GEOLOGICAL, MINERALOGICAL AND PETROGRAPHICAL EXAMINATIONS IN THE COURSE OF EXPLORATIONS FOR BINDING RAW MATERIALS IN THE NEIGHBOURHOOD OF VÁC

GY. VITÁLIS and MRS. J. HEGYI-PAKÓ

Central Research and Design Institute for Silicate Industry, Budapest

INTRODUCTION

During the cement raw material explorations, — for the Cement and Lime Works Duna —, in the neighbourhood of Vác, detailed geological prospecting was made by our Institute on the limestone area Nagyszál and the clay area of Gombás *(Fig. 1.)*. 24 core drillings of about 3550 metres in the Nagyszál limestone district and 2660 metres of 56 core drillings in the Gombás clay area were made. The connected laboratory investigation of materials served first of all the purpose of qualification for cement and lime industrial use, beside the knowledge of the mineral and petrographical structure of the area.

THE LIMESTONE EXPLORATION AREA OF NAGYSZÁL

Geological conditions. The underlaying rock of usable raw materials in the area is the Triassic dolomite of Carnian age, to be found also on the SE border of the exploration area in a little hill on the surface. The drilling No XV—1 situated on the east side of the area, penetrated nearly 100 m, the drilling No XVI—3 67,7 m of thickness into the dolomite with calcareous dolomite interbeddings. Dachstein limestone layers of Norian age, formerly considered homogeneous, are to be found in the overlaying of the dolomite series, with clayey limestone, dolomitic limestone, calcareous dolomite, even subordinately dolomite interbeddings. These ware penetrated in some places, with drillings, 200 m thick *(Fig. 2)*. The dolomitic interbeddings of the limestone formations are partly of syngenetic, partly of late hydrothermal origin.

The karstic cavities of limestone stratas are filled with red and brown Pleistocene clay, — with debris of limestone and sandstone —, silty clay, and sandy clay. In some karstic holes of Norian limestones, in the depth of 20, 30, 70, even 105 m below surface, as filling „Hárshegy" sandstone of subgressive origin, Oligocene age, conglomerate and breccia can be observed too. Taking these into account, in the karstic symptoms of the limestone we can separate with certainity a period before Lower-Oligocene and a Post-Oligocene period.

The limestone series area is covered, in connection with the fractured structure, with „Hárshegy” sandstone and conglomerate layers of various 0—60 m thickness, depending upon the individual blocks.

