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GEOLOGICAL STRUCTURE OF THE SOUTHERN PART OF THE GREAT HUNGARIAN PLAIN.

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(With 29 Figures and 5 Tables.)

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I. Introduction.

The great Hungarian Plain or Alföld first attracted the attention of the oil exploring geologists, when it was proved that the inner rim of the Carpathians, in contrast to Galicia, was unfit for greater accumulations of oil owing to its extremely indeterminate structure. Geological investigations succeeded in discovering traces of oil in the Kárpátalja, natural gas in Transsylvania and in the

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small oil field of Bükkszék. In Transdanubia the Hungarian American Oil Industry Co. worked on the oil fields of Lispe, Lovászi and Hahót in the years 1937 to 1945 attaining a daily output of about 11.300 barrels of oil. It was evident that the search for hydrocarbons should be reassumed in the Great Plain too, in spite of the fact that the Hungarian Fisc had drilled their deep wells without any particular results. The work was started in 1940. The results obtained till the end of 1944 will be reviewed in brief in the following lines. The writer expresses his hopes that this work will not cease entirely after world war II but has only been postponed, and that the further exploration of the Great Plain will be reassumed very soon.

II. Former Assumptions as to the Geological Structure of the Great Plain.

J. Böckh, the explorer of the oil field Egbell on the basis of salt dome examinations in Transylvania assumed that the salt formation must also exist in the Great Plain. He further assumed that this formation in the Great Plain is much folded and disturbed in its general development, and therefore offers a favourable foundation for the accumulation of hydrocarbons (1).

Professor E. Cholnoky conceived the Great Plain to be a continuous basin the rims of which have sunk and form a large and steep block fault system. The well Budapest-Városliget 1. served as a foundation to his theory. About 3 kms East of the Danube, at a depth of about 3.200 ft, this well has struck the Trias dolomite strata which crop up on the right bank of the Danube. He further assumes that the Danube and the Tisza have taken their courses along great fault lines (2).

Professor L. de Loczy jun. however, formulated the best theory. It is as follows:

The Great Plain is a continous large basin. While in the Mesosoic period, in Transdanubia and at the rim of the Great Plain, the Hungarian Central Mountains were formed (Bakony, Vértes, Pilis, Bükk, Mecsek and Villányi Mountains), the Great Plain was a continuous inland sea. The elevation of the Alföld began only after the Upper Cretaceous period This elevation must be considered as the result of epirogenic movements in the course of which the pretertiary fold- and thrust structures were succeeded by fault structures. At the beginning of the Eocene period the whole Plain was a continuous

mainland. In the Oligocene and Miocene periods again a depression followed which reached its maximum between Upper- and Lower Mediterranian. During this period several transgressions and regressions alternated. The transgressions were connected with orogenic phases and the regressions with sedimentation. The second sinking of the Great Plain was not uniform. Thus the older Miocene- and Paleocene sea did not overflow the whole region, but only formed broad channels along the line Budapest—Miskolc—Eperjes and gulfs in the region of the present districts of Békés and Csanád. In the Upper Mediterrane the whole region was then uniformly inundated. In the Upper Pliocene the territory became again a uniform continent. After the Levantiian the brooks and rivers formed fresh water ponds and swamps (3).

In consequence of the supposition that amongst the Tertiary sediments there might also be hydrocarbonous deposits — (in very many Artesian water wells smaller amounts of marsh gas and methane have been found) — the Hungarian Fisc drilled several deep wells the geological results of which are compiled in table No. 1. As regards hydrocarbons these wells cannot be said to have been very successful (4). Besides unimportant traces of oil and asphalt, only in the following wells more considerable amounts of gas have been found:

Hajdúszoboszló 1.	130.647	cu ft/day
Hajdúszoboszló 2.	116.523	„
Karcag 1.	141.522	„
Karcag 2.	38.982	„
Debrecen 1 + 2.	150.067	„
Total:	577.741	cu ft/day.

The gas consists of 98 per cent methane and can only be exploited together with great quantities of water.

The well Baja 1., also mentioned in table I, was sunk by the Anglo-Persian Oil Co., and the well Tiszakürt 1. by the Hungarian American Oil Industry Co. by order of the State.

III. Geophysical Preparatory Work.

Torsion Balance Measurements.

The earlier torsion balance measurements were limited to the region of Makó—Arad (1908—09) and to the region of Baja—Kecskemét—Debrecen—Hajduszoboszló and some smaller districts on the

northern edge of he Great Plain (1920—40) (5). In 1940 these measurements were extended to the so called „gas-region" east of the Tisza, where the small structure of Tótkomlós NW. of Mezőhegyes was surveyed. After this, in 1940—43, the gravity structures of Battonya, Ferencszállás and Sándorfalva were determined by means of the torsion balance. As a starting point the gravity value $\triangle g = 20{,}05 \cdot 10^{-3}$ c.g.s., found near Makó in 1908 by Oltay was chosen. These measurements were executed by the Royal Hung. Baron Roland Eötvös Institute under the direction of Mr. E. Fekete and Mr. E. Bassó.

At the same time the „Seismos" Ltd., Hannover, was charged to survey the whole territory south of the line Dunaföldvár—Kecskemét—Körös river—Mezőtur—Püspökladány—Kismarja—Nagyvárad. To speed this work up the „Gesellschaft für praktische Lagerstättenforschung", Berlin, was also called upon later to help and carried on its work in the Bácska. Both these contractors used the Thyssen—Bornemissza Gravimeter. The results obtained from torsion balance and from the gravimeter agree very well. There are, it is true, some differences in the gravity values; but these are merely due to the fact that the torsion balance gives the values without the Bouguer correction.

By these extensive works the gravity chart of the entire southern part of the Great Plain has been compiled (Fig. 1, 2). A total of 27 marked gravity maxima and 20 minima was found. The measurements have also been extended to the mountains at the rim of the Great Plain in order to make possible a better interpretation of the results.

The more conspicuous gravity structures were then checked by seismic investigations. The seismic measurements comprised reflection and refraction methods, and were executed by the „Seismos" Ltd. Hannover, and by the „Gesellschaft für praktische Lagerstättenforschung", Berlin, with 12 seismograph apparatuses. In the velocity curves two marked velocities could be observed: viz. one of 3,500 m/sec and one of 6,000 m/sec. Moreover seismic measurements have confirmed the supposition that the gravity measurements give the gravity diagram of the basin's substructure. It could be gathered from the measurements that most of the gravity maxima are to be interpreted as marked elevations of the base rock. Greater discrepancies, evidently caused by a difference in the specific gravity of the rocks, turned up in the structures Sándorfalva and Gyula only. In the reflexion profiles three well reflecting horizons could gene-

rally be made out. In their course disturbances caused by faults could very rarely be observed. The seismic measurements have shown that the subsoil of the basin lies at a considerable depth: 8,200—11,500 ft, and that the gravity structures mean an elevation as high as 3,281—4,921 ft, below the surface. As an exception may be considered the structure of Madaras—Tompa, where the gravity diagram of the subsoil has been considerably influenced by the thick layers of miocene sediments.

IV. The latest deep well drillings.

On the structures determined by geophysical measurements 16 wells have been drilled. Their geological results are summed up in table II.

On the structure of Biharnagybajom 16 wells have been brought down by the counter flush method. The Trauzl equipment used here only allows drilling to a depth of 656 ft, which is not sufficient considering the lack of a marked key horizon. Therefore, the drilling of shallow wells has not been continued.

From a geological point of view the drillings have very well confirmed the seismic measurements. They have shown that the smaller and larger basins forming the Great Plain are flled with very uniform sediments of considerable thickness. Coloured clay, marly clay and shaley marl beds alternate with thinner and thicker beds of fine sand, course sand and sandstone. In general we can state that the Pleistocene and Levantiian beds are characterised by the coloured clay, the upper Pannonian by the light gray and very sandy shaley marl, the lower Pannonian by the dark gray compact marly clay.

The colour of the coloured clay varies from blue to bluish gray, greenish gray, greenish yellow, yellowish green, brownish green, brown and dark brown. It is unstratified, though, and contains rather thick lignite beds. The contents of calcium carbonate has been frequently secreted and formed limy-marl concretions. The marl nodules can reach a considerable size; they are harder than their surroundings, and their colour is a light yellowish green or grenish gray.

The clays of the upper Pannonian are characterised by a predominantly gray colour and a more conspicious stratification. The contents of calcium carbonate increases a little, the rocks are full of

lignite, and frequently thinner or thicker continuous beds of lignite may be found. The stepped fracture of the strata is striking.

In the upper part of the lower Pannone we still find rather limy middle gray beds of shaley marl with thick intercalations of fine sand or thinner ones of sandstone. In the lower parts of the lower Pannone these beds change to a compact dark gray marly clay, the upper part of which is rather uniform, compact, hard, and well stratified. Its lower part contains several thick beds of a friable light gray fine sandstone. In the lower Pannonian no more lignite beds are found; only carbonized remainders of plants are abundant (Fig. 3).

It is remarkable that in the northern wells (Körösszegapáti, Kismarja) the sandstone layers are rather unimportant and less developed than in the southern wells (Tótkomlós, Tiszakürt, Ferencszállás, Sándorfava) (Fig. 4—5).

The density of the marly clay is constantly increasing with the depth, is characterized by a conchoidal fracture and finally changes to a browny gray calcareous marly stone, which is interlaced with thin fissures. The fissures are often filled with milk-white calcite veinlets, and pyritic concretions are frequently found.

The whole series from Holocene to the bottom of the lower Pannonian is rather sandy. It may well be maintained that above the lower Pannonian the sand is predominant. The sands of the Holocene. Pleistocene and Levantiian alternately consist of finer or coarser quartz grains. Now and then they change to fine gravel. The sands of the Upper Pannonian are fine grained and very micaceous. The lower Pannonian sandstones mainly consist of fine grained to middle grained quartz with a little less mica. In the Lower Pannonian marly clay the embedments of finest sandy mica films are very typical.

In the deep drillings a manifold basement has been pierced, namely; crystalline schists, shale, dolomite, breccia of dolomite and limestone, and conglomerate.

The crystalline schist belongs to the paragneiss group; it is very amphybolitic and shows strong metalliferous traces. The shale is rather soft, almost clay. Its colour is a dark gray; it is very light of weight wavy and folded. The dolomite has a crystalline structure; it is brownish gray and contains many dark gray chert noddles and is full of fissures. In the fissures well developed druses of calcite and dolomite crystals. The breccia is rather a change to conglomerate, as it consists of larger boulders of dolo-

mite and limestone cemented by a calcareous and siliceous cementing material. The conglomerate consists of very manifold gravel grains, likewise in a calcareous and siliceous cementing material.

The flora and fauna of the pierced strata is very poor (See table III).

Very few typical forms have been found, so that a sharp distinction of Pleistocene, Levantiian and Upper Pannonian by means of the fauna is impossible. Upper- and Lower Pannonian as well as Tortonian can easily be separated.

V. The Explored Structures.

1. Tótkomlós.

In the structure of Tótkomlós the results of the gravity measurements do not agree with the results of the seismic exploration and of the deep wells. Therefore, the seismic measurements had first to be repeated very thoroughly, and thus a better conformity was obtained (Fig. 6—8).

The structure represents a flat anticlinalfold with a NW—SE axis. It rises up from a depth of about 6,560 ft towards the southeast and culminates in a region already belonging to Rumania at about 3,250 ft, below the surface. The structure is broken by two faults with a SN—NE direction, one of which may be found in the neighbourhood of well Tk. 1. and Tk. 2., and the other near Tk. 5.

The basement itself has only been encountered by the well Tk. 6. It consists of Triassic-dolomite. Above this basement there is a deposit of dolomite- and limestone breccia with enclosures of green strongly pyritic sand and big boulders, also consisting of limestone and dolomite. This layer contains poor accumulations of oil and rich deposits of gas, the oil supposedly having been strongly encroached by water through faults. These strata together with the Lower Pannonian marly clay beds wedge out towards the SE. So we cannot speak of a real anticlinal fold or an upwarping but rather of a faulted-buried hill structure.

2. Ferencszállás.

The gravity picture of the structure Ferencszállás is very significant. It strikes with steep flanks from SE to NW. Seismic measurements proved the presence of a weak elevation at a depth of appro-

ximately 8,530 ft, the flanks of which dip at 3—4° (Figure 9—10). The well Ferencszállás 1. had to be abandoned at a depth of 8,441.9 ft due to technical difficulties in the Lower Pannonian lime marl.

3. Sándorfalva.

The structure of Sándorfalva constitutes in its gravity picture an extensive flat shield (Fig. 11).

Seismic measurements did not reveal any elevation or anticline, and, therefore, strengthened the supposition that the substructure lies at considerable depths (9,800 ft). Therefore, the structure may be interpreted only as a deep-seated gravity anomaly respectively as a regional effect in gravity. (Fig. 12.) The well Sándorfalva had to be abandoned for technical reasons at a depth of 6,546 ft in Lower Pannonian marl clay.

4. Madaras.

The structure Madaras-Tompa is the most significant elevation which had been found in the whole Plain (Fig. 13). The gravity picture shows an extensive structure with steep flanks and a SW—NE striking trend. The seismic measurements showed at a depth of approximately 754.5 ft, a strongly reflecting bed, which was first interpreted as the basement rock. For this reason, the well Madaras 1. was started with a medium outfit (Fig. 14—15). But the refraction measurements showed that the reflecting area belonged only to the 4,000 meter per sec. travel time zone, which from experience corresponds to tertiary sediments. The basement rock with its 6,000 meter/second velocity has to be looked for at a depth of approximately 2,600—3,300 ft. The well Madaras 1. most probably reached at a depth of 754.5 ft a Mediterranean conglomerate, and drilling had to be abandoned at a depth of 987.5 ft.

5. Biharnagybajom.

The structure of Biharnagybajom is also rather extensive as it has a striking trend from SW to NE (Fig. 16). The seismic measurements proved the gravity meter findings (Fig. 17). There is here an elevation of the basement rock from 8,200 to approximately 3,300 ft (Fig. 18). Owing to the political events, the well Biharnagybajom 1. could not be started.

6. Kőrösszegapáti.

The structure Kőrösszegapáti represents an oblong well-developed elevation, the striking trend of which is in the southern part SW—NE, in the northern part WSW—ENE (Fig. 19). The seismic and gravimetric measurements coincide well and the wells proved the results in every respect (Fig. 20). The SE flank of the structure is steeper the NW flank (Fig. 21—22). The Pannonian transgressed on the crystalline basement rock on the SE flank. On the other hand, an outpinching Tortonian conglomerate deposit, which most probably passes into Sarmatian, is found on the NW flank (Fig. 22). Rich gas and weaker oil accumulations are found in these conglomerates. The well Körösszegapáti 1. encountered gas only; the well Körösszegapáti 3. went to water. The well Körösszegapáti 5. which had been staked out above the edge water zone could not be completed because of the political events.

7. Kismarja.

The structure of Kismarja represents also a very well-developed elevation of the basement of a more round shape with a SW—NE striking trend (Fig. 23). The highest point reaches up to approximately 2,950 ft, and the flanks are rather steep (Fig. 24). The seismic and gravimetric measurements, as well as the results of the wells, coincide very well. The wells Kismarja 1. and 2. both reached the crystalline basement rock. The Lower Pannonian clay beds pinch out toward the top, the same may be said of the weak Tortonian conglomerate deposits, which have been encountered in the well Kismarja 2. As neither gas nor oil traces were encountered in this conglomerate, it is not to be expected that in its southwestern continuation, where the thickness most probably increases, such accumulations could be expected (Fig. 25).

VI. Technical Completion of Wells.

Table IV shows the drilling outfits used; Figure 26 give a summary of the casing used.

(a) Tótkomlós 1.

Drilling time: 23 May 1941 to 4 August 1941. On 4 August 1941 the well encountered at a depth of 5,311.4 ft, strong gas shows, at

which time the loss of circulation was very great. It came to a blow-out, which could only be brought under control on 10 August 1941.

