

III. Median grain diameter of the analyzed samples (Md-value)

INVESTIGATION RESULTS OF THE UPPER PLIOCENE (LEVANTINE) SEDIMENTS

The borehole of Nyárlőrinc explored the Levantine formations between 273 and 688 m, i.e. in a tickness of 415 m. After the profile of FRÁNYÓ, F. [1976] as well as according to our grain composition analysis the Levantine formations contain much more sand strata than the Upper Pannonian ones. 52 samples were investigated from the sequence and this is more than in case of the Upper Pannonian since the explored sequence is thicker and within the sequence there are more sand strata.

Previously, the sedimentological investigations demonstrated that the Levantine formations are of cyclic development, the sand strata within each cycles are arranged according to definite regularities [MOLNÁR, B., 1973]. In harmony with the former statements, the profile of Nyárlőrinc is of cyclic structure [MOLNÁR, B., 1973]. Regarding the grain composition of the section between 420 and 688 m this is a sequence which becomes finer from down. Between 113 and 420 m, reaching down to the Pliocene another sedimentary cycle can be distinguished with upward refining sediments.

The grain-size of sand strata of the sequence various between rather wide limits, i.e. between 0.08 and 1.2 mm. The sand strata are coarser in the lower and finer in the upper third of the sedimentary cycles (Tables 1—2, *Figs. 1—2*).

The heavy-mineral composition of the Levantine strata is more abundant than that of the Upper Pannonian. All samples contain several mineral species. In addition to the hypersthene and amphibole shown at the beginning of Table 1—2, in the sample the other orthorhombic pyroxenes, i.e. augite, diopside, magnetite-ilmenite and augite occur. This is fairly shown by the column of 1—2, of *Figs. 1—2*. The two combined columns pass through the whole Levantine without breaking as against the Upper Pannonian.

In the sequence chlorite plays a predominant role though as against the 80 percent of the Upper Pannonian strata its average quantity amounts here only to about 30 percent. Deviation is, however, rather significant, because its quantity varies between 2.1 and 73.2 percent and the wide limits of grain-size distribution is responsible for this, since this considerably affects the change of mineral composition. The decrease of chlorite as compared to the Upper Pannonian is unambiguous.

Epidote and clinozoisite occurred also in smaller quantites is most of the samples, as well as the hornblende when moving upwards. The quantity of garnet is also changing but is represented by about 15 to 20 percent being more abundant than in the Upper Pannonian. Garnet plays important role in composition, as well. The weathered mineral content of the Levantine is more than that of the Upper Pannonian but proved to be less than that of the Pleistocene. In two sites, i.e. in a depth of 472 resp. 663 metres the high quantities of carbonate minerals represented by 26.0 resp. 35.8 percent can be observed, and is indicated in Table 1 within the Levantine sequence. Nevertheless, this phenomenon is characteristic rather of the Pleistocene. In these samples the rock detritus of carbonate material is also important in addition to calcite and dolomite. The greater quantities of carbonate minerals of predominantly epigenic origin can be traced back to the more varying lacustrine-fluviatile sedimentation and to the climatic changes, respectively.

The photos of Plate II fairly show the more diversified mineral composition as compared to that of the Upper Pannonian. In the photos of the Upper Pannonian chlorite predominated, in these pictures, however, numerous other minerals can also be seen.

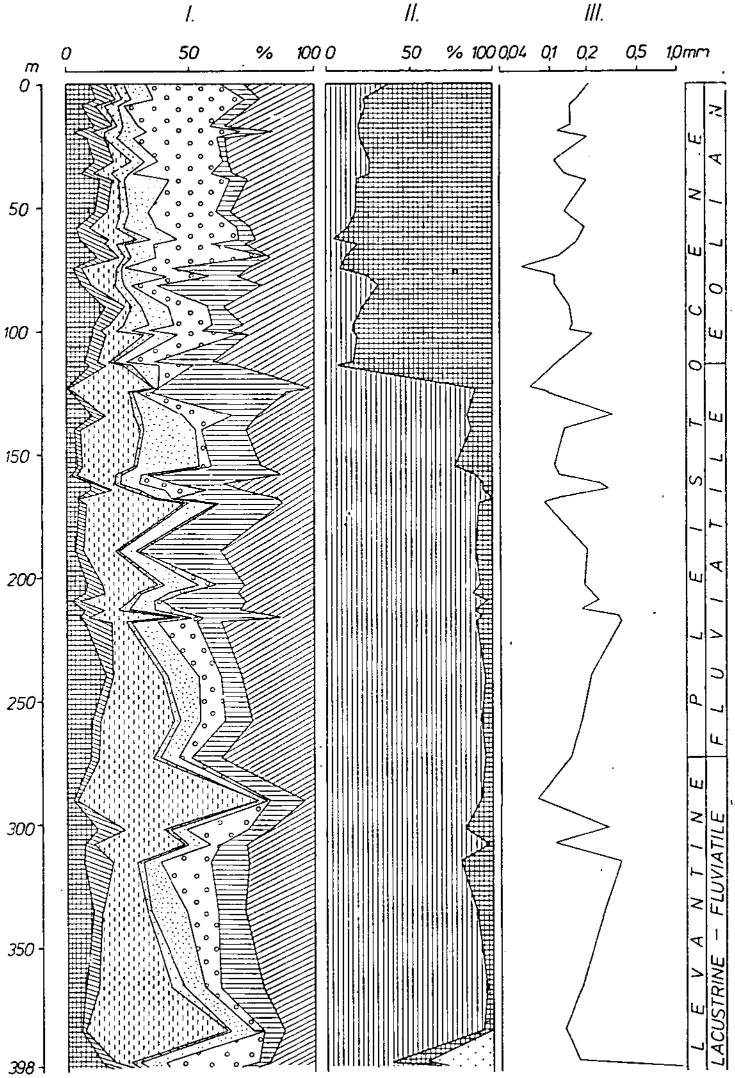

Fig. 2. Results of heavy mineral, grain-shape and grain-size analysis of the section between 0 and 400 m of the borehole at Nyárlőrinc