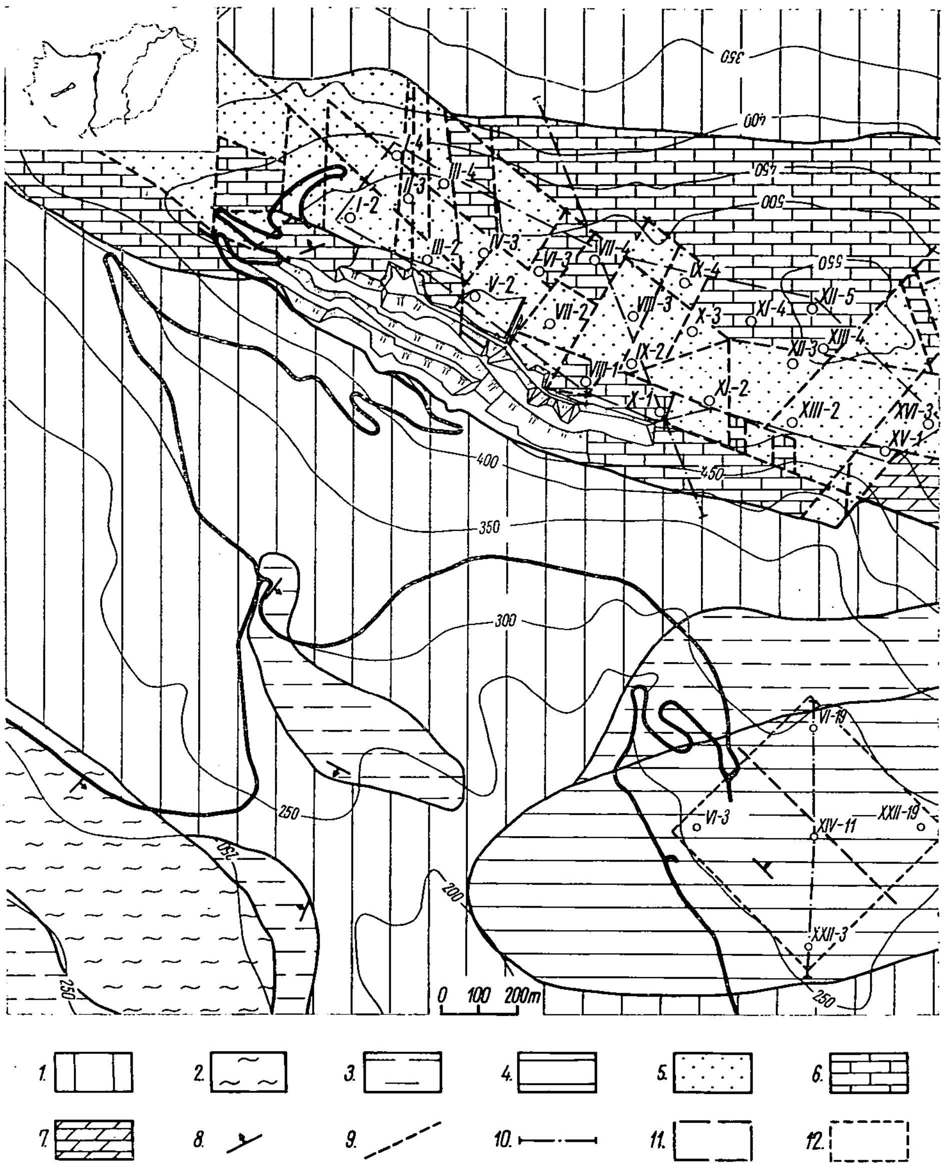

Fig. 1. Geological sketch map of raw material exploration in the surrounding areas of Vác. (After L. JUGOVICS and F. SZENTES with supplement.)
1. Sandy clay, loess, talus (Pleistocene). *2.* Sand, clay-marl (Helvetian). *3.* Clayey sand, sand, sandstone (Kattian). *4.* Marly aleurite (Rupelian). *5.* „Hárshegy” sandstone and conglomerate (Lattorfian). *6.* Dachstein limestone (Norian). *7.* Dolomite (Karn). *8.* Dip. *9.* Fault. *10.* Line of profile. *11.* Limestone exploration area Nagyszál. *12.* Clay exploration area Gombás.

We determined exactly the cavities in the limestone, the depth of fractured layers, clayey sections, depth of sandstone interbeddings — with drillings and electrical loggings with the methods: gamma-ray, gamma-gamma-ray and gamma-ray neutron. The method of this is shown on a part of the drilling log No IV—3 *(Fig.4)*.

1—3 cm thick calcite veins were observed in the filling of larger joints in the limestone stratas seen in operating quarry. The calcite veins refer to former thermal spring activity. During which the hydrothermal metasomatose, caused by thermal springs, — on the greatest part of the area —, dolomitized the limestone in various degrees.

Geological structure. The uplifted horst of the Nagyszál mountains along WNW-ESE longitudinal fractures, is dissected on the whole by transversal faults with directions of NE-SW and N-S *(Fig. 1)*. Average of dip angle of faults is 65°. The limestone strata of the exploration area Nagyszál dips averagely 30°, in the direction NNW, — on base of measurements made in the quarry. The smallest dip angle is 20°, the greatest 45° *(Fig. 2)*.

According to the investigations of chemical and mineralogical composition, the comparative distribution of rock sorts, penetrated in the 24 exploration holes of the area Nagyszál, till the depth of 420 m, are the following:

Sort of rock	Percent
Clay, silt and rock debris (Pleistocene)	5,10
Sandstone and conglomerate (Lower-Oligocene)	11,30
Limestone (Upper Triassic)	52,97
Limestone, clayey and clayey soiled (Upper Triassic)	5,84
Limestone with dolomite (Upper Triassic)	10,65
Calcareous dolomite (Upper Triassic)	10,05
Dolomite (Upper Triassic)	4,09

Table 1 contains the average and extreme values of the rocks chemical composition. The presence of the sandy, clayey, dolomitic stain to be seen from this, was shown by the thermal (derivatographic) and X-ray diffractogram investigations too.