Under a 135 atmospheric pressure and through a 3/8" bean the well produced 3,111.800,0 cuft gas/day. During the blow-out, approximately 630 to 1,260 barrels of crude oil, together with great quantities of salt water, were also erupted. During the throttled-reduced production, only a gas rich in gasoline could be produced without oil and saltwater. On 18 June 1943 the gases worked themselves up behind the casing, and after having gone wild for 4 days the hole caved in and was ruined. There was left behind a crater of approximately 33 yd in diameter filled with salt water. At the second blow-aut, approximately 190 barrels/sec. saltwater without any oil traces whatsoever erupted.

(b) Tótkomlós 2.

Drilling time 15 October 1941 to 13 March 1942. From 5,249,5 ft downwards, the well at once showed great circulation losses, and for this reason was eventually discontinued at a depth of 5,449,6 ft. The extremely severe frost also necessitated a shut-down for a longer period. A total of 5 production tests were made (Fig. 27).

1. Test between 5,431,8—5,364,3 ft. Result: 353 cuft/h salt water with an outflow temperature of 83° C.
2. Test between 5,308,5—5,338 ft. Result: the same, together with some gas with a strong gasoline odor.
3. Test between 5,256 and 5,273,1 ft. Result: The same salt water from the tubing. In the annular space between the 2 1/2" and 6 5/8" tubing, accumulated gas and oil. It could be drained every hour, whereby much gas and approximately 16 US gallons of oil could be entraced at each draining. The oil was always followed by salt water. The pressure in the annular space amounted to 80 atm.
4. Test between 3,106,9 and 3,149,6 ft, produced much gas with salt water at a pressure of 100 atm.
5. Test between 2,933 and 2,959,3 ft, showed the same results as test 4. A great quantity of fine sand was also brought to the surface.

Through the sudden closing of the Crismas Tree, a strong side pressure developed which loosened the flanging of the Christ-

mas Tree some tenths of mm. Through this narrow opening, fine sand was blown under high pressure and the sand ray sawed through the supporting bolts. The Christmas Tree toppled over and it was followed by a wild gas and sand blow-out which lasted for 28 hours. The eruption quietened down after the well had caved in. The well head is shut by a check valve whereby a pressure of 9—11 atm. could be observed.

(c) Tótkomlós 3.

Drilling time: 5 May 1942 to 3 October 1942. The well reached the base conglomerate without trouble at a depth of 5,549,6 ft, when drilling was discontinued.

The production tests made between 5,394,8 and 5,427 ft, and 3,090.5 and 3,169,2 ft encountered only some slightly salty water with a temperature of 48° C. and 56° C. respectively, which showed very insignificant inflammable gas traces. A bottom cementation job was made with 50 sacks of cement. Cement plugs were set between 3,504 and 3,156.7 ft, with 65 sacks of cement, and 3,090.5 and 2,811.6 ft, with 50 sacks of cement. The 6—5/8" and 9—5/8" casings were pulled out after unscrewing the joints.

(d) Tótkomlós 4.

Drilling time: 29 June 1942 to 3 October 1942. The well was drilled without incidents. A twist-off of the 3 1/2" drill pipe occurred at 183.7 ft, when pulling out. The drill pipe could be unscrewed to 5,375.77 ft. Besides a drill pipe, a core barrel and two drill collars remained in the well. A bottom cementation was made with 80 sacks of cement. Two cement plugs were set between 5,052.6 and 4,855.8 and 4,822.8—4,685.1 ft. The 9—5/8" was cut and pulled at 430 m.

(e) Tótkomlós 5.

Drilling time: 21 January 1943 to 15 March 1943. A great circulation loss was encountered at 5,054.5 ft when strong gas traces were observed. The well had to be shut down. In the meantime, the bit got stuck at the bottom. The well had to be abandoned after 2,086.6 ft of drill pipe were pulled.

(f) Tótkomlós 6.

Drilling time: 22 May 1943 to 20 September 1943. From the depth of 4,429.3 ft, in order to avoid sudden circulation losses, the Passler pilote core-barrel was used, thereby reducing the drilling speed. The well reached the Trias beds without incidents and, as no oil or gas traces were encountered, was abandoned without conducting any production tests.

(g) Ferencszállás 1.

Drilling time: 5 August 1942 to 9 May 1943. A twist-off occurred at a depth of 8,051.5 ft deep when the well was 8,441.9 ft, deep. The fishing job was unsuccessful. In the meantime, the well started to overflow and, therefore, it had to be shut in. Production tests showed 45.28 barrel water per hour, through 5/16" bean, with small gas shows. The water temperature was 45—58° C. The well was killed at a back pressure of 130 atm and was shut in with a cement plug between 6,581.7—6,187.8 ft. A second production test between 6,023.7—6,030.3 ft, showed 12.58 barrel/hr. water with a temperature at the outflow of 53° C. Afterwards a cement plug was set with 40 sacks of cement between 6,030.3—5,863 ft. A total of 2,914.0 ft, 6—5/8" and 982,5 ft, 9—5/8" casing was pulled out. This well is the deepest so far drilled in the Plain.

(h) Sándorfalva 1.

Drilling time: 21 August 1942 to 6 January 1943. The drilling bit got stuck at a depth of 6,546 ft, by overburdening of the drill pipe through pulling, the bit broke at a depth of 118,1 ft. Until 20 March the well could be freed down to 4,084 ft, by pulling the drill pipe; the well was then side-tracked by whipstocking and drilled to 5,105 ft. But in spite of this, the well had to be abandoned as the depth intended could not be reached due to the narrowing.

(i) Madaras 1.

For reasons already given, this well had to be abandoned at a depth of 988.81 ft.

(j) Kismarja 1.

Drilling time: 4 January 1944 to 29 February 1944. The drilling of the well was uneventful and showed no traces of hydrocarbons. There are two cement plugs between 2,296.6—2,460.6 and 492.1—410.1 ft, 492.1 ft, of 9—5/8" casing was cut and pulled out.

(k) Kismarja 2.

Driling time: 20 May 1944 to 8 August 1944. The well reached the basement rock without shows and was abandoned. No production tests were made.

(l) Körösszegapáti 1.

Drilling time: 4 February 1943 to 30 April 1943. At a depth of 4,451.5 ft, there was suddenly a circulation loss and a blow-out occurred. The drill pipe was run to the bottom, and after an eruption of 26 hours the well was shut with 4"/3" Christmas Tree. The production tests showed 1,942,050 cuft gas/day through a 2/8" bean. Gas pressure was 172 atm. During this production test, 19.8 US gallons of oil were recovered. It was tried several times to kill the well with Hematite and Baryte circulation mud, but this was unsuccessful because of the strong foam formation.

(m) Körösszegapáti 2.

Drilling time: 12 June 1943 to 7 December 1943. Beginning from 4,417.76 ft, the Passler pilot core barrel was again used, which slowed down the drilling speed. The well reached the basement rock without incidents. Two production tests were made, the first with a liner between 4,944.38—5,026.4 ft, which showed slight traces of gas. For the second test the 6—5/8" casing was perforated by the Schlumberger method with 40 shots between 4,708.16—4,724.56 ft, and 4,888.6—4,908.29 ft. Result: 883 cu ft gas/day.

(n) Körösszegapáti 3.

Drilling time: 12 October 1943 to 4 March 1944. The well reached the basement rock without incidents. A production test was made between 5935.19—6037.86 ft, with gas lift from well No. 1. The cores of these wells showed good oil traces and had a strong

gasoline odour. The Schlumberger log showed 10—15 Ω resistance and 20—45 mV porosity. (Fig. 27.) The well showed during an eruption of 20 minutes approximately 63 barrel oil-water emulsion, and then nothing. After having been shut down for 12 hours, the fluid level increased to 1312.3 ft, and approximately 1/5 to 1/7 of the fluid column consisted of oil. After 12 days of bailing tests, it was obvious that the well was on the oil-water contact. During the bailing tests, approximately 140 barrels of oil were recovered. The well was cemented off between 5971.28—5797.39 ft, with 25 sacks of cement. The 6—5/8" casing was cut and pulled out at 3916.44 ft.

(o) Körösszegapáti 4.

Drilling time: 28 April 1944 to 10 July 1944. The well was drilled without incidents. There was no need for production tests.

(p) Körösszegapáti 5.

The well was staked out higher on the structure than No. 3. and reached the depth of 4429.3 ft, without incidents, where the 9—5/8" casing was cemented. The well was left behind all ready for operation when political incidents intervened.

The workshop and storerooms in Tótkomlós, Berekböszörmény and Pocsaj, as well as the drilling outfits WIAG # 6, WIAG # 11 and ELWERATH S 55 were left behind in good condition, as their transfer could always be delayed for one reason or another. Looting or destruction was only done by the native population and the retreating German SS troops.

VII.

The Gas of the Deep Tests.

1. Tótkomlós 1.

Composition of the Gases:

Crude Test:	CO_2	48.6%	Airless test:	CO_2	51.4%
	CH_4	44.9%		CH_4	47.5%
	O_2	1.2%		O_2	— %
	N_2	4.3%		N_2	— %
	C_2H_6	1.0%		C_2H_6	1.1%
		100.0%			100.0%

Heating value of the gases as determined by microcalorimeter:

Crude test	4910 kcal/N m^3
Airless test (dried)	5200 „ „ „
Heavy hydrocarbons ...	32000 „ „ „

The gasoline content of the gas, determined by the Lurgi apparatus, amounted to 68 g/m^3.

2. Tótkomlós 2.

	5256—5273,1 ft	3106,9—3149,6 ft	2933—2959,3 ft
CO_2	50.0%	52.8%	42.0%
CH_4	46.0%	38.8%	50.1%
C_2H_6	2.3%	5.1%	4.1%
N_2	1.7%	3.3%	3.8%
	100.0%	100.0%	100.0%

The gasoline content of the gas, determined by the Lurgi apparatus, amounted to 80 g/m^3.

3. Körösszegapáti 1.

CO_2	58.4%
CH_4	39.0%
CO	0.4%
N_2	2.2%
	100.0%

The Oil of the Deep Tests.

1. Tótkomlós 1.

Colour: dark chocolate brown

Specific weight at 15° C	0,858 = 33.5 API — Grade
Freezing point: plus 23° C	
Viscosity at 100° F	67.8 Saybolt sec = 2.1 E°
Viscosity at 50° C	54.4 „ „ = 1.7 E°

Distillation at Bar. 740 Hg mm:

Temperature	Volume %	Weight %	Spec. Gravity
206—250 C°	5.9	5.9	0,801
250—275 C°	14.2	20.1	0,813

Vacuum Distillate at 40 Hg mm:

Temperature	Volume %	Weight %	Spec. Grav.	Visc. at 100° F in Saybold sec.
—200 C°	15.7	15.7	0,827	39.2
200—225 C°	14.0	29.7	0,833	44.0
225—250 C°	10.2	39.9	0,847	54.1
250—275 C°	10.4	50.3	0,866	78.6
275—300 C°	6.0	56.3	0,878	98.2
Residue:	22.3	78.6	0,953	

Conradson of the residue: 5.84 Spec. Grav., calculated to oil 1.50 weight %.

Summary of results:

Name	%	Spec. Grav.	Visc. at 100° F.
Light gasoline	—	—	—
Gasoline	—	—	—
Kerosene	20.1	0,809	—
Gasoil	32.5	0,809—0,844	—
Light lube oil	23.8	0,844—0,855	50—100 S
Medium lube oil... ...	—	—	—
Heavy lube oil	—	—	—
Loss	1.3	—	—
Residue	22.3	0,953	—
	100.0%		

Paraffin content of the oil according to the Butanon A. S. T. M. system: 9.8 weight %.

Hard asphalt content of the oil: 0.14%.*

2. Tótkomlós 2.

Colour: dark brownish green

Spec. Grav. at 15° C	0,820	
Viscosity at 20° C	5.9	E°
Freezing point	plus 15	C°
Sulphur content	0.24	%
Paraffin content	10.5	%
Hard asphalt content...	0.26	%
Raw gasoline content at 180°	8.23	%
Kerosene	34.00	%
Gasoil	17.10	%
Residue	40.41	%
	100.00	%

* As determined by the Crude Oil Chem. Laboratory of the Hungarian American Oil Co.

3. Körösszegapáti: 1.

Colour: leight yellow

Spec. Grav. at 20° C		0,770	
Initial boiling point	plus	54	C°
at 100° C		72	Volume %
at 120° C		91	Volume %
Last boiling point	plus	145	C°
Light gasoline (Spec. Grav. at 15° C—0,720)			12.42%
Heavy gasoline (Spec. Grav. at 15° C—0,759)			35.26%
Kerosene (Spec. Grav. at 15° C—0,791)			50.03%
Residue			1.12%
Loss			1.17%
			100.00%

4. Körösszegapáti 3.

Two analyses were made, the first sample originates from a fresh eruption, the second sample was taken from a slush pit after several days.

Analysis 1.

Colour of the crude oil: blackish brown

Spec. Grav. 15° C	0,875	
Kin. Viscosity 20° C	52.9	c St.
Viscosity 20° C	6.98	E°

Distillation test of 100 cm° oil according to Engler:

Initial boiling point 46° C			
Gasoline	(—180° C Spec. Grav. 15° C	0,735)	17.0 Vol. %
Kerosene	(—280° C „ „ „ „	0,818)	15.0 „ %
Gasoil	(—325° C „ „ „ „	0,840)	21.0 „ %
Pacura	(„ „ „ „	0,944)	45.0 „ %
Loss			2.0 „ %
			100.0 Vol. %

Analysis 2.

Colour: blackish brown

Spec. Grav. 15° C	0,882	
Kin. Viscosity 30° C	57.0	c St.
„ „ 50° C	11.8	c St.
Viscosity 30° C	7.5	E°
„ 50° C	2.0	E°
Freezing point MOSZ	plus 18.0	C°
Water content	6.5	Gew % (Grav.)

Distillation test of 100 cm° according to Engler:

Initial boiling point: 64° C		
up to 118° C overflowing	5	Vol. %
„ „ 144° C „	10	„ „
„ „ 215° C „	20	„ „
„ „ 278° C „	30	„ „
„ „ 310° C „	39	„ „
Total distillate	39	Vol. %
Residue	59	„ „
Loss	2	„ „
	100	Vol. %

Light gasoline	D 15° C	0,720	7.71%
Heavy gasoline —180° C	„	0,7745	2.60%
Kerosene —270° C	„	0,804	15.56%
Gasoil —310° C	„	0,829	10.25%
Pacura			63.14%
Loss			0.74%
			100.00%

The Water of the Deep Tests.

For comparison, analyses of the waters from well Tótkomlós 1. and well Moreni 1. (Rumania) are given. The water from the Moreni well originates from Meotian beds which correspond to the Lower Pannonian.

	Moreni 1*	Tótkomlós 1	Moreni 1	Tótkomlós 1
	Salt Content		Relative to 100% Salt	
	g/l	g/l	%	%
Cl'	103,311	9,890	61.28	54.34
Br'	0,526	— —	0.31	— —
J'	0,016	— —	0.01	— —
SO_4"	Sp.	0,005	— —	— —
HCO_3'	0,127	0,995	0.07	5.47
K'	0,385	— —	0.23	— —
Na'	53,640	6,997	31.82	38.44
NH_3,	0,109	0,020	0.065	0.11
CA··	8,635	0,124	5.13	0.68
Mg··	1,719	0,031	1.02	0.17
Fe··	0,045	Sp.	0.03	— —
SiO_3H_2	0,058 SiO_2	0,145 SiO_3H_2	0.035 SiO_2	0.79
	168,571	18,207	100.000	100.00

The water of the well Körösszegapáti 3. is worthy of attention. The results of the analyses were no longer furnished.