In the Levantine strata the CAILLEUX's grain-shape analysis have shown also mostly sharp splintery grains (*Figs. 1—2;* Table V, photo No. 3). The bright-surfaced slightly rounded grains reach greater amounts at two sites, i.e. between 396 and 398 m (24 to 40%) and in 501 m (57%). Out of the investigated strata these proved to be the coarsest ones, thus this is responsible for the extreme values. On the other hand, in the former lake-shore strip the wearing effect of the rolling sea might prevail to greater extent.

In the upper part of the Levantine when moving upward between 289 and 439 metres the rounded, unglazed aeolian quartz grains also occur in an average quantity of not more than 10 percent, but changing between 1.0 and 29.0%. At the same time, in the upper part of the Levantine, between 289 and 384 m the more rounded quartz grains eroded more considerably by water disappear. The appearance of the aeolian grains as well as the disappearance of the bright-surfaced rounded grains may be the "forecast" of the Pleistocene aeolian facies. Thus, in the Levantine though being more variegated than the Pannonian, the sharp splintery grains prevail which is fairly shown by the photo No. 3 of Plate V.

When summing up it can be stated that at Nyárlőrinc considerable change followed with respect to the source area after the sedimentation of the Upper Pannonian sequence. The Levantine, with its varying mineral composition is now similar to the mineral composition of the Danube alluvium [MOLNÁR, B., 1964]. The only difference is its greater chlorite content. Consequently, at Nyárlőrinc the "Danube Tectonic Trench" is filled up by the Danube since the Levantine. This might proceed in form of alluvium transported into the former lake.

INVESTIGATION RESULTS OF THE PLEISTOCENE SEQUENCE

The borehole explored the Pleistocene sequence between 0 and 273 metres. In this sequence the sand strata are frequent, thus 43 samples were analyzed. On the basis of the results the Pleistocene sequence can be divided into two parts: between 113.2 and 273.0 metres and between 0 and 113.2 metres, respectively. Their introduction follows this order.

Pleistocene fluviatile sequence

The section of the borehole between 113.2 and 273.0 metres, i.e. an interval of nearly 160 metres is the continuation of the sedimentary cycle started in the Levantine. From this section of 160 metres 20 samples were analyzed. According to the terminating phase of the sedimentary cycle the grain-size composition of the sands is somewhat finer than that of the underlying one. The grain-size varied between 0.07 and 0.36 mm, i.e. within relatively narrow interval. The grain-size composition of the coarsest samples did exceed the medium-grained sand, neither.

The heavy mineral composition of the Pleistocene sequence is the unbroken continuation of the underlying Levantine with the only difference that out of the igneous minerals the hypersthene and basaltic amphibole occurring previously only in the upper part of the Levantine become here more frequent (Table 2). The other minerals of igneous origin are of similar quantity as in the Levantine.

The extreme values of chlorite are only 6.3 and 39.9%. The average quantity is also somewhat lower than in the Levantine. This is shown also by column No. 3. I of *Fig. 2*. The metamorphic tourmaline, epidote, clinozoisite and kyanite occur nearly in all samples but all these minerals show a quantity of max 2%. Hornblende becomes ever significant from down upwards. In several samples it exceeds 10 percent, moreover in one samples its amount is 21.7%. In the Levantine its quantity reached or exceed 10 percent only once, i.e. 13%. Garnet is somewhat less than in the Levantine, its quantity varies randomly between 0 and 17 percent.

Calcite—dolomite resp. the carbonatic rock detritus showed extreme values in the Levantine only twice. Within the interval of 113.2—273.0 m of the Pleistocene their quantity exceeded 10 percent already in eight samples, moreover, in three samples its amount proved to be 30.0%, in one sample 43.1%.

The greater quantities of carbonate minerals can probably be explained by the climatic changes of the Pleistocene. It is well-known that the Levantine and Pleistocene strata of the Great Plain often contain lime concretions. A part of the carbonatic rock detritus of Nyárlőrinc is also fine lime concretion or the crumbled part of it.

It is worthy of mention in Table 2 the high percentages of the mineral assemblage denominated "other micas" consisting in this case predominantly of muscovite and sericite. It can be observed in several boreholes of the Great Plain that in the terminating phase of the sedimentary cycle, i.e. when low-energy fluviatile transportation took place, the mica of large specific surface accumulates, if it is present. The accumulation here can be explained also by this fact. The change in grain-size considerably influences the quantity of micas. In case of the finer-grained sand, for instance, the analyzed fraction of 0.1—0.2 mm means the coarsest part of the sample, which contains large quantities of mica. In case of coarser samples this proves to be inverted [MOLNÁR, B., 1969]. In this section of the Nyárlőrinc borehole the samples of same or nearly same grain-size composition contain rather different quantities of mica, i.e. muscovite or sericite. E.g. the samples No. 40 or 41 of Table 2, where 22.0 resp. 1.2% mica was found though both of the samples are nearly of the same grain-size, i.e. of 0.34 and 0.36 mm, respectively.