On *Fig. 3/a* a derivatogram of a Dachstein limestone sample is shown, from the bore hole VIII—3, depth 105,0 m, situated in the middle part of the area. Beside the endotherm calcite peak, near to 950 or 900° C of the DTG and DTA curves, no other curve or peak can be observed referring to other crystalline component.

The value of 98, 96% $CaCO_3$, calculated from the analysis of the sample, corresponds very well with the 99,14% calcite content computed from the TG curve. *Fig. 3/b* is the derivatogram of the dolomitic limestone from the depth 146,0 m of the bore hole No VIII—3. A steep endotherm peak is to be seen with a 770° C temperature maximum, before the calcite peak near to 900° C, characteristic for the decomposition of magnesium-carbonate of dolomites. The CaO content of the sample is 46,57, the MgO content 7,47%. Dolomite content, calculated from the TG curve is 35%. On *Fig. 3/c* a derivatogram of a dolomite is to be seen, from the depth 136,0 m of bore hole VIII—3. The first endothermic peak here, originating from decomposition of $MgCO_3$ is by far greater than the former. CaO content of the sample is 32,62%, MgO content is 19,12%. The dolomite content calculated from the TG curve is 87%.

According to thermal and X-ray investigations, contaminating material of the Norian Dachstein limestone in the area is dolomite, quartz, clay mineral and feldspar.

Table 1

Average and extreme values of chemical analyses*

	Loss on ignition	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	SO_3	$CaCO_3$
	Per cent by weight									
Limestone (Upper Triassic)										
Minimum	41,68	0,09	0,01	0,01	51,36	0,09	0,02	0,01	0,01	91,68
Maximum	44,34	3,61	1,28	0,57	55,97	2,20	0,50	0,22	0,05	99,91
Average	43,08	0,74	0,23	0,12	55,05	0,50	0,21	0,11	0,02	98,26
Clayey and clayey coloured limestone (Upper Triassic)										
Minimum	13,48	6,48	0,65	0,41	15,92	0,10	0,17	0,16	0,01	28,42
Maximum	38,77	65,63	8,36	6,67	49,61	1,41	1,08	0,80	0,08	88,55
Average	29,54	26,31	4,46	2,04	36,07	0,56	0,51	0,44	0,04	67,95
Dolomitic limestone (Upper Triassic)										
Minimum	37,10	0,32	0,01	0,01	42,73	2,39	0,02	0,01	0,01	—
Maximum	45,90	12,11	0,88	14,74	53,54	11,60	0,49	0,19	0,70	—
Average	43,13	1,37	0,23	1,55	47,27	6,07	0,25	0,11	0,02	—
Calcareous dolomite (Upper Triassic)										
Minimum	41,91	0,10	0,07	0,07	33,17	10,74	0,12	0,05	0,01	—
Maximum	47,11	5,21	1,10	2,32	42,75	19,69	1,07	1,90	0,07	—
Average	45,84	0,67	0,30	0,44	35,98	16,52	0,38	0,21	0,02	—
Dolomite (Upper Triassic)										
Minimum	31,78	0,32	0,09	0,12	20,37	13,56	0,44	0,14	0,02	—
Maximum	46,39	15,15	7,41	10,37	32,16	20,94	0,68	0,43	0,02	—
Average	41,40	7,25	2,04	3,21	27,99	17,62	0,56	0,25	0,02	—
Marly aleurite (Middle Oligocene)										
Minimum	4,28	28,78	2,47	0,82	2,09	0,10	0,13	0,02	0,01	3,73
Maximum	30,73	78,23	18,19	7,02	25,00	10,58	2,15	2,56	3,98	44,63
Average	13,14	51,82	13,73	5,17	9,56	2,41	0,58	1,80	0,71	17,75
Rock floured clayey silt (Pleistocene)										
Minimum	7,89	49,43	10,50	3,63	6,15	2,04	0,54	1,41	0,02	10,98
Maximum	15,18	63,10	14,60	5,88	14,28	3,52	1,02	2,55	2,18	25,49
Average	11,78	54,28	12,97	4,82	9,25	2,92	0,80	2,12	0,30	16,61

* Remarks: Maximum and minimum values in the Table, are not everywhere datas of the same rock samples.