VIII. Summary.

The southern part of the Plain is not a uniform big basin. The line Solt—Kiskunhalas—Zenta—Magyarpadé, seemingly the continuation of the Valer fault, divides this part of the Plain into two halves (Fig. 28). The part of the territory southwest of this line lies considerably higher than the really low territory NE of this line. The demarcation line of the big deep territory in the south may be given by the line Aradi—Lázárfölde—Nagybecskerek—Boka, as has been also shown by the geophysical measurements made in the Bánság. The basement rock lies again higher south of this line. The less sunken „foreground" is characterized by mountain chains descending into the Plain mostly in the striking trend of the rim mountains. In the Kiskunság this trend is SW—NE. In the Bácska the trend is more W—E. In the southern Bánság the mountains have partly S—E and partly SE—NW trend. Extensive mountain chains descend from the Transylvanian intermediate chain of mountains

* G. Macovei: Les gisements de Pétrole, Paris 1938, page 66.

into the inner part of the Plain with a SE—NW striking trend. Great elevations of the basement rock may also be noticed in the really big basin, which have an exclusively SW—NE trend. The flanks of these elevations are mostly not very steep. The sediments of the Upper Tertiary have been deposited on the basement rock in unconformity. The wells encountered (except thick sand and clay deposits of the Pleistocene, Levantiian and Pannonian) only Miocene and Trias deposits, which due to their composition must be looked upon as a talus. The solid Trias-rocks were only found on the NW slope of the sunken mountain chain which is the continuation of the Transylvanian intermediate chain of mountains descending into the Plain with a SE trend. The crystalline basement rock is only covered by thick Miocene or perhaps also Paleogene deposits in the Kiskunság and Bácska. (Fig. 29). The underground elevations are connected with the orogenic folding periods and were already completed before the deposit of the Tertiary sediments. Therefore, the upper sediments were not involved in any folding. For this reason we may not count with fold structures as regards these younger sediments in the Plain. Only in the southern Bácska, the Save folds may have influenced the younger sediments, but so far this is not supported by any proof.

On the other hand, it may be assumed that smaller parts of the basement rocks were blocks formely parted by smaller faults. There is reason to believe that the sinking of the underground is not even quite finished, and it is possible that the above mentioned blocks did not and do not participate in the sinking movement to the same extent. For this reason we may count on fault structures.

On the basis of the extensive gas deposits and more than good oil traces encountered, the presence of commercially productive hydrocarbon deposits is proved. Due to the few wels drilled, it is yet imposible exactly to determine the oil belts in the above mentioned faulty structures. Their extension and the commercial possibilities can not be determined yet either. Although these gases belong to the group of „wet" gases owing to their richess of heavy hydrocarbons, which are always connected with oil deposits, their high content of carbon dioxide is remarkable. The clarification of the origin of this carbon dioxide has to be left to later tests.

Appendix.

I have to acknowledge with gratitude the helpful cooperation of the geologists F. Sólyom, D. Sc. who surveyed drill logs *Tótkomlós* No. 3—4. and Körösszegapáti No. 1—5., L. Körössy, D. Sc. who surveyed drill logs *Ferencszállás* No. 1., *Sándorfalva* No. 1. and *Madaras* No. 1., and G. Csiky, D. Sc. who surveyed drill logs *Tótkomlós* No. 5—6., and *Kismarja* No. 1—2. Mining engineer F. Hegedüs controlled part of the drillings from the technical point of view.

L. Strausz, D. Sc. and L. Bogsch, D. Sc. helped in determining fossils in general, Fahrion, D. Sc. and Grill, D. Sc. the microfauna. K. Sztrókay, D. Sc. helped in the precise determination of crystalline schists. Oil, gas and water analysis was made in laboratories of the *Hungarian American Oil Industry Co.*, of the *Hungarian Technological Institute* and of the *Erdölproduktions-Gesellschaft, Vienna.*

Geophysical and geological surveys were controlled by F. Forche, D. Sc. and J. Kapounek, D. Sc. General control was performed by Mining engineer D. Ing. H. Wolff and Mining assessor F. Brüggemann.

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* In Hungarian only.

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   a) manufacture, b) type, c) spooling capacity, d) V min., e) V max., f) diameter-, g) wide-, h) number of the brake bands.
3. Engines.
   a) manufacture, b) type, c) capacity, d) Rev. per Min., e) number.
4. Slush pumps.
   a) manufacture, b) type, c) theor. capacity per double strokes, d) theor. capacity at 35 double strokes per Min., e) number.
5. Drive countershaft.
   a) manufacture, b) type, c) number.
6. Derrick.
   a) manufacture, b) height nom, c) wide of the rod platform, d) capacity.
7. Sub structure.
   a) manufacture, b) height.
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    a) manufacture, b) type, c) size, d) Rev. min., e) Rev. max.
13. Number of the drilled wells.
14. Whole output.
15. Work-days.
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H = Haniel-Lueg, D = Demag, T = Trauzl, W = Wirth, MN = Man, Dz = Deutz, EW = Eisenwerk Wuelfel.

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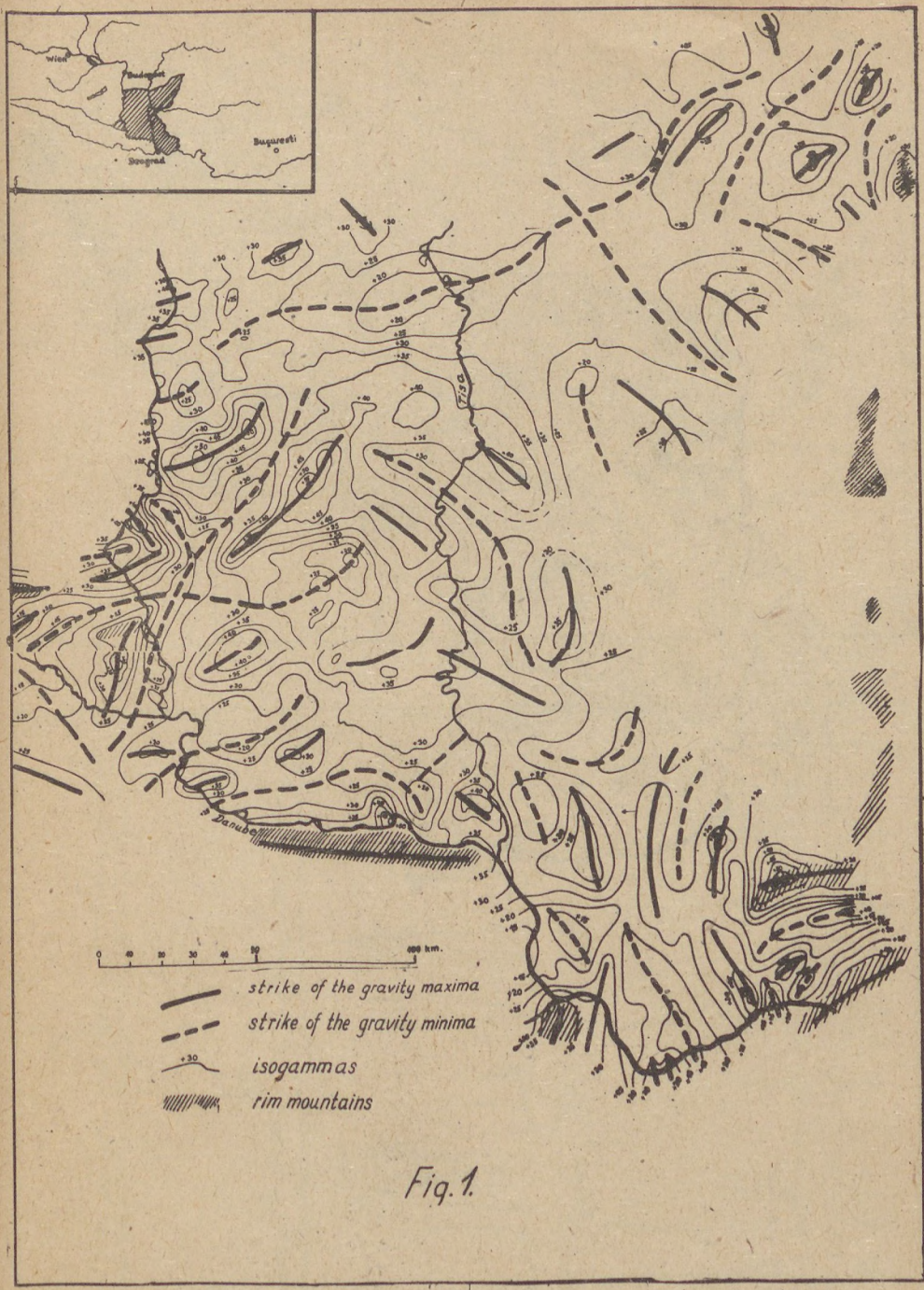
Fig. 1. Oil and Gas eruption of the well Tótkomlós No 1. Deepness 5.311,4 ft. Pressure 135 atm. (Phot. by the autor).

Fig. 2. Oil eruption of the well Tótkomlós No 2. Deepness 5.256,0—5.273,1 ft.

Fig. 3. Some fossils from wells Tótkomlós No 1 and No 2. 1—2 *Viviparus Sadleri* Parts. — 3. *Prosodacna* sp. — 4—6. *Limnocardium abichiforme* Gorjanović—Kramberger. — 7. *Valenciennius* sp. ex. aff. — 8. *Valenciennius* cfr. *annulatus* Rousseau. — 9. *Congeria* sp. (Natural size).

Felelős kiadó: *Tasnádi Kubacska András.*

21.246—48. „Élet" Irod. és Nyomda Rt. Bpest, XI., Bartók B.-út 15. — Igazgató: Laiszky Jenő.


Wien
Budapest
Bucuresti
Beograd
Danube
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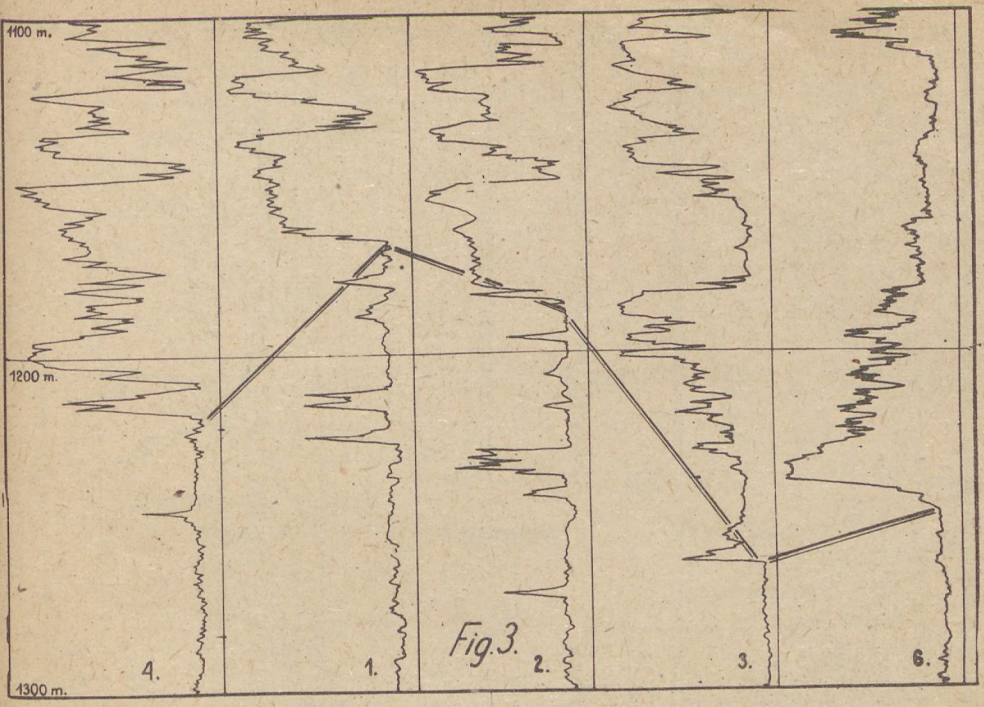
strike of the gravity maxima
strike of the gravity minima
isogammas
rim mountains

Fig. 1.

Fig. 2.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1200 m.
1300 m.
4.
1.
2.
3.
6.

Fig.3.

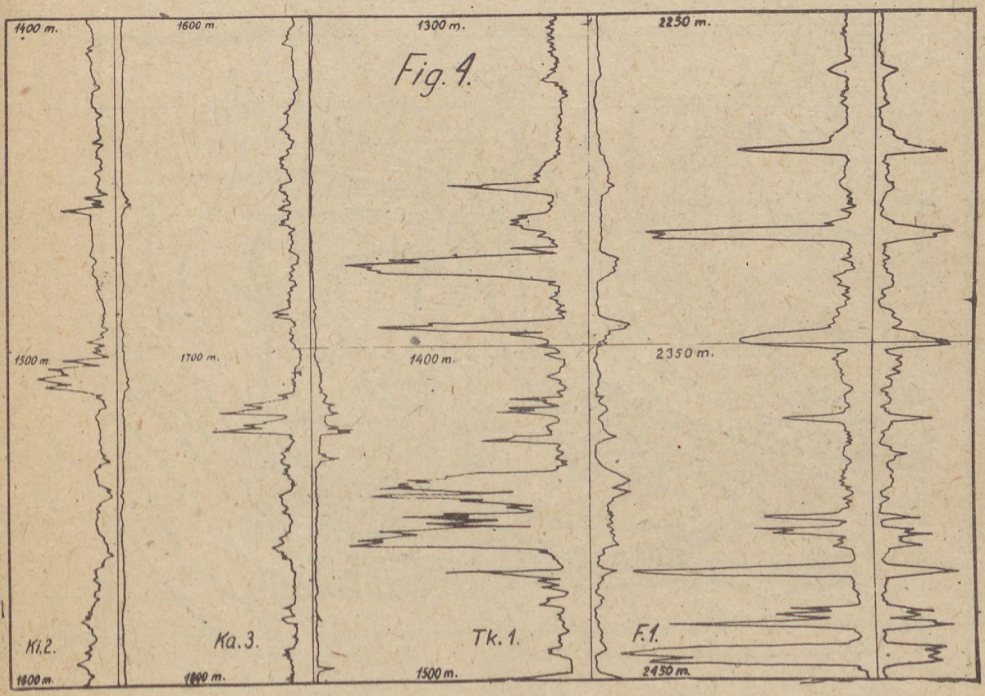

1400 m.
1600 m.
1300 m.
2230 m.
1500 m.
1700 m.
1400 m.
2350 m.
Ki.2.
Ka.3.
Tk.1.
F.1.
1600 m.
1800 m.
1500 m.
2450 m.

Fig.4.

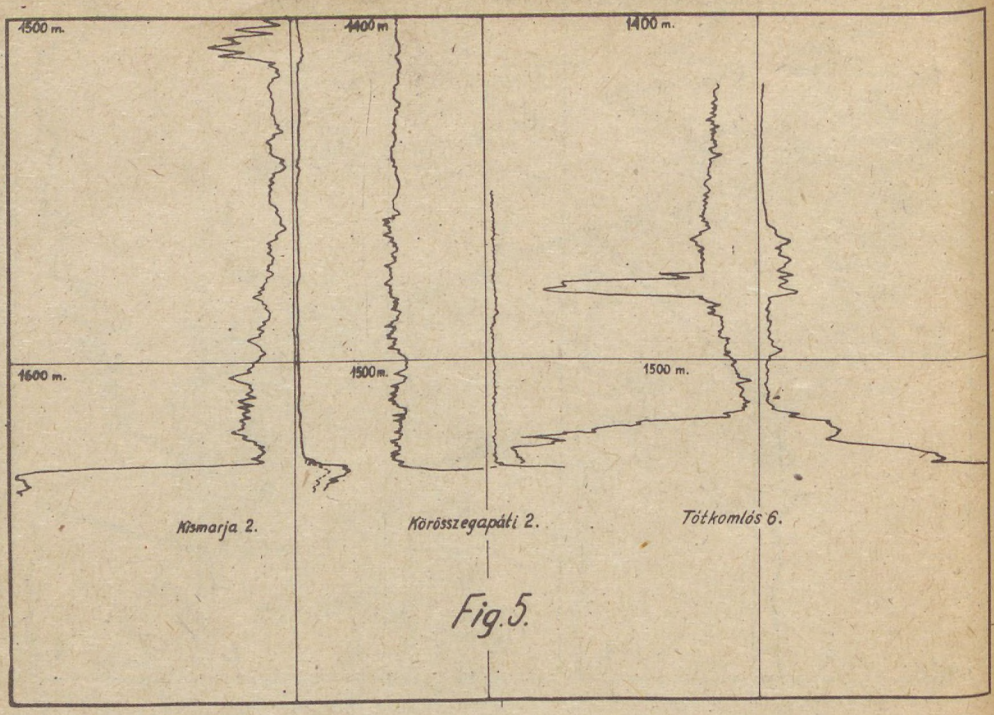

1500 m.
1600 m.
1400 m.
1500 m.
1400 m.
1500 m.
Kismarja 2.
Körösszegapáti 2.
Tótkomlós 6.