The weathered minerals slightly accumulate as compared to the Levantine. In the colder phases of the Pleistocene the chemical weathering affected the minerals but similarly to the Upper Pannonian or Levantine complete weathering can be observed only in less minerals, thus these minerals remain in the strata as weathered minerals.

The microphotos of the section between 113.2 and 273.0 m are shown by the pictures 1—2 of Plate II. As it can be seen, hornblende occur in greater amounts. Minerals occurring first or occurred only once can also be found, e.g. actinolite-tremolite. Consequently, the photos also indicate the ever varied mineral composition when moving upwards, i.e. to the Pleistocene strata.

According to the CAILLEUX's grain-shape analysis in this section of the Pleistocene sequence the quartz grains are also predominantly sharp and splintery (Plate V, Photos No· 1—2). The quantity of the sharp splintery grains varied between 85.4 and 100.0 percent. The slightly rounded, bright-surfaced partly water-worn grains are practically absent similarly to the upper part of the Levantine. On the contrary, the aeolian rounded, mat quartz grains are present in a quantity changing between 0 and 19%. Their appearance may be the forecast of the subsequent Pleistocene aeolian facies, as a continuation of the upper part of the Levantine.

It is seen from the fact above that similarly to the Levantine, the lower part of the Pleistocene sequence is the continuation of it as fluviatile deposition of Danube. Regarding its mineral composition the heavy mineral composition characteristic of the recent alluvium of Danube is much more emphasized as compared to that of the Levantine. This is reflected first of all by the smaller amounts of chlorite and by the greater amounts of hornblende. Thus, at Nyárlőrinc the filling role of Danube continued also in the Pleistocene.

Pleistocene aeolian sequence

In the Nyárlőrinc borehole 23 samples consisting of rather homogeneous mainly fine-grained sand were analyzed from the section between 0 and 113.2 m. The predominating grain-size of the samples varied between 0.06 and 0.22 mm. Only the grain-size composition of four samples differed from that of the fine-grained sands. Out of them two proved to be fine-grained, the grain-size composition of the others was shifted towards the medium-grained sands, the latter one reaching only max.

0.02 mm. This means that in this sedimentary sequence the sand strata were transported and deposited by a rather equilibrated average energy.

It is characteristic of the heavy mineral composition of the section between 0 and 113.2 m that the quantities of the minerals shown in column 1. I of Table 2, i.e. hypersthene and other orthorhombic pyroxenes, as well as those of augite and diopside together, increased as compared to the older sedimentary sequences. This is valid also of magnetite and ilmenite. It is a more significant change, however, that the chlorite quantity considerably decreased, its value varies between 0 and 15.5%, its average quantity varies only between 5 and 10%. Tourmaline, epidote and clinozoisite show similar quantities as the underlying Pleistocene fluviatile strata, i.e. their average quantity is about 2%, though in certain cases this amounts to 4%. Zoisite is insignificant. The quantities of amphibole are similar, those of actinolite-tremolite are somewhat lower. Important change is the considerable increase of the garnet quantity. Its quantity is above 10% in all samples, its extreme values vary between 10.0 and 44.8%. Its quantity increases upwards, in general.

The quantities of calcite—dolomite and of the carbonatic rock detritus, resp. shows random change, similarly to the Pleistocene fluviatile section. The extreme values vary between 0 and 25%, i.e. are somewhat lower than in the Pleistocene fluviatile sequence. Their appearance and the reason of it resp., are the same as in case of the Pleistocene fluviatile sequence.

Muscovite and sericite comprehended under the term "other micas" in the Tables were identified in ten out of the 23 samples. Their maximal quantity, however, proved to be 1.2% indicating the practical disappearance of these minerals from this sequence. The weathered mineral content varied between 16.0 and 40.5%, thus this value is greatest in the whole profile of the borehole. The reason if this can be traced back to the less intense chemical weathering of the cold Pleistocene climate, similarly to the Pleistocene fluviatile strata.

The total heavy mineral content of the fraction of 0.1—0.2 mm of the investigated samples which means practically the relation of heavy and light minerals in weight percent, seems to be rather uniform, i.e. between 0.5 and 7.6 percent. In the older part of the sequence the fluctuation proved to be more considerable. This is caused by the greater differences in the grain-size composition, further by the fact that the fluviatile transport could produce smaller "outcrops" which resulted in mineral accumulation within the sequence. This can be observed to greater extent in the older section of the profile.

The CAILLEUX's grain-shape analysis showed considerable changes in this part as compared to the former ones *(Fig. 2,* III*)*. While downwards the sharp splintery grains predominated, in the section between 0 and 113.2 m this was changed. Here the worn and mat grains become predominating, thus in harmony with the CAILLEUX-method the aeolian grains play preponderant role [CAILLEUX, A., 1952]. Upward from 113.2 m the maximal quantity of the sharp splintery grains amounts only to 35%. The quantity of the aeolian grains, however, varies between 64.1 and 94.9%. The slightly rounded bright-surfaced grains are lacking. The photos introduced in Plate VI fairly show this phenomenon. As against the previous stereomicroscopic photos here the strongly rounded grain prevail. The same phenomenon can be observed in case of the heavy minerals. The heavy minerals in Plates I and II are sharp and splintery, those in Plate III and IV are rounded.

The differences in heavy mineral composition indicate also the aeolian transport, e.g. the considerable percentual accumulation of magnetite, ilmenite and of the hard garnet, the considerable decrease of chlorite and micas. It is well-known that blown sands contain no or rather small quantity of mica.