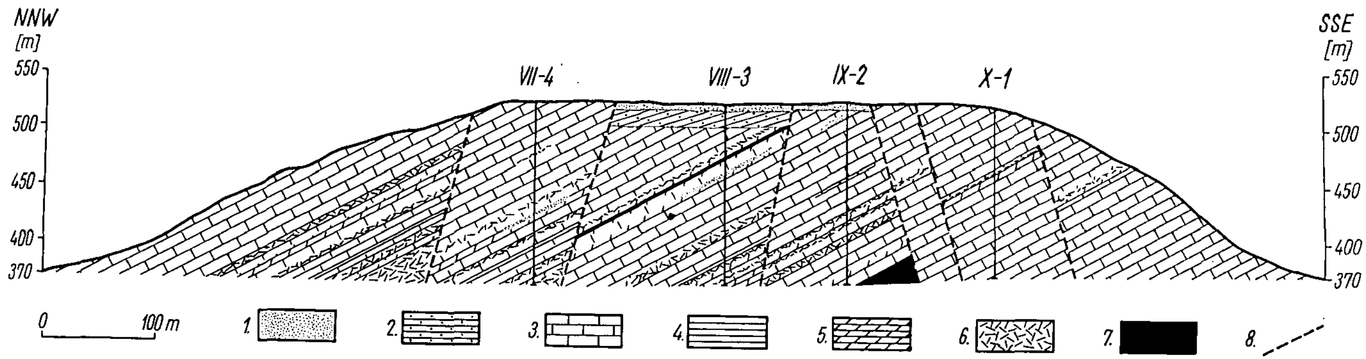

Fig. 2. Geological profile of limestone exploration area Nagyszál. *1*. Clay, silt, sand, small gravel (Pleistocene) covering surface and filling cavities. *2*. Sandstone and conglomerate (Lower Oligocene). *3*. Dachstein limestone. *4*. Clay and clayey coloured limestone. *5*. Dolomitic limestone. *6*. Calcareous dolomite. *7*. Dolomite (Upper Triassic). *8*. Fault.

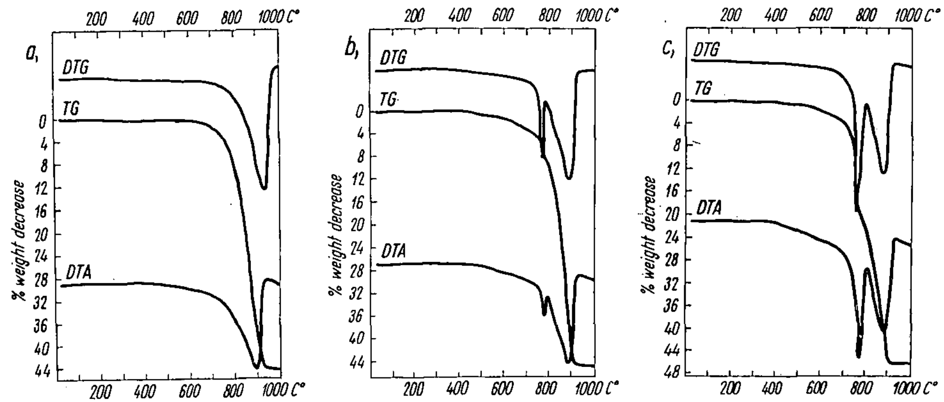

Fig. 3. Thermal curves of Upper Triassic Dachstein limestone (a), dolomitic limestone (b) and dolomite (c) from No VIII-3 boring, Nagyszál.

In the course of our investigations we looked for a connection between the technological characteristics and the results of geophysical examinations made in the bore holes. We show on *Fig. 4* the geophysical and exploitability profile of the interval between 30—130 m from well No IV—3, indicating fluid losses too, observed