Fig.5.

Fig.6.

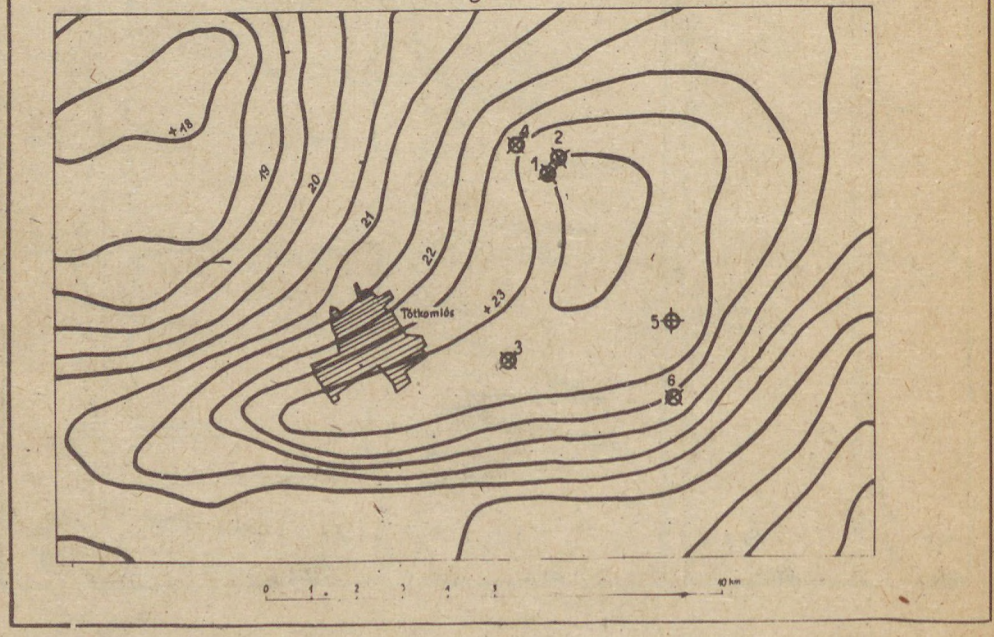

+18
19
20
21
22
+23
Tótkomlós
1
2
3
5
6
0
1
2
3
4
5
10 km

Table I.

			Hajdúszoboszló 1.	Ha. 2.	Debrecen 1.	D. 2.	Tiszaberek 1.	Tiszaörs 1.	Karcag 1.	Kc. 2.	Hortobágy 1.	Ho. 2.	Ho. 3.	Ho. 4.	Vérvölgy 1.	Tiszakürt 1.	Baja 1.
Holocen + pleistocen			134,0	126,0	186,0	185,0	173,0	182,0	209,0	182,0	245,0	176,0	199,0	183,9	133,0	166,0	90,0
Pliocæn	Levanticum		—	—	? 402,0	983,0	—	—	? 1063,0	801,0	—				—	634,0	? 222,0
	Pannonicum	Ponticum	1090,87	1111,0	1000,0		596,0 715,0	777,0	1220,0		1002,0				343,1	1545,0	1240,0
		Mæoticum		? 1348,0	1316,0	1038,6	1291,0	1882,0			1115,0					2259,0	
Miocæn	sup.	Sarmatien		÷ 1447,0	1347,0		1500,1									—	1300,0
	med.	Tortonien		—	1472,0											2311,5	1369,3
		Helvetien		—													
	inf.	Bourdigalien		—	1532,0												
Oligocæn	sup.	Cattien		—	1606,0												
	med.	Rupelien		—	1737,66												
Trias				2032,0													

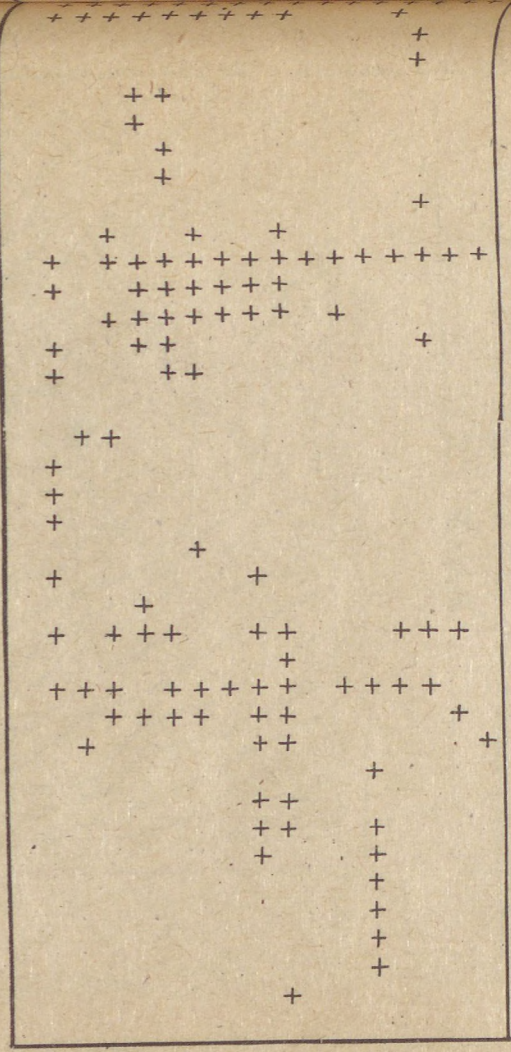
Table II.

			Kismarja 1.	Ki. 2.	Körösszegapáti 1.	Ka. 2.	Ka. 3.	Ka. 4.	Ka. 5.	Tökkomlós 1.	Tk. 2.	Tk. 3.	Tk. 4.	Tk. 5.	Tk. 6.	Ferenczszállás 1.	Sándorfalva 1.	Madaras 1.
Holocen + pleistocen			75,0	150,0	150,0	155,0	165,0	170,0	160,0	200,0	205,0	210,0	220,0	175,0	160,0	180,0	150,0	74,0
Pliocæn	Levanticum		500,0	580,0	540,0	560,0	600,0	600,0	580,0	590,0	600,0	610,0	655,0	550,0	665,0	875,0	520,0	95,0
	Pannonicum	Ponticum	770,0	970,0	850,0	875,0	900,0	935,0	875,0	1050,0	1068,0	1100,0	1075,0	1045,0	1040,0	1700,0	1650,0	150,0
		Mæoticum	1051,0	1630,0	1356,0	1531,0	1812,0	1858,0	1350,0	1618,9	1605,0	1675,0	1685,0	1540,0	1475,0	2573,0	1995,2	224,7
Miocæn		Sarmatien	—	—	—	—	—	—			? 1661,5	? 1691,5	? 1704,0		—			? 301,4
		Tortonien	—	? 1639,0	? 1356,8	—	1842,0	—							—			
Trias			—	—		—	—	—							1531,5			
Palæosoicum			1052,9	1640,8		1532,3	1843,9	1863,0										

Table III

Fossils:

Wells:	Madaras 1	Sándorfalva 1	Ferenczállás 1	" 6	" 5	" 4	" 3	" 2	Tótkomlós 1	" 5	" 4	" 3	" 2	Kürtösgagapáti 1	" 2	Kismarja 2	" 1
Carbonized remainders of plants	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Carbonized leafs		+						+	+								+
Chara oogonium									+								
Planorbis sp		+	+			+		+	+								
Planorbis planorbis Linné			+														
Planorbis corneus Linné			+														
Limnea sp.		+															
Limnea palustris			+														
Vallonia pulchella			+														
Lithoglyphus sp.		+												+			
— " — naticoides			+														
Helix sp.		+						+	+								
Unio sp.		+	+		+	+	+	+	+	+							
Nerita sp.	+						+										
Limax sp.		+															
Pisidium sp.		+					+										
Theodoxus sp.	+	+	+			+	+		+	+							
Paludina operculums	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Hydrobia sp.	+	+	+			+											
Halobia sp.												+					
Bythinella sp.														+			
Valvata sp.		+												+			
Viviparus sp.	+	+	+			+	+	+	+								
Viviparus sadleri Partsch									+								
Viviparus cf. bifarcinatus Bielz			+														
Valenciennius sp.			+	+	+		+	+	+							+	
— " — annulatus Rousseau							+		+					+			
— " — ex. aff. intermedia							+										
— " — reussi							+										
— " — reussi-kiseljaki									+								
Prosodacna sp. (? Vutskitsi)								+									
Monodacna ex. aff. pseudocatillus Barbot de Marny							+										
Didacna deserta Stoliczka					+												
Adacna cfr. deserta Stoliczka						+											



— " — dzichiforme Gujanovic-Kramberger
— " — cfr. rogenhoferi Brusina
— " — cfr. riegeli Hoernes
— " — cfr. othiophorum Brusina
— " — lenzi
— " — penslii
— " — secans
— " — biharense Bogsch

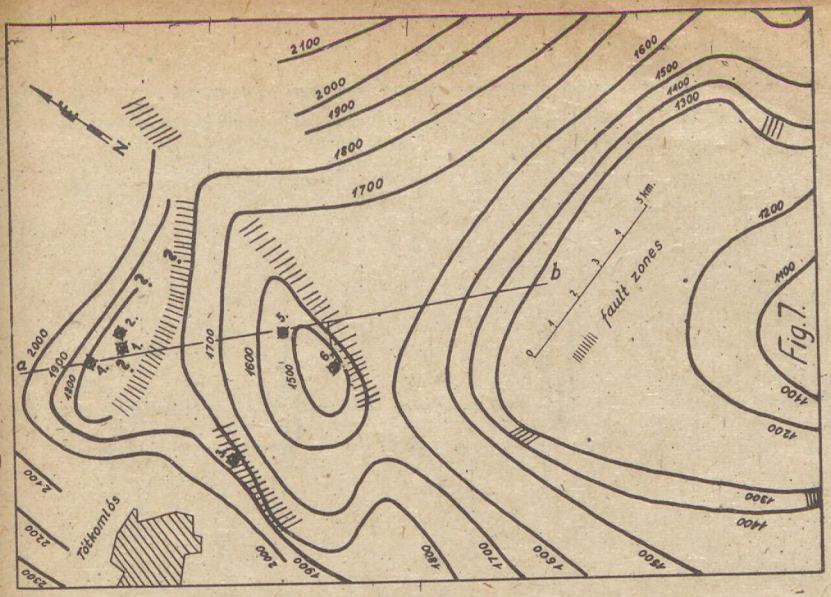
Dreissensia sp.
Congeria sp.
— " — czjzeki Hoernes
— " — banatica Hoernes
— " — cfr. zagrabiensis Brusina
— " — superfostata Brusina

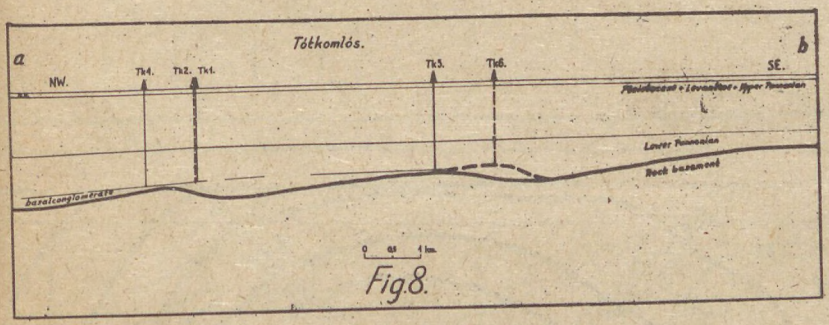
Melanopsis sp.
— " — bouéi Férussac
— " — faberi Brusina
— " — affinis Handmann
Gyraulus sp.
Cardium sp.
Daonella sp
Fish sheds
Fish fins
Ostracoda sp.
— " — Type B
— " — Type D
Cytheridea mülleri
Cypridina hastata
Rotalia beccarii
Elphidium crispum
Pozalis malo
Miliolina sp.
Asterigerina planorbis
Spicutums
Shark's teeth

1.	2.							3.					4.					5.			6.			
	a.	b.	c.	d.	e.	f.	g.	h.	a.	b.	c.	d.	e.	a.	b.	c.	d.	e.	a.	b.	c.	a.	b.	c.	d.
			t	m/s	m/s	cm	cm				HP	U/min				l.	l.						m	m	t
WIAG 6.	H	S150	20	1,08	15,3	120	25	2	MN	G5V33	200	550	2	H	GP 7¼x16	44,4	1450	2	EW	G39	2	H	37	7,4	150
" 11.	H	S150	20	1,08	15,3	120	25	2	MN	G5V33	225	600	2	H	GP7¼x16	44,4	1450	2	EW	Mhh23	2	H	41	8,0	200
" 25.	D	25 t	20	1,08	9,8	140	20	2	MN	G5V33	225	600	2	W	LK7¼x16/40	44,4	1450	2	D	—	2	D	41	8,0	200
" 18.	T	CF	1,8	0,50	1,50	53	10,5	1	Dz	MAH220	18	900	1	T	75x85(110)ø	1,12	124	1	-	—	—	T	9		3,5
" 23.	T	CF	1,8	0,50	1,50	53	10,5	1	Dz	MAH220	18	900	1	T	75x85(110)ø	1,12	124	1	-	—	—	T	9		3,5
Elwerath S.53.	W	DH338	27	1,04	10,4	130	22	2	Dz	DZ8M428	280	750	2	W	LK7¼x18/40	52,5	1840	2	W	—	2	W	41	8,0	200

7.	8.					9.				10.			11.			12.					13.	14.	15.	16.
a.	b.	a.	b.	c.	d.	a.	b.	c.	d.	a.	b.	c.	a.	b.	c.	a.	b.	c.	d.	e.				
	m			t				t				t			t			mm				m	nap/(days)	m/nap/(day)
H	2,8	H	Rd	125	5	H	RF	125	4	H	B	125	H	SN	70/125	H	F 27½	700	22	140	4	6.443,6	532	12,0
H	2,8	H	Rd	150	6	H	RF	150	5	H	B	150	H	SN	70/125	H	F 27½	700	22	140	7	10.750,2	642	16,7
D	2,8	D	-	200	6	D	-	160	5	D	-	160	H	SN	70/125	D	27½	700	55	130	1	1.995,2	132	15,1
T		T		4	2	T		4	1	T		4	T		4	T	10	254	130	450	5	940,0	93	11,2
T		T		4	2	T		4	1	T		4	T		4	T	10	254	130	450	11	2.400,0	155	13,6
W	2,8	W	RK	180	6	W	Rb	150	5	W	RH	150	W	RS	70/150	W	RT 27½	700	22	146	3	5.766,9	537	12,1

Table IV.


N
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
b
fault zones
Tótkomlós
Fig.7.


a
Tótkomlós.
b
NW.
SE.
Tk4.
Tk2.
Tk1.
Tk3.
Tk5.
Pleistocene + Levantine + Upper Pannonian
Lower Pannonian
Rock basement
basalconglomerate
Fig.8.