Previous investigations indicated that in the Danube—Tisza Interfluve, thus also at Nyárlőrinc a thicker aeolian sequence is deposited consisting of aeolian sand and loess or of its varieties [Molnár, B., 1961]. The faunal analyses of E. Krolopp carried out in the material of Nyárlőrinc verified this fact. As to personal communication, in a depth of 124 m and below the material of Nyárlőrinc contains fluviatile molluscs. Above 124 m, however, no fluviatile species are found. The sand strata in 124 m of the Nyárlőrinc borehole are fluviatile also according to the grain-shape and heavy mineral analysis. Unfortunately, between 113.2 and 124 m finer sediment is found, thus this could not be analyzed. This silt layer, however, is the terminating phase of the fluviatile cycle following before the complete deceleration of filling and consisting of fine-grained material, thus it is closely assigned to the fluviatile facies.

The coincidence of data is not accidental and this proves the correctness of the previous investigations, i.e. that in the Danube—Tisza Interfluve at thicker aeolian sedimentary sequence is found.

The heavy mineral composition of the blown sand differs from the Pleistocene fluviatile strata only in the percentual quantities of the minerals compared to each other, otherwise the same minerals occur. Thus, in the meantime the source area did not change. The material of the blown sand derives also from the Danube alluvium. This sand, however, was developed so that it was transported by aeolian way through several ten kilometres. Consequently, the former fluviatile sand transformed into aeolian sand. The roundness value of sand grains are often higher even than those of the blown sand in the Danube—Tisza Interfluve. Thus, the sand got its recent position through being transported in a greater distance.

SUMMARY

On the basis of grain-size composition, micromineralogical and grain-shape investigations carried out in the Nyárlőrinc borehole the following conclusions can be drawn:

1. The material of the Nyárlőrinc borehole derives from source areas differing from each other.

(a) The Upper Pannonian section of the sequence is poor in heavy mineral species, it contains mostly metamorphic minerals, predominantly chlorite.

(b) The Levantine and Pleistocene part of the profile is rich in minerals. Its material of varied composition consisting mostly metamorphic minerals being nearly similar to the recent sand of the Danube derives from the river.Thus, Danube appeared in this area in the Early Pliocene (Levantine).

2. Regarding the material transport, in the Pleistocene sequence of the Nyárlőrinc borehole two phases can be distinguished. Between 113.2 and 273 m the fluviatile formation, while between 0 and 113.2 m the aeolian formation are characteristic. The material of both phases derive from the Danube. Sand was blown up from the Danube valley, and after aeolian transport through several ten kilometres it was deposited in its recent location.