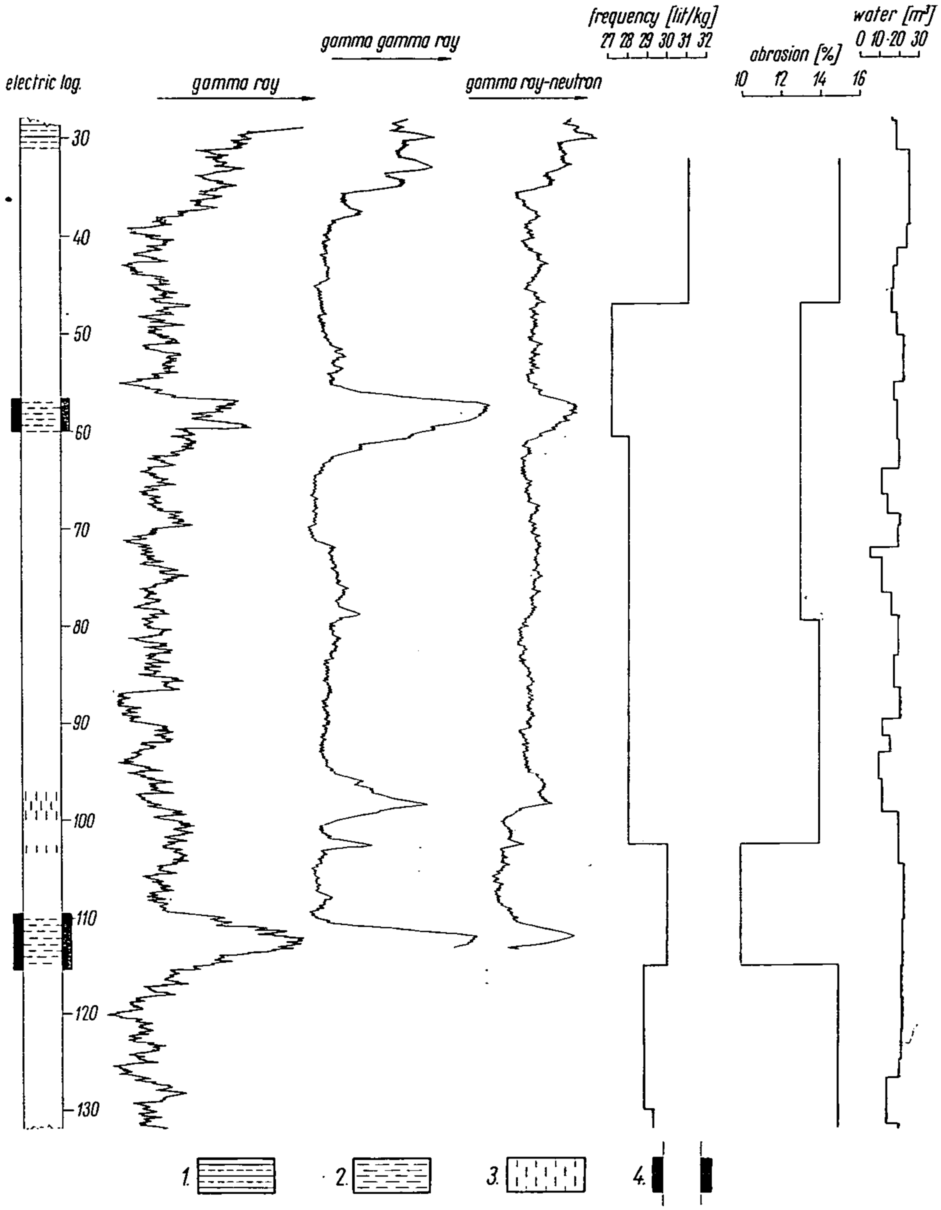

Fig. 4. Radioactive and exploitability profile from depth interval 30—130 m of bore hole No IV-3. Nagyszál, — with drilling fluid losses. *1.* Sandstone. *2.* Clay interbedding. *3.* Fissures. *4.* Cavern.

during drilling. After the evidence of radioactive measurings made in the holes, we marked the cavernous, clay stained and broken intervals. The average samples taken for technological examinations, — in the given section —, are from the depth intervals of 32,2—46,9; 46,9—60,5; 60,5—79,5; 79,5—102,6; 102,6—115,0 and 115,0—130,0 metres.

It became evident, that the values of frequency and wear out are generally in connection with radiological profiles. So for example the increase and wear out values show a decrease of raw material quality in the depth between 60—110 m, with caverns, clayey impurity. Data referring to the quantity of used drilling water, or loss of water, are mostly in connection with karstic features and the changing of rock quality.

THE CLAY EXPLORATION AREA OF GOMBÁS

Geological conditions. The base of usable raw material in the area is „Hárshegy" sandstone and conglomerate, Lower Oligocene, tectonically broken up chessboard like.