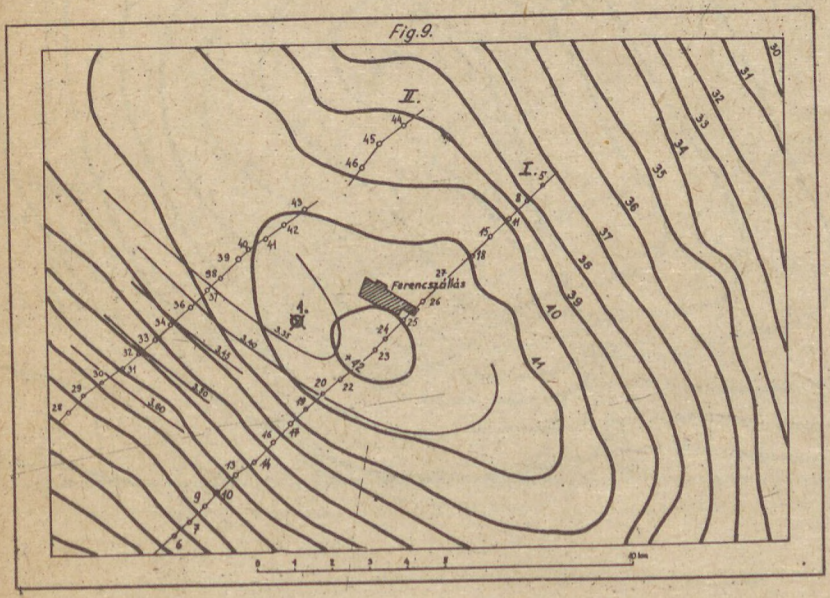


Fig.9.
II.
I.
Ferencszállás
40 km

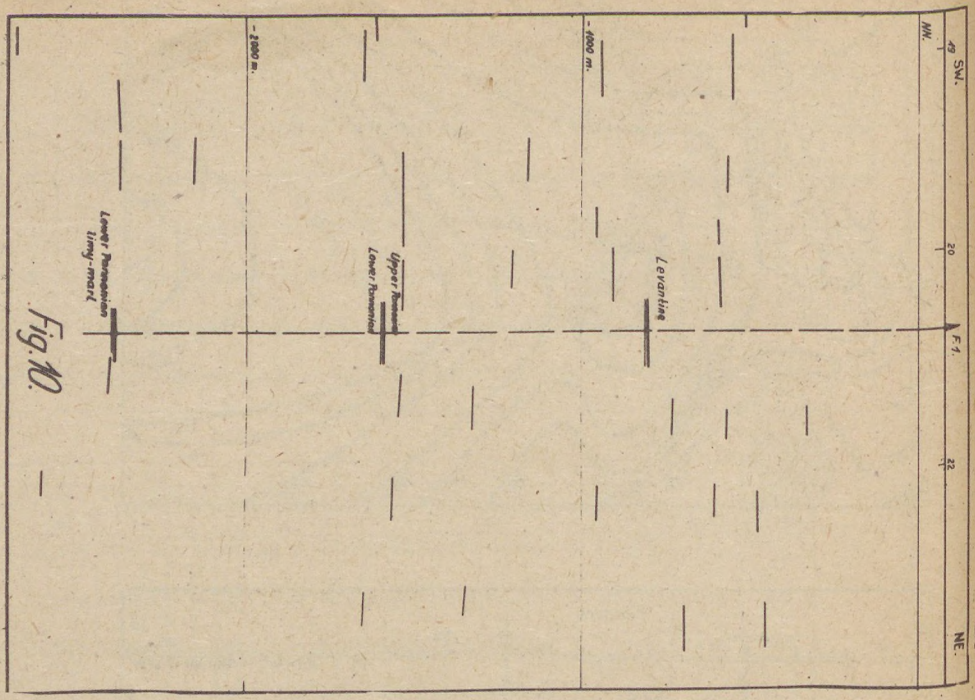

-2000 m.
-1000 m.
NW.
SW.
NE.
F 1.
Lower Pannonian limy-marl
Upper Pannonian
Lower Pannonian
Levantine

Fig. 10.

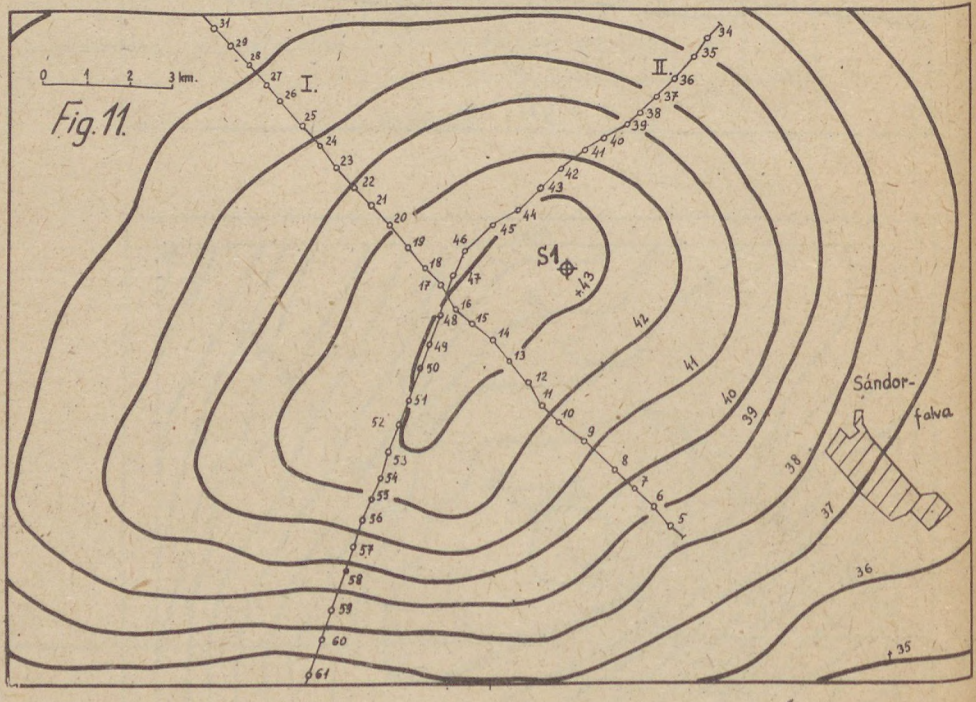

0 1 2 3 km.
I.
II.
S1
+43
Sándor-falva
+35

Fig. 11.

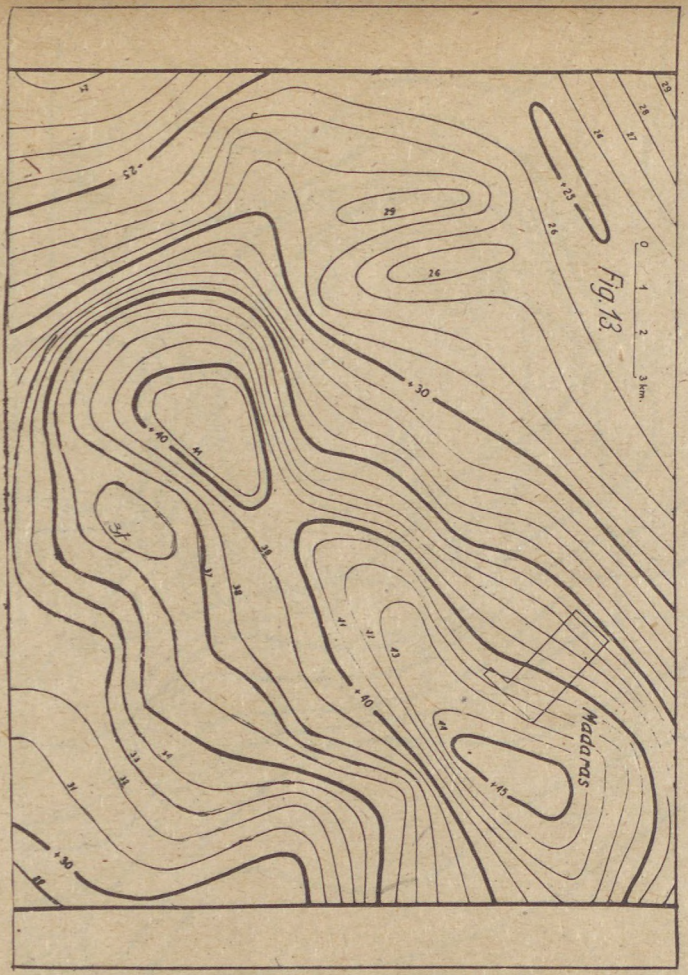

+30
+40
+25
0 1 2 3 km.
Madaras

Fig. 13.

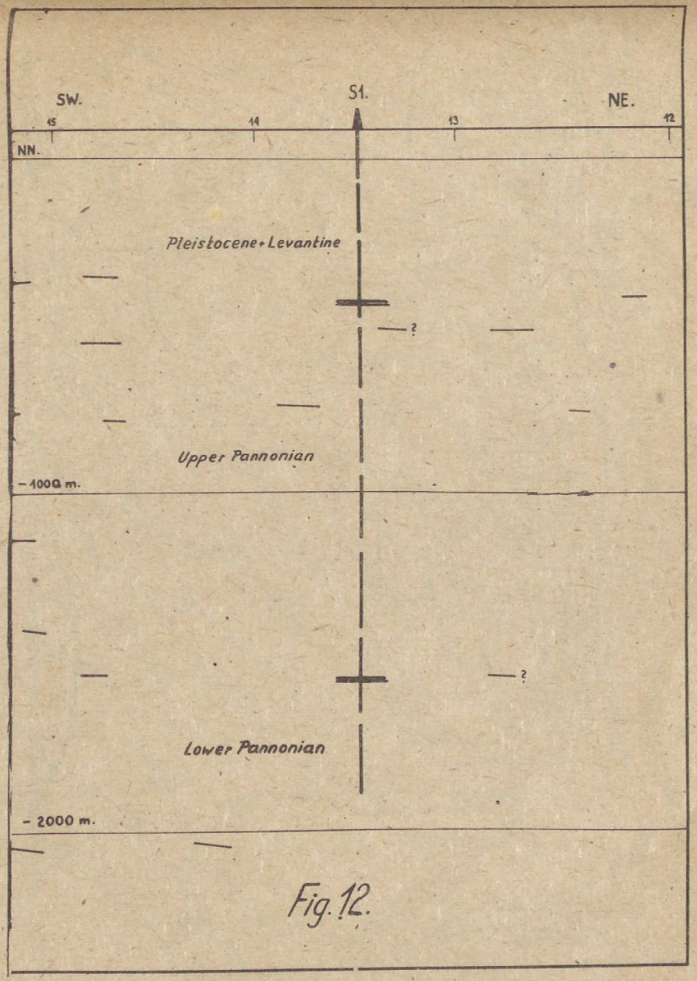

SW.
S1.
NE.
15
14
13
12
NN.
Pleistocene + Levantine
?
Upper Pannonian
– 1000 m.
?
Lower Pannonian
– 2000 m.

Fig. 12.

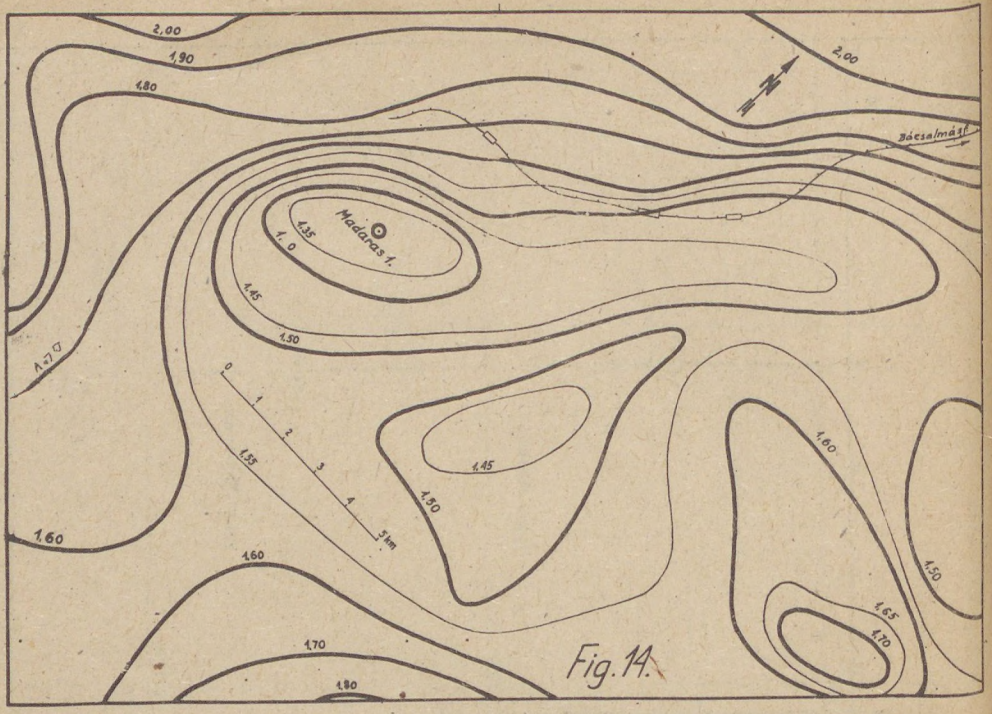

2,00
1,90
1,80
2,00
Bácsalmás
Madaras 1.
1,35
1,40
1,45
1,50
1,55
1,60
1,45
1,50
1,60
1,50
1,65
1,70
1,70
1,80
0 1 2 3 4 5 km

Fig. 14.

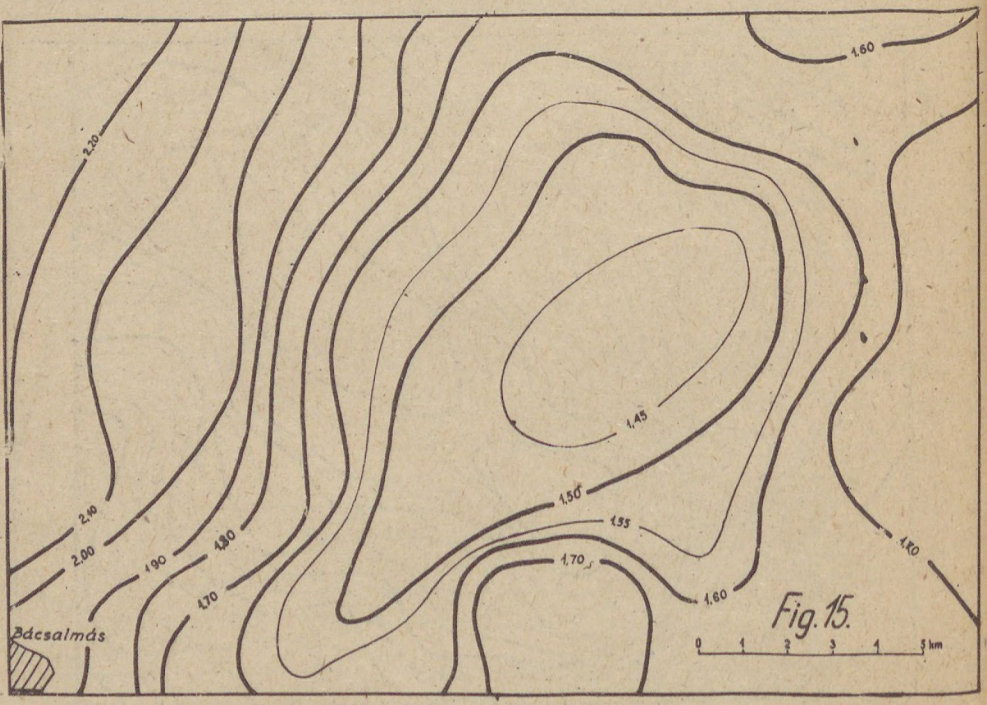

1,60
2,20
1,45
1,50
1,55
1,60
1,70
2,40
2,00
1,90
1,80
1,70
Bácsalmás
0 1 2 3 4 5 km

Fig. 15.