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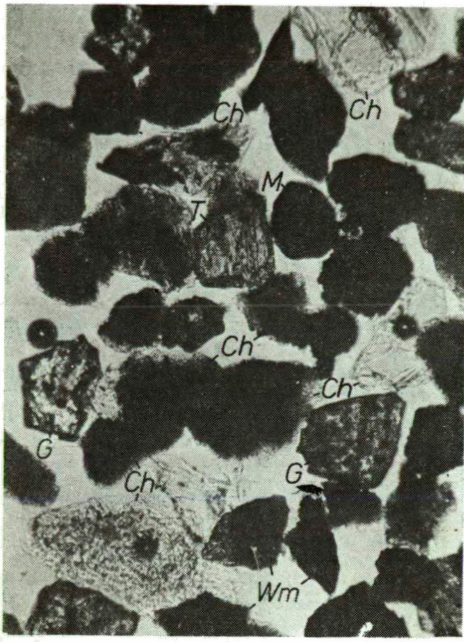
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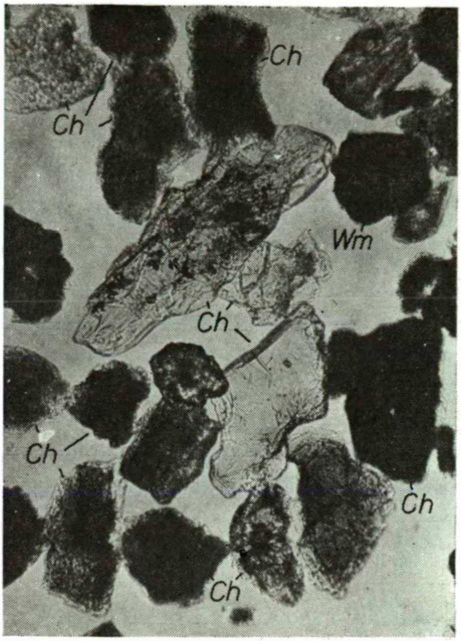
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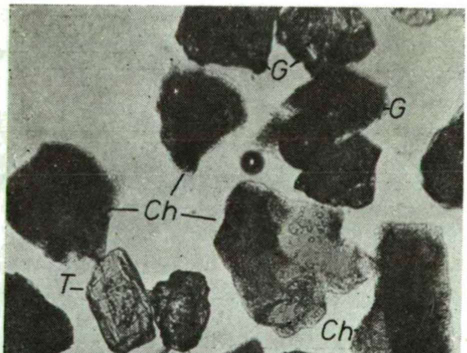
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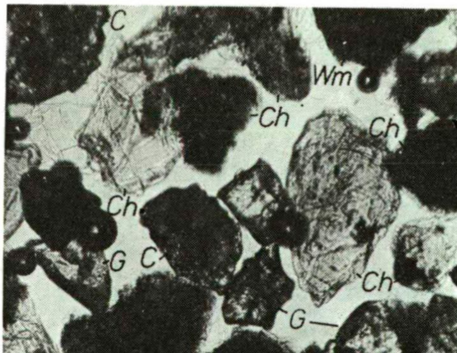
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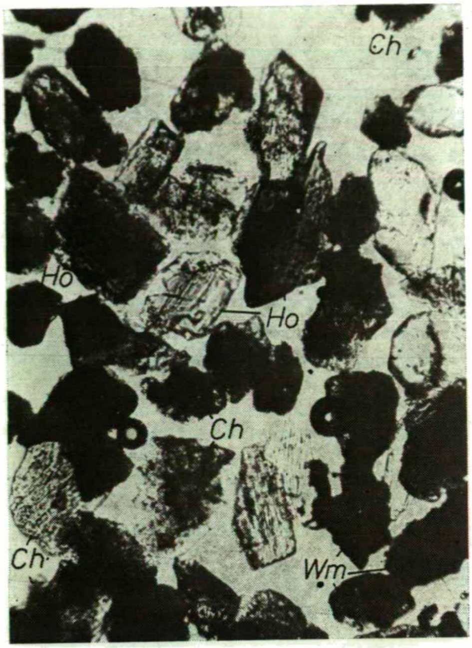
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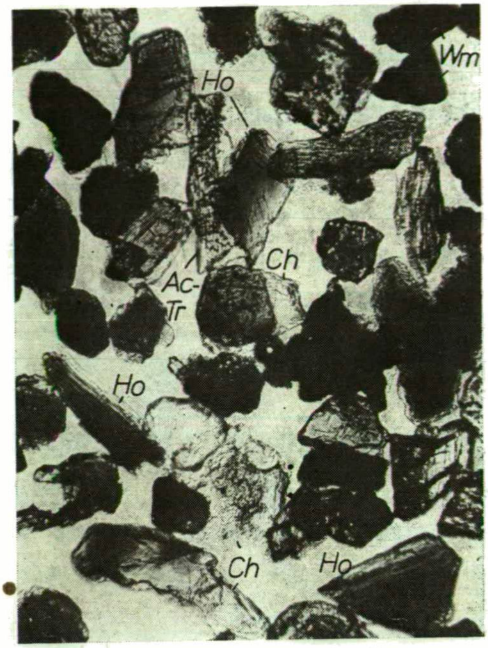
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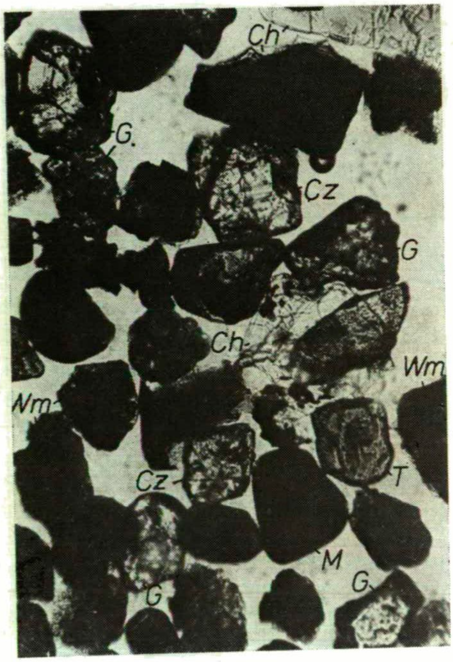
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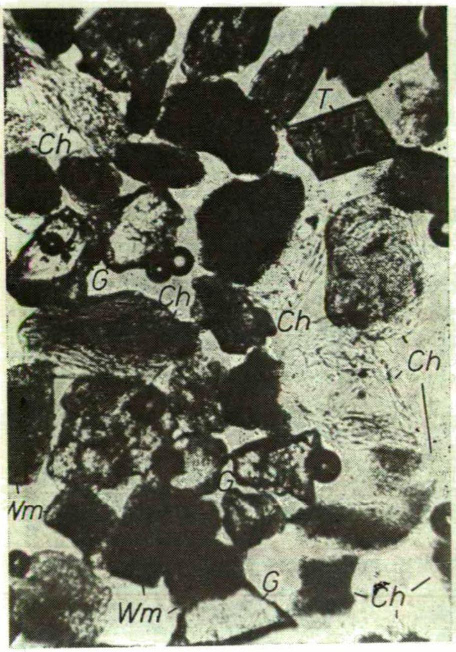
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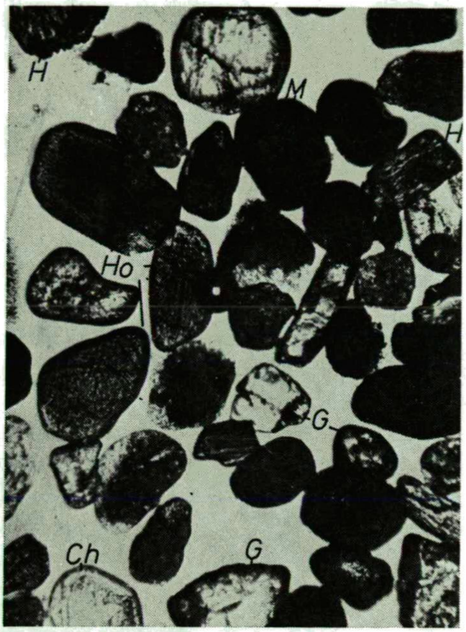