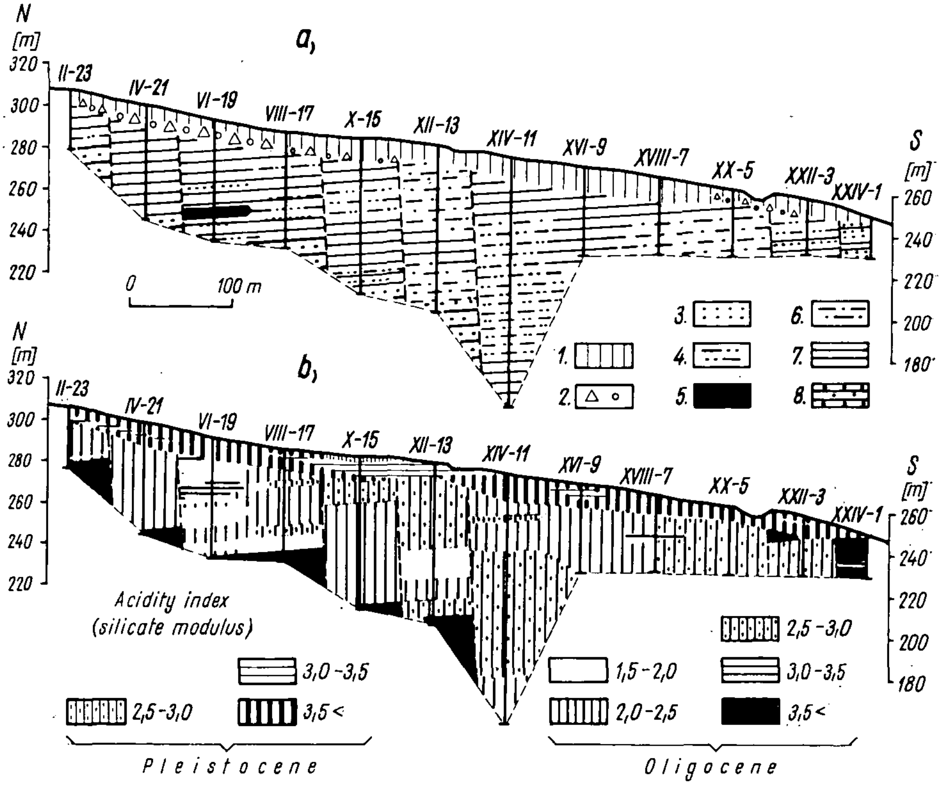

Fig. 5. Geological (a) and Silicate Module (b) profiles of clay exploration area Gombás. *1.* Clay formation coverstrata. *2.* Gravel and talus (Pleistocene). *3.* Fine and small grained loose sandstone, sand. *4.* Fine sanded marly aleurite. *5.* Aleurite with sandstone streaks. *6.* Partly fine sanded marly aleurite. *7.* Marly aleurite (Middle Oligocene); *8.* Sandstone and conglomerate (Lower Oligocene).

The raw material to be used for the cement industry is composed from marly aleurite, in some places with thin fine grained sandstone and sand stratas, which belong to the formation of „Kiscell clay", Upper-Oligocene.

An Upper-Oligocene sand-sandstone strata of great thickness, contacts with the former, along joints.

Pleistocene clay, silty clay, sandy clay, boulders and gravel transferred from talus (0—16 m thick) composes the layer upon Oligocene. The situation of clayey and gravely stratas to each and to the Oligocene stratas is conform.

Geological and exploitability relations of the Gombás area are shown on *Fig. 5*, with a geological (a) and a silicate module (b) profile.

Geological structure. The directions of fractures observed in the explored area correspond with the course of fractures drafted upon datas of drillings. It is similar with the structural directions of the Rupelian, Kattian and Helvetian formations in the area. The marly aleurite stratas, — on the SW side of the NW-SE course main fault, middle part of the region —, are everywhere more than 100 m thick. The underlying sandstone and conglomerate strata is, in the NE part of the exploration area, because of faults, near the surface, proceeding toward NE, the thickness of usuable raw material decreases.

A trace of former thermal spring activity, connected with tectonic movements, can be observed in the marly aleurite strata too. The hydrothermal alterations, because of the water sealing quality of marly aleurite, are only to be observed near the bottom sandstone stratas. They are present in drillings generally with a thickness of 0,1—0,7 m.