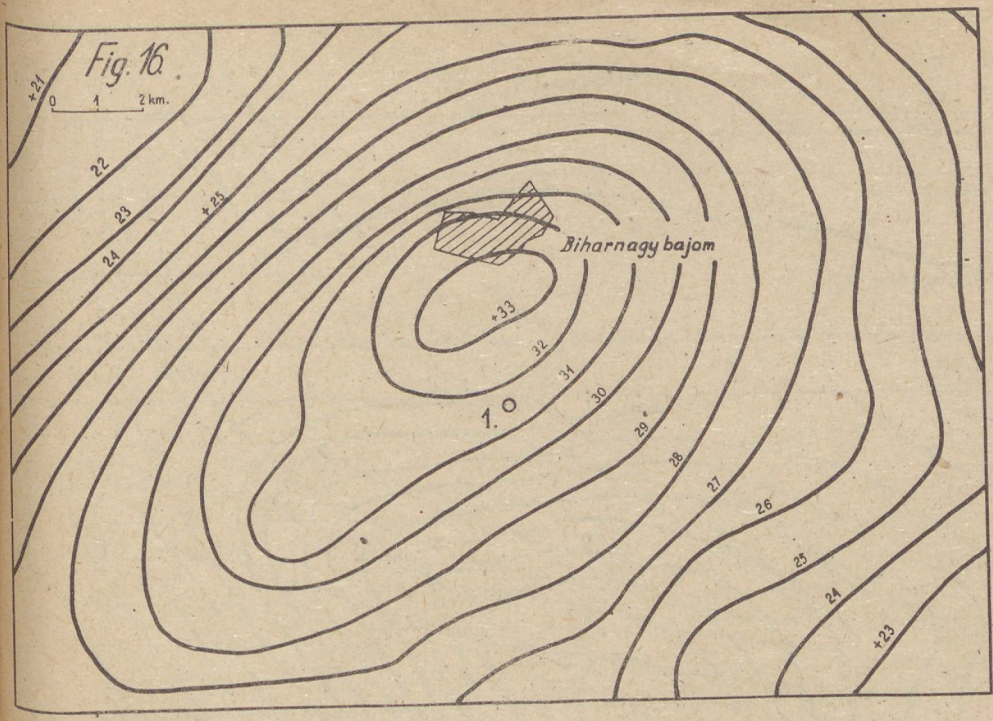


Fig. 16.
0 1 2 km.
Biharnagybajom
1.0
+21
22
23
24
+25
+33
32
31
30
29
28
27
26
25
24
+23

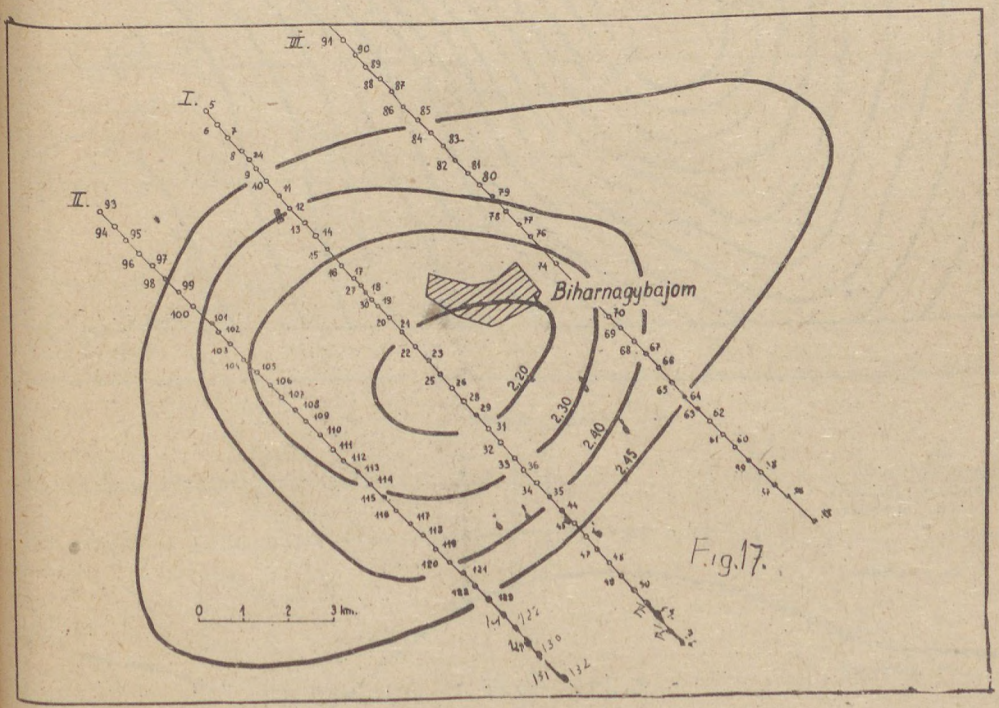

I.
II.
III.
Biharnagybajom
2.20
2.30
2.40
2.45
0 1 2 3 km.

Fig. 17.

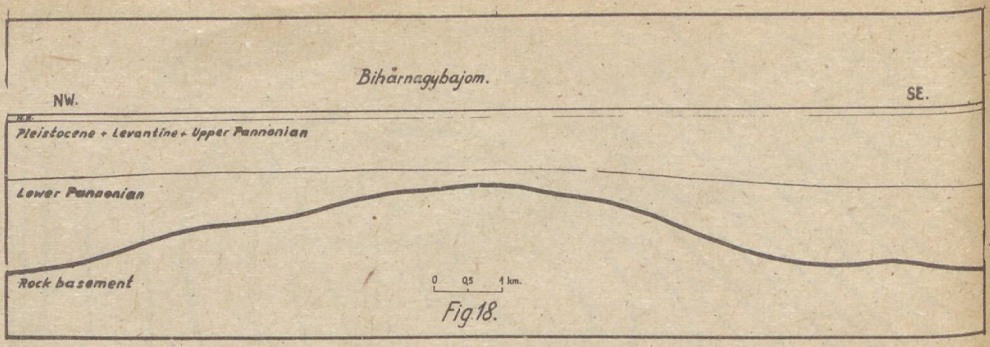


Fig.18.

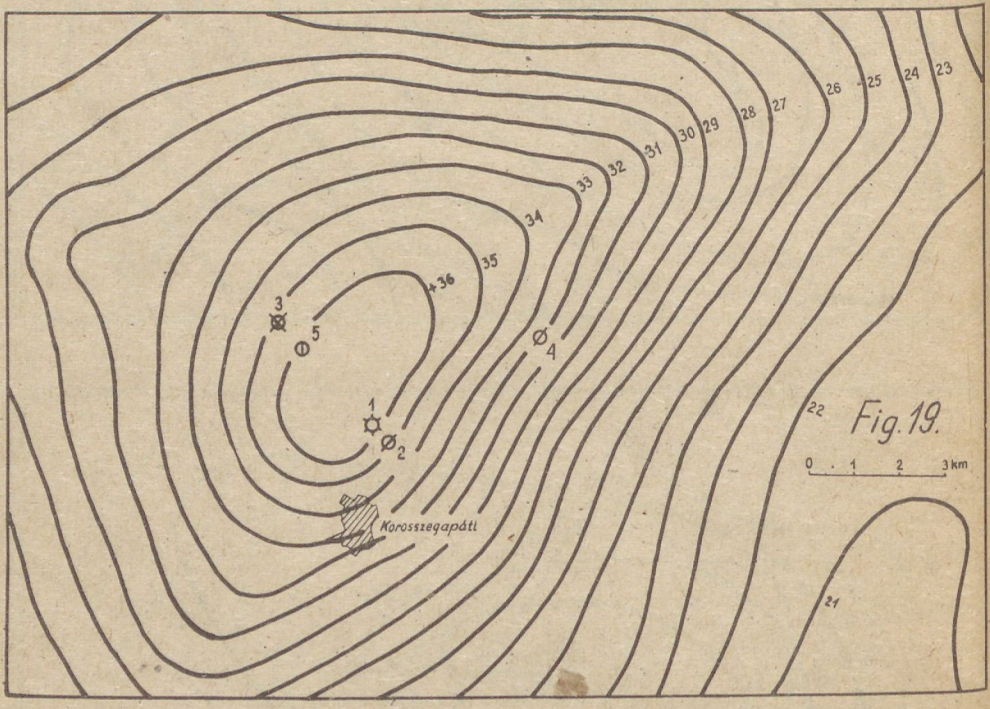


Fig.19.

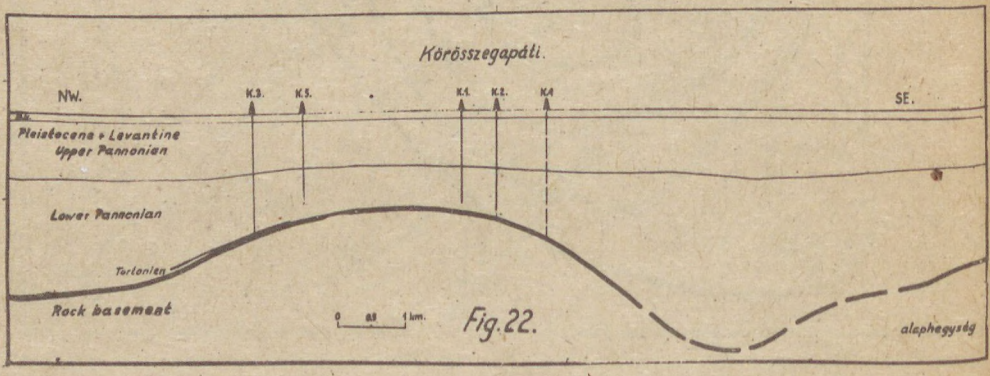


Fig.22.

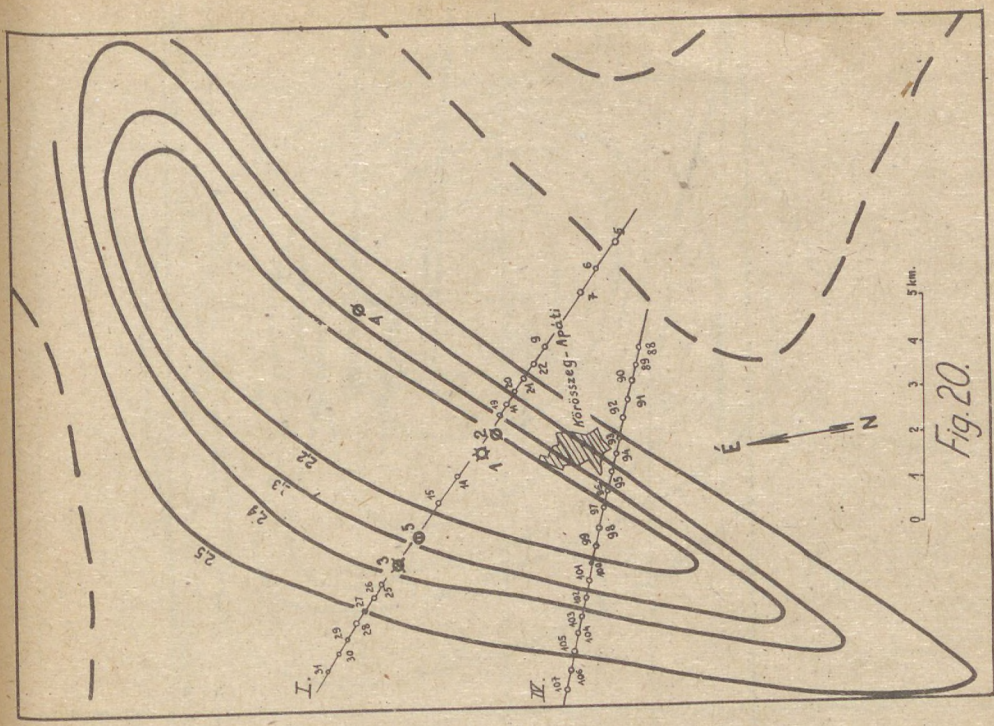

Körösszeg-Apáti
I.
II.
É
N
0 1 2 3 4 5 km.

Fig. 20.

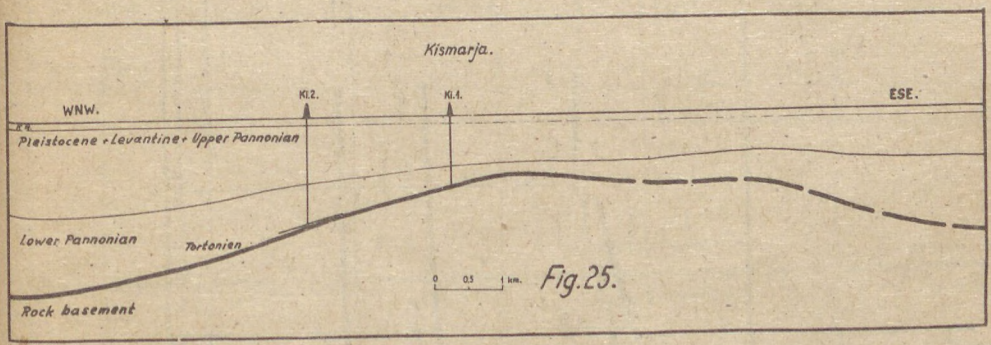

Kismarja.
WNW.
Ki.2.
Ki.1.
ESE.
Pleistocene + Levantine + Upper Pannonian
Lower Pannonian
Tortonien
Rock basement
0 0.5 1 km.

Fig. 25.

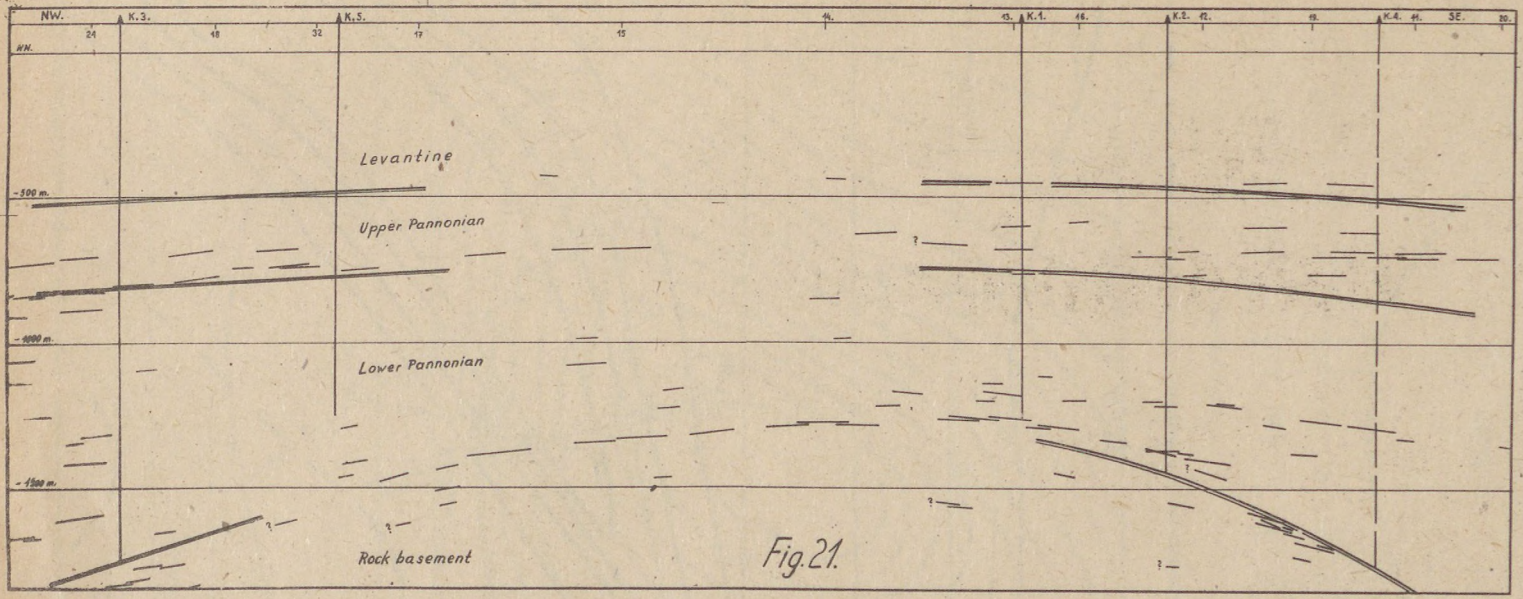

NW.
K.3.
K.5.
K.1.
K.2.
K.4.
SE.
24
18
32
17
15
14.
13.
16.
12.
19.
11.
20.
NN.
Levantine
-500 m.
Upper Pannonian
-1000 m.
Lower Pannonian
-1500 m.
Rock basement

Fig. 21.