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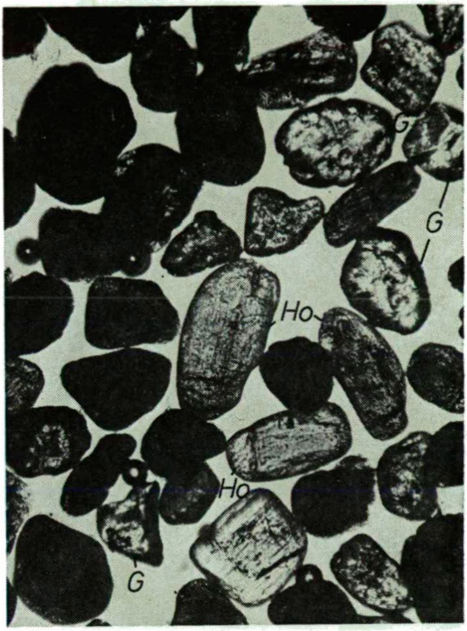

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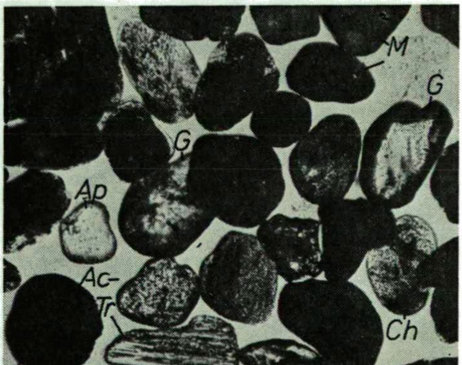

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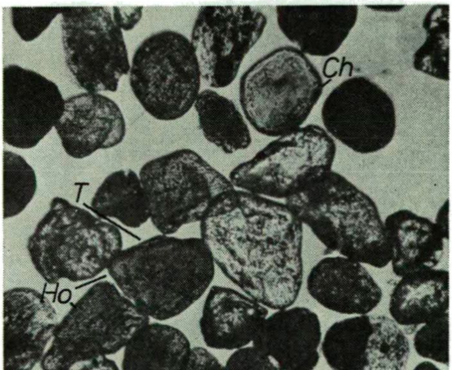

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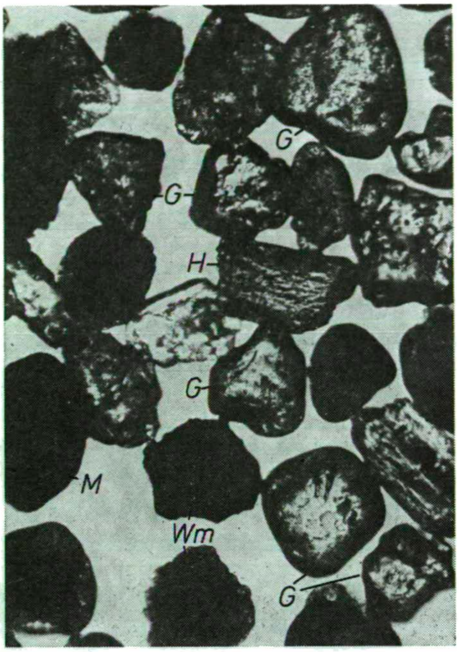

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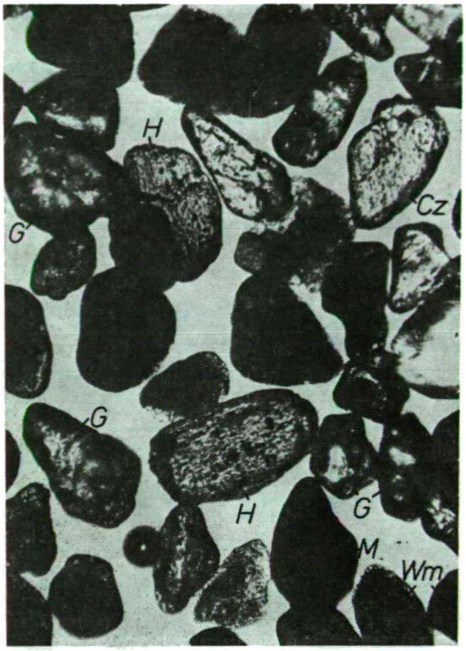

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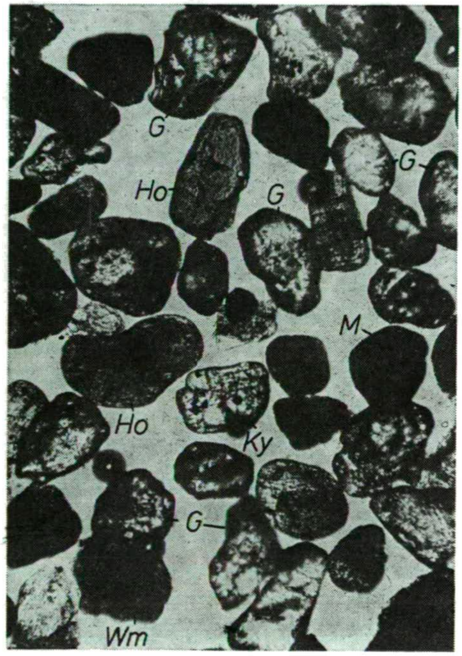