The average and extreme values of *chemical analyses* made on the rock samples of drilling in the area, are included in Table 1.

The typical thermograms of Middle-Oligocene marly aleurite are shown in *Fig. 6.*

According to the thermogram shown on *Fig. 6/a,* the sample taken from 15,0 m contains calcite, a small quantity of clay mineral and, on base of X-ray diffraction investigations quartz and feldspar too. The great exothermic peak around 400° C, on the DTA curve of *Fig. 6/b* is characteristic for pyrite. On the DTA curve of the hydrothermally decomposed marly aleurite, — shown on *Fig. 6/c* —, the pointed

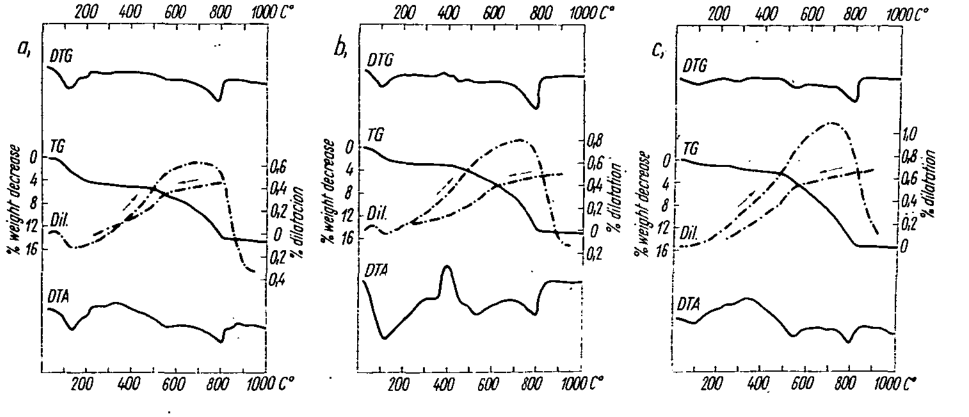

Fig. 6. Thermal curve of Middle Oligocene marly aleurite (a), pyritic marly aleurite (b), and marly aleurite decomposed hydrothermally (c) from bore hole No XXII-19, Gombás.

exothermic peak, characteristic for pyrite, vanished, instead of it an exothermic peak can be seen. This difference between DTA curves of pyritic fresh and hydrothermally altered rock samples can be observed in case of other samples too. All three types of clay-minerals (kaolinite, illite, montmorillonite) can be shown in drilling samples clay-mineral character is in no case definite, thermograms on DTA and DTG curves of the clay-minerals components are presumably badly crystallized or of mixed structure.

We made grain size distribution curves with hydrometrisation from typical materials of the area. These investigations were made in two states of conditions (normal or maximally peptized with Na_2CO_3). We publish the cover curves of grain size distribution belonging to two conditions, on *Fig. 7.* In accordance with the

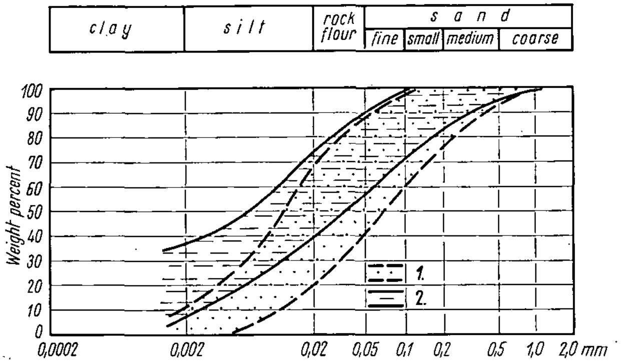

Fig. 7. Grain size composition cover curves of the Middle Oligocene marly aleurite exploited in area Gombás.
1. Normal state. *2.* Peptized state.

curves, the „Kiscell-clay", mapped and known by this name in literature, is really no clay, but as the thermal examinations and grain size distribution curves prove, marly aleurite, according to the fractions of bounded silty rock flour, rock floured silt, and subordinately rock floured clayey silt. With the remark marly, we tried to emphasize the carbonate content and binding of clay.

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DR. GYÖRGY VITÁLIS
MRS. J. HEGYI PAKÓ
Central Research and Design
Institute for Silicate Industry
Bihari u. 6.
Budapest X, Hungary