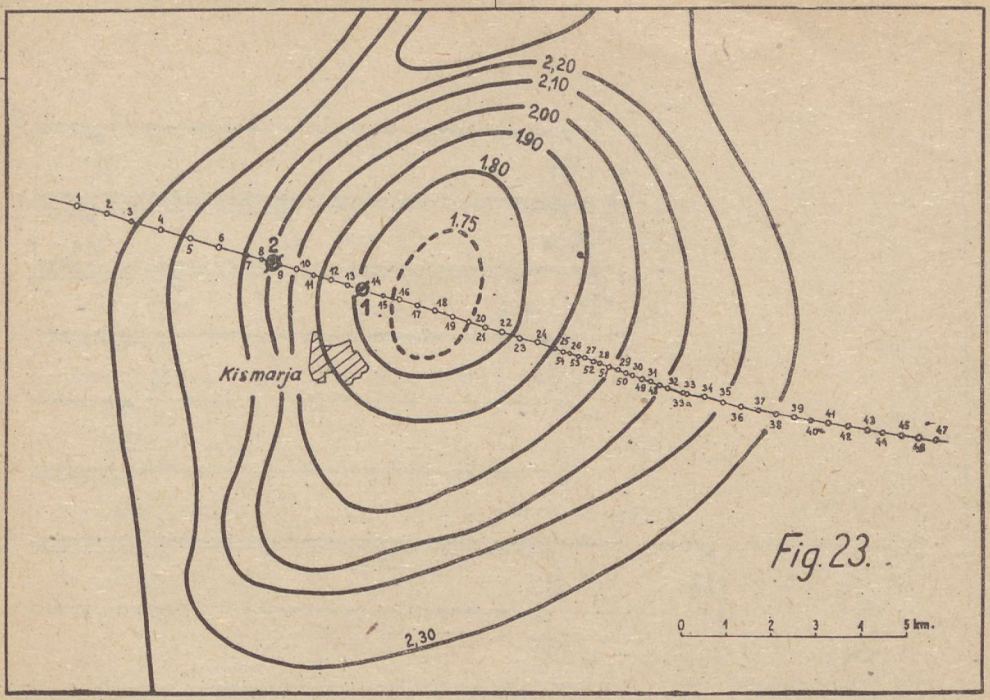

2,20
2,10
2,00
1,90
1,80
1,75
2,30
Kismarja
0 1 2 3 4 5 km.

Fig. 23.

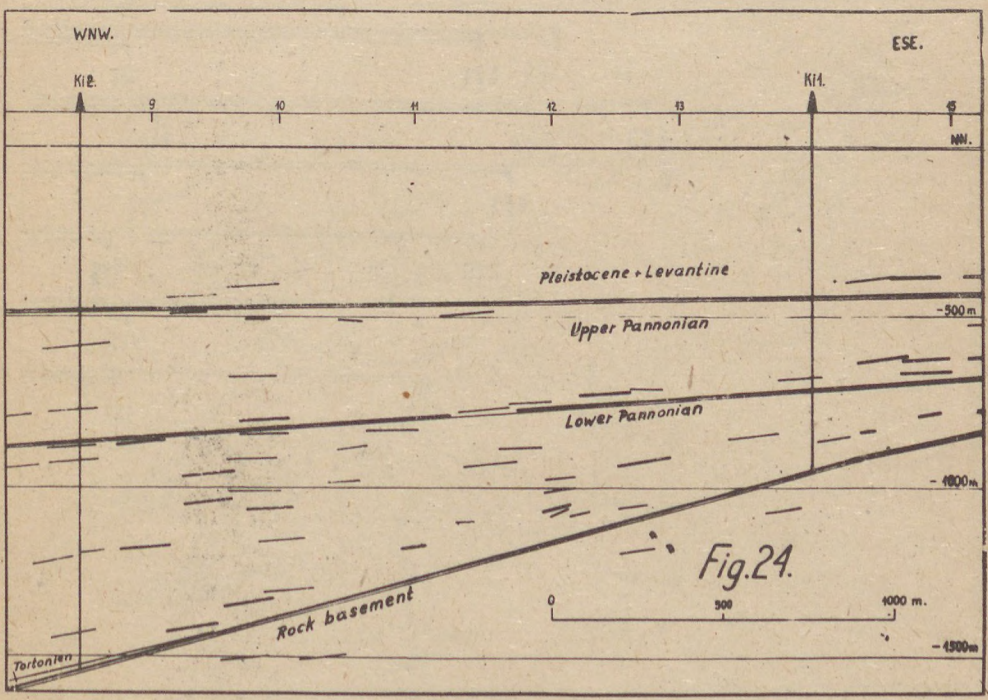

WNW.
ESE.
Ki2.
Ki1.
NW.
Pleistocene + Levantine
Upper Pannonian
Lower Pannonian
Rock basement
Tortonian
-500 m
-1000 m
-1500 m
0 500 1000 m.

Fig. 24.

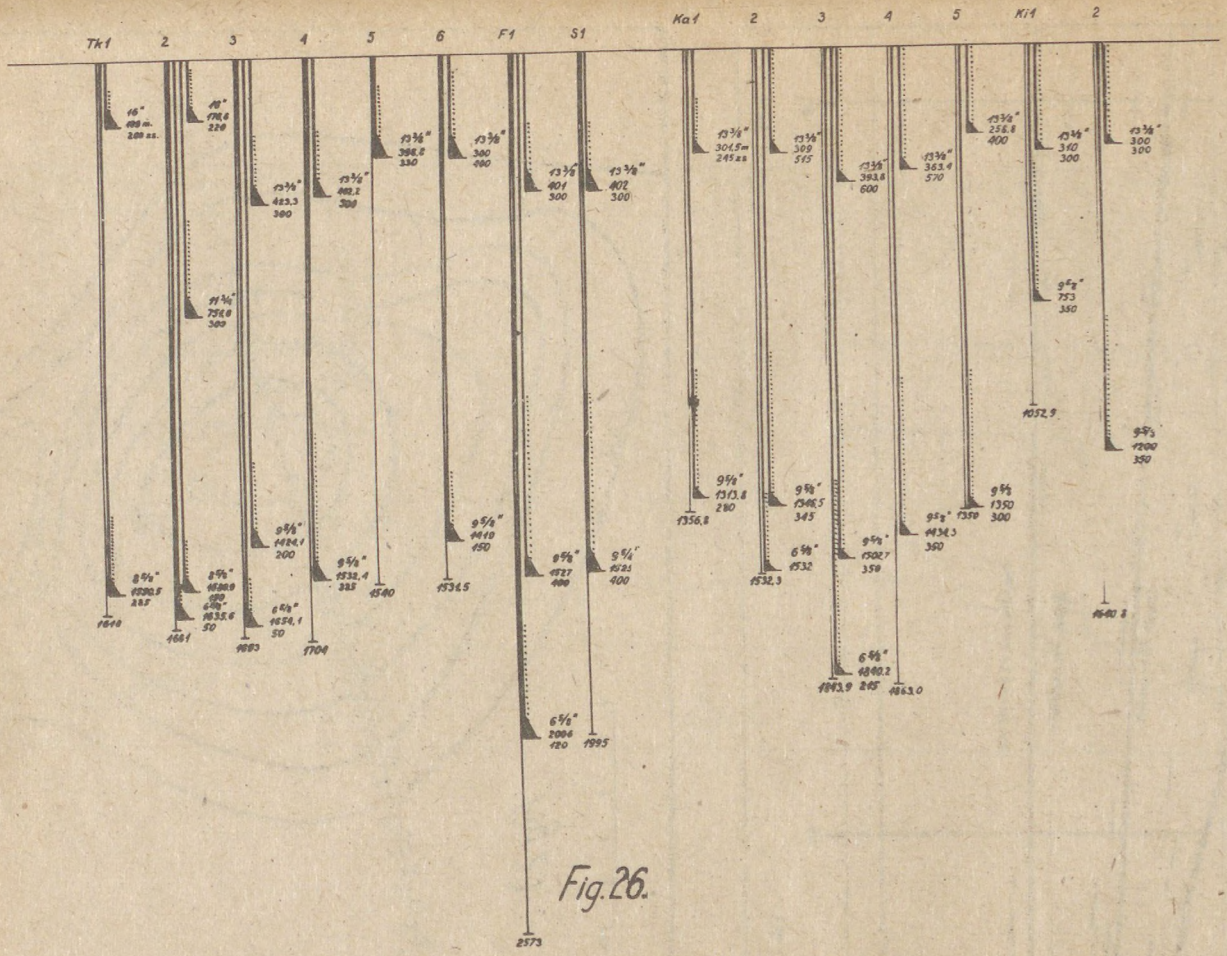
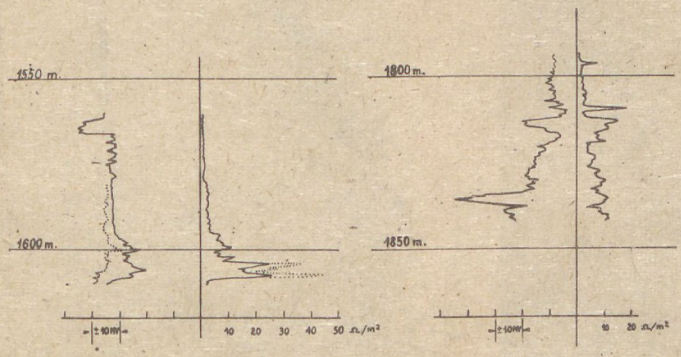


Fig. 26.



Tótkomlós 2. Körösszegapáti 3.

Fig.27.

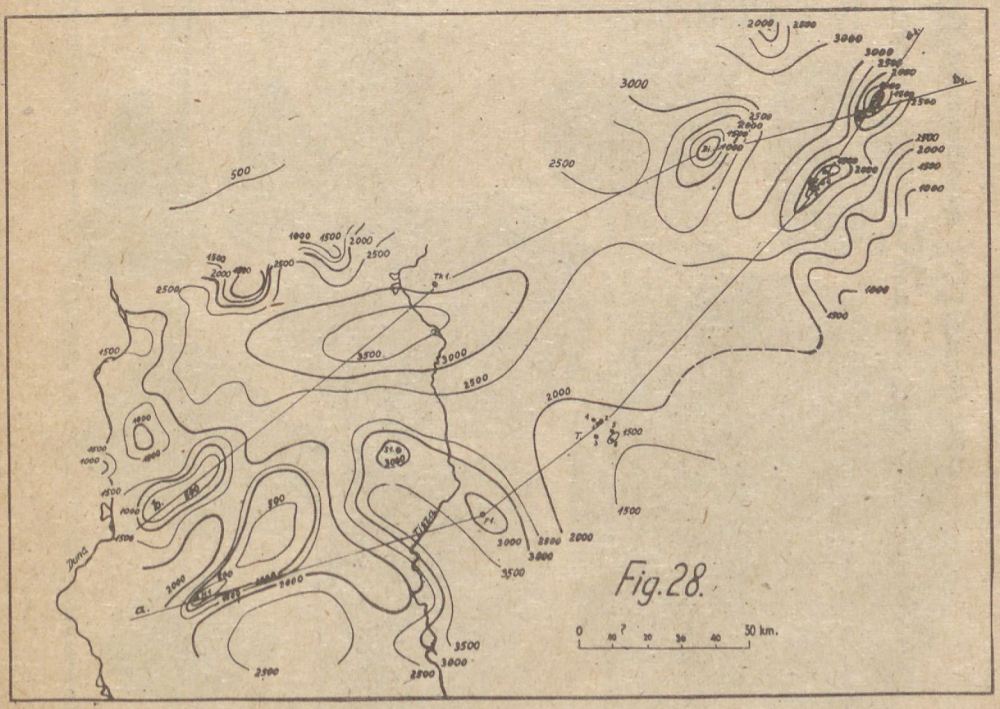


Fig.28.

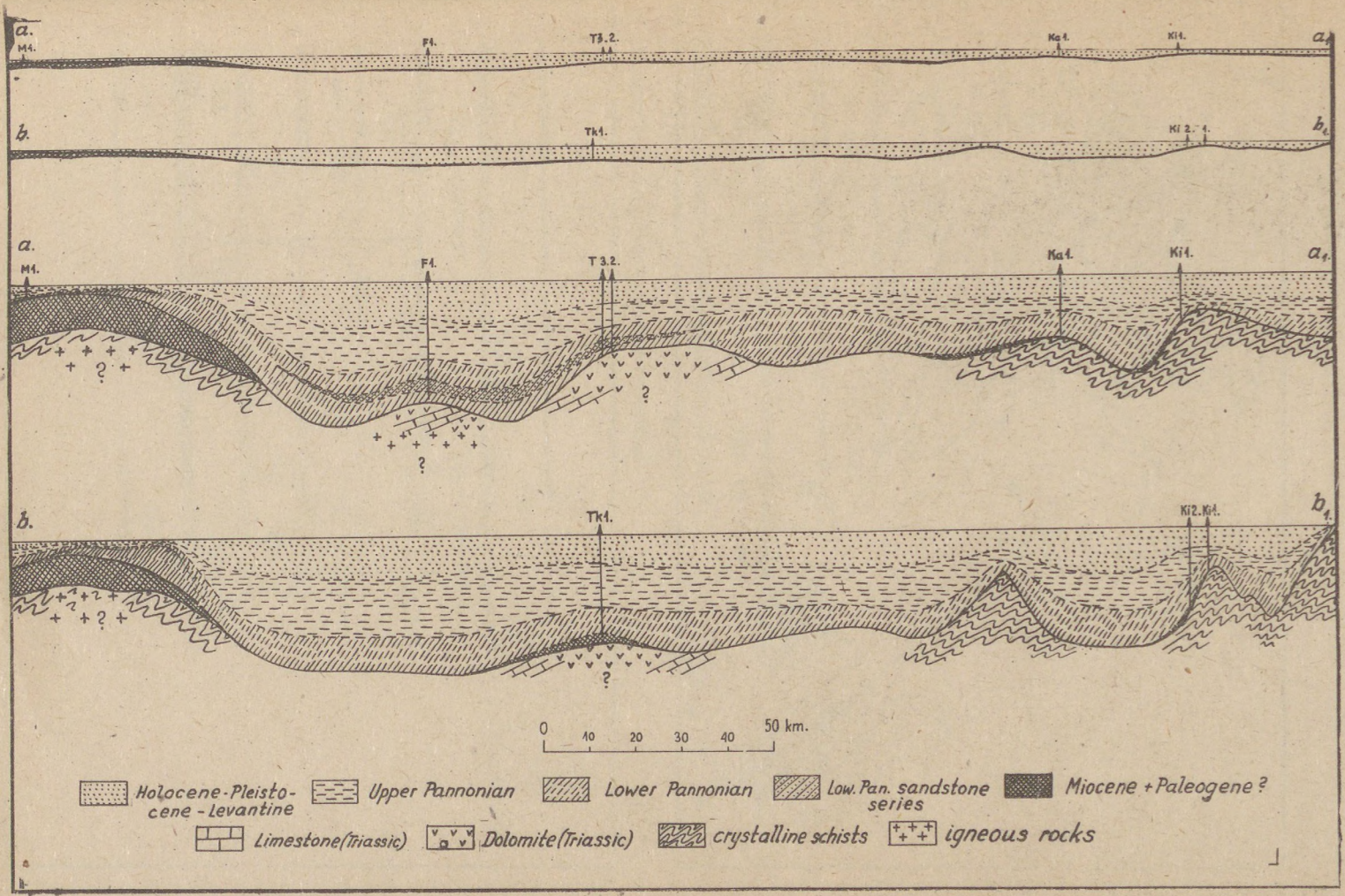
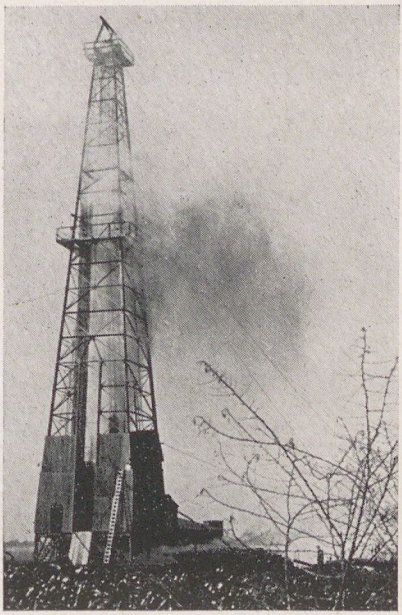
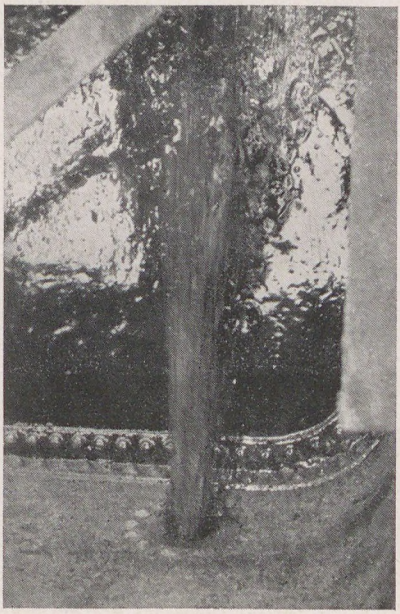

a.
M4.
F4.
T3.2.
Ka4.
Ki4.
a1
b.
Tk4.
Ki2.4.
b1
M4.
F4.
T 3.2.
Ka4.
Ki4.
a1
Tk4.
Ki2.Ki4.
b1
0 10 20 30 40 50 km.
Holocene-Pleisto-cene-Levantine
Upper Pannonian
Lower Pannonian
Low. Pan. sandstone series
Miocene + Paleogene ?
Limestone(Triassic)
Dolomite(Triassic)
crystalline schists
igneous rocks