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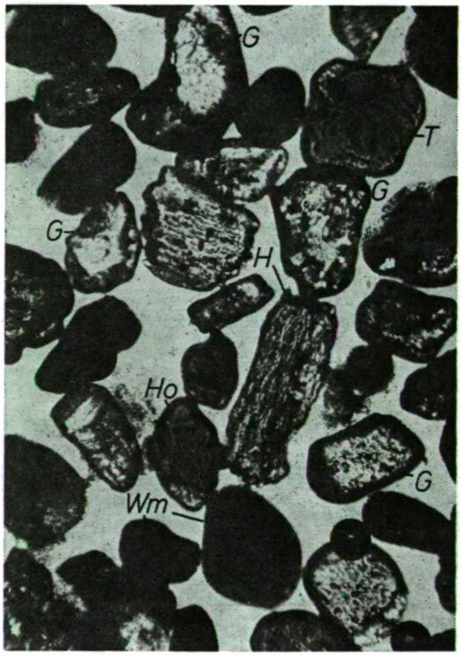

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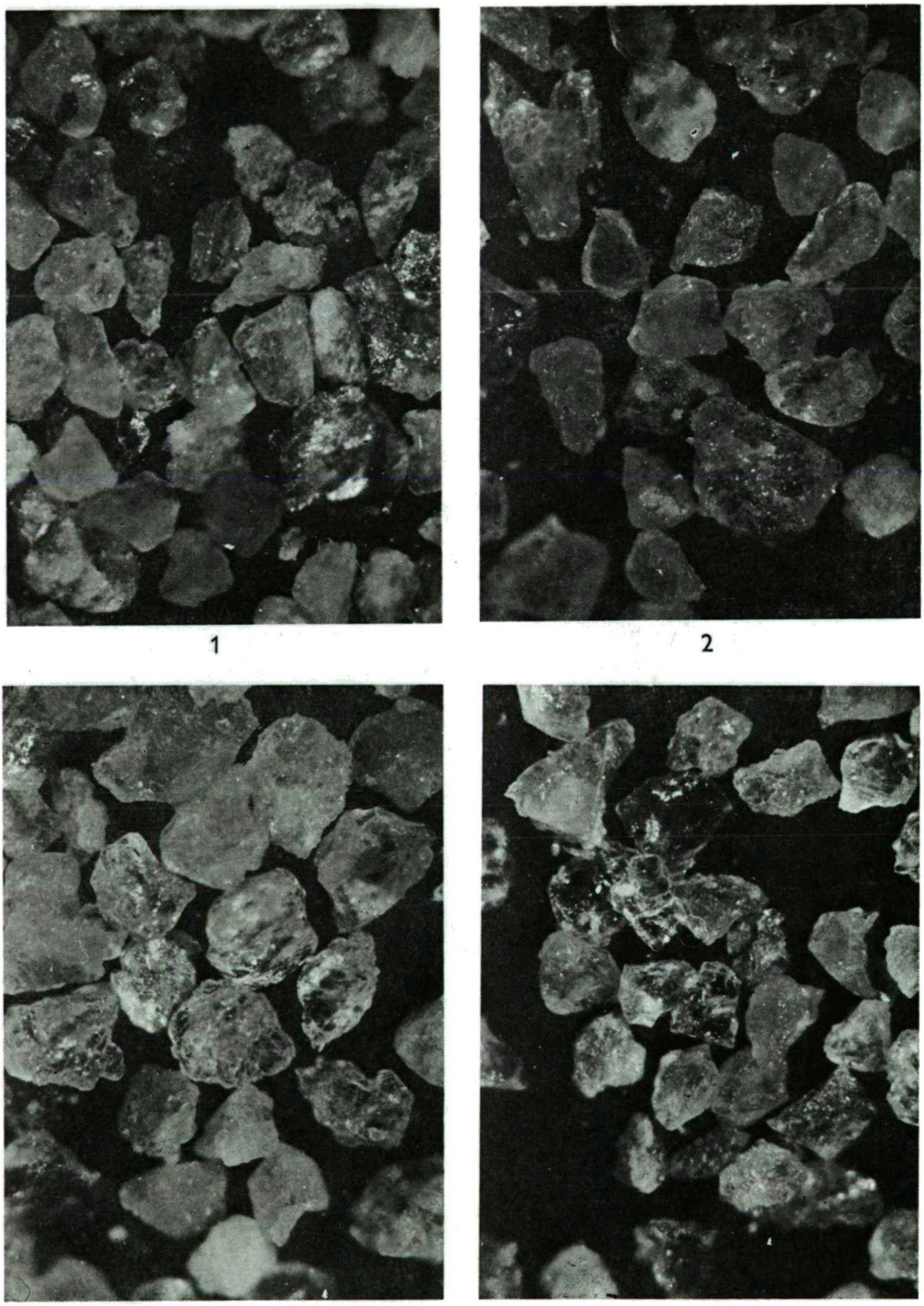

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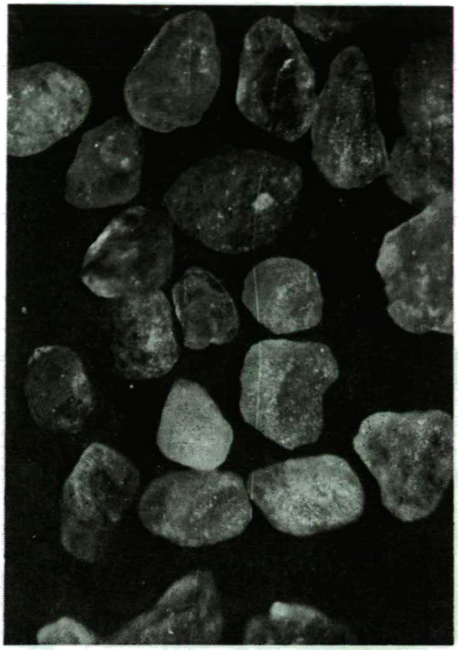

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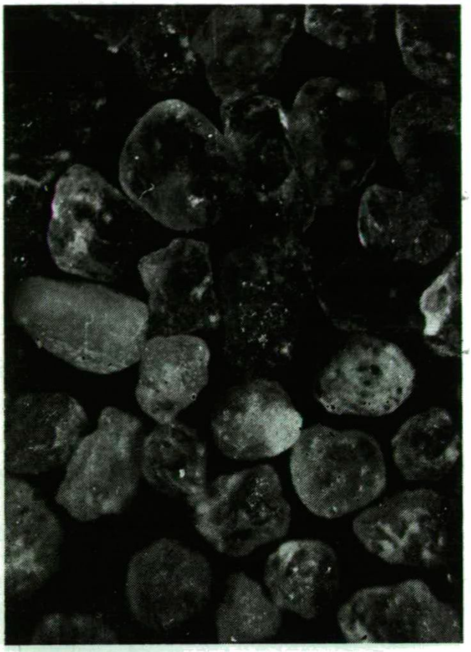

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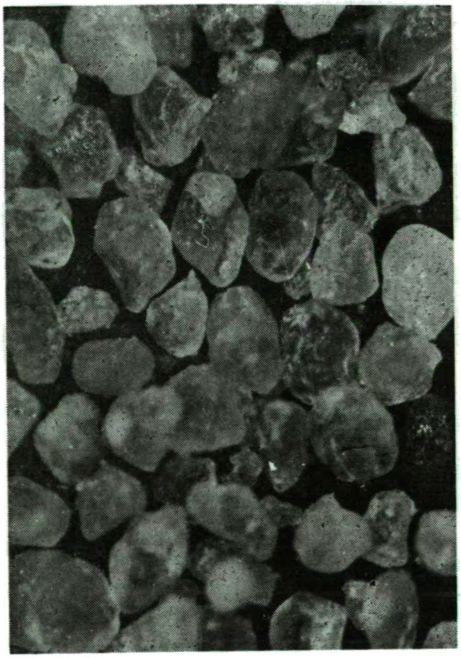

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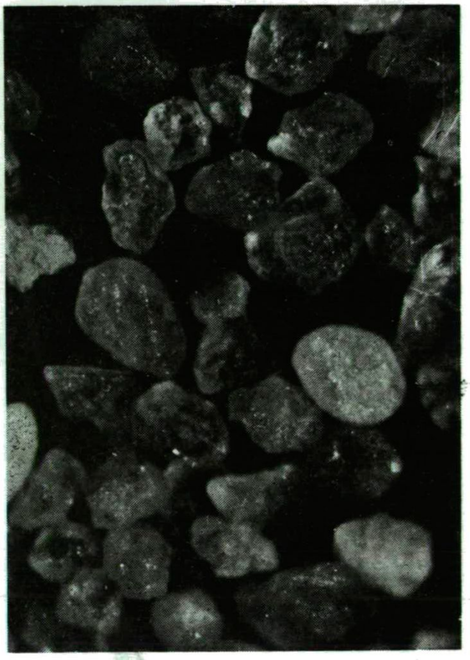

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Explanation of Plates I—VI

Plate I: Heavy minerals of sand samples of the Upper Pannonian (Pliocene) in the Nyárlőrinc borehole: The photos of plates I—IV were made by mineralogical microscope with paralleled nicols, interbedding the minerals in nitrobenzol of n=1.552. In all photos the heavy minerals of the 0.1—0.2 mm fraction can be seen. *Abbreviations of minerals: H:* hypersthene, *Au:* augite, *Di:* diopside, *BH:* basaltic amphibole, *M:* magnetite, *Ap:* apatite, *B:* biotite, *Ch:* chlorite, *T:* tourmaline, *Cz:* clinozoisite, *Ho:* hornblende, *Ac—Tr:* actinolite—tremolite, *G:* garnet, *Ky:* kyanite, *C:* calcite-dolomite, or carbonatic rock detritus, *Wm:* weathered mineral.

1. 692.67—694.60 m
2. 763.57—769.02 m
3. 769.30—775.08a m
4. 769.30—775.08b m

Plate II: Heavy minerals of the Pleistocene fluviatile (1—2) and Levantine fluviatile-lacustrine (3—4) sand samples from the Nyárlőrinc borehole.

1. 139.74—140.37 m
2. 154.7 m
3. 439.19—440.0 m
4. 496.69—500.0 m

Plate III: Heavy minerals of the Pleistocene blown sand samples from the Nyárlőrinc borehole.

1. 77.5 m
2. 89.60—90.81 m
3. 112.0 m
4. 113.2 m

Plate IV: Heavy minerals of the Pleistocene blown sand samples from the Nyárlőrinc borehole.

1. 2.0—3.0 m
2. 21.5 m
3. 31.0 m
4. 51.5 m

Plate V: The Pleistocene fluviatile (1—2), Levantine fluviatile-lacustrine (3) and Upper Pannonian lacustrine (4) sharp, splintery quartz grains. Photos of Plate V—VI were made under binocular stereomicroscope. The quartz grains assigned to the fractions 0.1—0.2 resp. 0.2—0.32 mm are shown.

1. 139.74—140.87 m
2. 158.0 m
3. 678.70—681.41 m
4. 769.30—775.08 m

Plate VI: Worn quartz grains of the Pleistocene blown-sand samples from the Nyárlőrinc borehole.

1. 8.5 m
2. 21.5 m
3. 81.0 m
4. 113.2 m