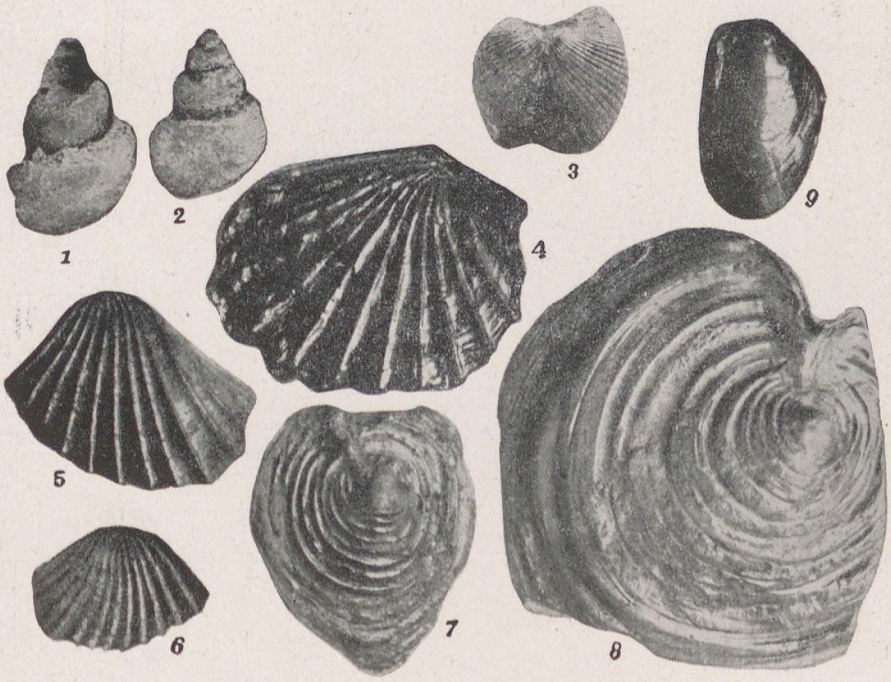
TABLE V.



1.



2.



3.

219 300338

Annales
Historico-Naturales Musei Nationalis Hungarici
Vol. XLI. Budapest, 1948. No. 2, p. 25–31.
Redigit: V. Székessy.

EIN NEUES AZURITVORKOMMEN AUS UNGARN.

Von V. Zsivny (Budapest).

(Mit 2 Abbildungen im Text.)

Im Jahre 1941 fand Dr. Franz Horusitzky im Mecsek-Gebirge (Südwest-Ungarn) in einem Kalksteinbruche Azurit, welcher zur Untersuchng in meine Hände gelangte.[1] Über die Ergebnisse derselben soll im folgenden berichtet werden.

Das Mineral ist in dunkelgrauem, dichtem Kalkstein als radialfaserige kugelartige, knollige, kornförmige oder fleckenartige Aggregate zu beobachten. Sie bestehen aus allerfeinsten Nädelchen, oder nach der Orthoaxe gestreckten, grösseren Kristallindividuen. Letztere können eine Länge von beinahe ½ cm erreichen, sie sind eng miteinander verwachsen und nur ihre äussersten Enden erheben sich aus der Oberfläche der Aggregate. In der Mitte der aus feinen Nädelchen bestehenden, im Durchschnitte seidenartig schimmernden Aggregate blieben manchmal Hohlräumchen, in welche dünntafelige Kriställchen hineinragen; unter diesen letzteren fand ich bloss ein einziges, welches freier ausgebildet und zugleich flächenreicher war. Zu näheren Untersuchung diente dieses Kriställchen (Krist. No. 1), ausserdem einer der obenerwähnten grösseren Kristalle (Krist. No. 2).

[1] Das Untersuchungsmaterial verdanke ich den Herrn Univers. Professoren E. Vadász und F. Horusitzky, ausserdem Herrn Dr. R. Streda.

M. T. AKADÉMIA KÖNYVTÁRA

Kristall No. 1. Das nach {$\bar{1}01$}, bezw. nach dieser naheliegenden Endflächen zweiter Art tafelige Kriställchen war mit einem Ende der Orthoaxe und zum Teil auch mit einer Fläche der Basis aufgewachsen. Die Länge in der Richtung der Orthoaxe betrug 1 mm, die Breite in dazu senkrechter Richtung 0·6 mm. Es konnten daran folgende 12 Formen bestimmt werden:

c {001}, m {110}, p {021}, σ {101}, P {223}
D {$\bar{1}04$} h {221}
$\mathcal{T}$ {$\bar{5}06$} R {$\bar{2}41$}
* {$\bar{7}08$} k {$\bar{2}21$}
Θ {$\bar{1}01$}

Ausser den oben angegebenen Endflächen zweiter Art konnten noch zwei weitere beobachtet werden, welche mit freiem Auge und mit der Lupe nicht unterscheidbar, sondern bloss durch ihre Reflexe voneinander trennbar waren;[2] es konnte jedoch nicht entschieden werden, ob die eine derselben als die noch nicht beobachtete Form {$\bar{7}06$} oder die bereits bekannte Form {$\bar{9}08$}, die andere als {$\bar{7}06$} oder die ebenfalls beobachtete Form {$\bar{6}05$} zu betrachten wäre. Im folgenden sollen diese beiden Formen (bloss povisorisch) kurz mit x_1, bezw. x_2 bezeichnet werden.

Die Kanten (221)/(021), (223)/(021), sowie die Ecke, gebildet von den Flächen (001), (223), (021) und ($\bar{1}04$), waren durch je eine sehr schmale bezw. winzige, nicht messbare, bloss mit dem Mikroskop zu beobachtende Fläche abgestumpft.

Die Formen der Orthozone waren mit Ausnahme von {101} mit voller Flächenzahl, {021} und {$\bar{2}41$} mit je einem Flächenpaare an einem Ende der Orthoaxe, alle übrigen Formen bloss mit je einer einzigen Fläche zu beobachten. Die Flächen von {$\bar{1}01$}, sowie die des Komplexes x_1, x_2 wiederholten sich 1 bis 2-mal. Das Kriställchen ist seiner natürlichen Ausbildung möglichst getreu, jedoch mit Weglassung der obenerwähnten, nicht messbaren kleinen Flächen, auf (010) projiziert, in Abb. 1 dargestellt. Weiters wurden die Flächen der einander sehr nahe liegenden Formen {$\bar{5}06$} und {$\bar{7}08$}, beziehungsweise x_1, und x_2, in der Abb. nicht getrennt, sondern zu je einer Fläche zusammengefasst dargestellt. Zur klareren Darstellung sind allein die Flächen der Form {$\bar{1}04$}, dann (101) und (22$\bar{1}$) verhältnismässig breiter, bezw. grösser als in Wirklichkeit.

[2] Ebenso schienen die Flächen von {$\bar{5}06$} und {$\bar{7}08$} mit freiem Auge oder mit der Lupe betrachtet, gleichzeitig zu reflektieren.

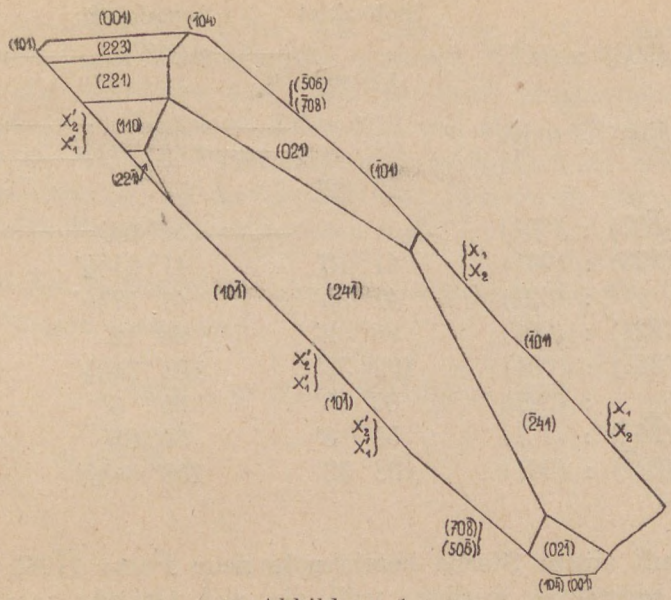


Abbildung 1.

Zur Bestimmung der beobachteten Formen dienten folgende Winkelwerte:

		beobachtet	berechnet[3]	Diff.
m c	(110) : (001)	87° 51'	88° 10'	— 19'
p c	(021) : (001)	60° 23'	60° 30'	— 7'
Θ	: ($\bar{1}$01)	70° 21'	70° 26½'	— 5½'
p''' R	(02$\bar{1}$) : ($\bar{2}$41)	51° 15'	51° 12½'	+ 2½'
R'''	: (24$\bar{1}$)	32° 44'	32° 46'	— 2'
σ c	(101) : (001)	44° 47½'	44° 44½'	+ 3'
D c	($\bar{1}$04) : (001)	14° 50½'	14° 37'	+ 13½'[4]
Ψ c	($\bar{5}$06) : (001)	42° 00'	41° 48'	+ 12'
	*($\bar{7}$08) : (001)	42° 56'	43° 11½'	— 15½'
Θ c	($\bar{1}$01) : (001)	47° 22½'	47° 10'	+ 11½'

[3] Die berechneten Werte beziehen sich auf die Elemente von P a l a c h e-L e w i s. (Crystallography of azurite from Tsumeb, Southwest Africa and the axial ratio of azurite, The American Mineralogist, **12**, 99—143, [1927]. Es soll hier erwähnt werden, dass in dieser Arbeit viele Winkelwerte und einige Symbole unrichtig mitgeteilt sind; diese wurden aber später [loc. cit. **27**, 334, 1942] richtiggestellt.)

[4] Nimmt man bloss die bessere Beobachtung, so ist beob. = 14° 43' und Diff. = + 6'.

		beobachtet	berechnet[3]	Diff.
$\mathfrak{P}$ c	$(\bar{9}08) : (001)$		50° 40'	+ 28'
x_1 c		51° 08'		
	$(\bar{7}06) : (001)$		51° 45'	— 37'
				+ 27'
x_2 c		52° 12'		
W c	$(\bar{6}05) : (001)$		52° 34'	— 22'
P c	$(223) : (001)$	41° 10'	41° 21½'	— 11½'
p	$: (021)$	41° 55'	41° 57½'	— 2½'
h c	$(221) : (001)$	68° 2'	68° 12'	— 10'
R''' c	$(24\bar{1}) : (001)$	102° 55'	102° 34½'	+ 20½'
R	$: (\bar{2}41)$	65° 3'	65° 6'	— 3'
R $\mathfrak{O}$	$(\bar{2}41) : (\bar{1}01)$	59° 8'	59° 25'	— 17'
k''' c	$(22\bar{1}) : (001)$	108° 32'	108° 34½'	— 2½'

Die mit einem Sterne bezeichnete neue Form $\{\bar{7}08\}$ muss als unsicher betrachtet werden, weil sie auf Grunde mangelhafter Reflexe bestimmt wurde. Auch das Auftreten der bereits bekannten Form $\{\bar{5}06\}$ konnte nur unsicher festgestellt werden.

Die $*\{\bar{7}08\}$ nahestehende Form $\{\bar{5}06\}$ beschrieb A. Łaszkiewicz von Medzianka (Polen).[5]

Über die Beschaffenheit der Flächen kann folgendes bemerkt werden:

Grösse: Unter den Flächen am Ende der Orthoaxe herrscht $(24\bar{1})$ vor, dann folgen $(\bar{2}41)$ und (021); (101) und die Flächen von $\{\bar{1}04\}$ erscheinen bloss als ausserordentlich schmale Streifen, die Fläche $(22\bar{1})$ als winziges Dreieck.

Glanz: Mit Ausnahme der Flächen von x_1 und x_2, deren Komplexe mit damastartigem Glanz erscheinen, sind die Flächen der übrigen Formen sämtlich glänzend, unter welchen sich die Flächen der Basis und von {021}, sowie je eine einzige beobachtete Fläche der Prismen vierter Art und von {110} mit besonderem Glanz hervortreten.

Reflexe: (001) gab einen sehr lichtstarken dreifachen Reflex; die

[5] Morfologja azurytów łysogórskich, Arch. Min. Tow. Nauk. Warszaw., 3 (für 1927), 129—153 (polnisch), 154—158 (französisches Résumé), [1928], S. 148 und in der Tabelle X. — Łaszkiewicz gibt die sphärischen Koordinaten der Projektion auf (010) an. Der in der obrigen Winkeltabelle mitgeteilte $(\bar{5}06) : (001)$ Wert bezieht sich auf die Palache-Lewis'schen Elemente.

Flächen der Prismen vierter Art und von {021}, ebenso (110) schmale, aber beinahe ausnahmslos einfache, die Endflächen zweiter Art ebenfalls schwache und meistens stark auseinandergezogene Reflexe. Das sehr schwache Reflexbild von (101), (00$\bar{1}$), ($\bar{1}$04) und (22$\bar{1}$) war im Fernrohre überhaupt nich zu beobachten, weshalb ich auf die Einstellung des Aufblinkens der Flächen in dem zur Lupe umgestalteten Fernrohre angewiesen war.[6]

Kristall No. 2. Ergänzt in Abb. 2. An diesem wurden bedeutend weniger Formen beobachtet:

c {001}?, m {110}, Θ {$\bar{1}$01}, h {221}

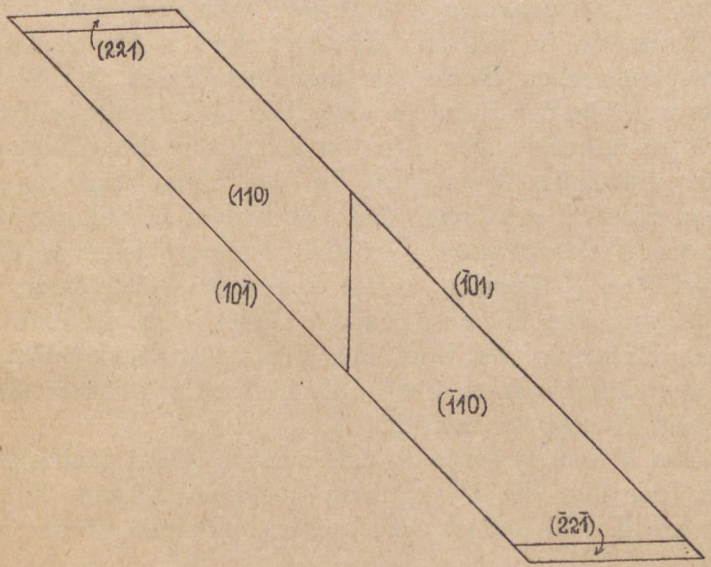


Abbildung 2.

Die Basis erscheint wahrscheinlich (mit beiden Flächen), sie war aber durch Messung nicht verifizierbar. {$\bar{1}$01} konnte bloss mit einer Fläche, {110} und {221} mit je einem Flächenpaare an einem Ende der Orthoaxe beobachtet werden. Beobachtete und berechnete Winkelwerte:

[6] Wenn ihre Messung zu einer solchen Fläche erfolgte, deren Reflex sonst gut zu beobachten gewesen wäre, wurde auch letztere Fläche zum Anfblinken eingestellt, oder eine entsprechende Einstellungskorrektur angewendet.

		beobachtet	berechnet	Diff.
m m'''	(110) : ($\bar{1}$10)	98° 47'	98° 54'	— 7'
Θ'm'''	(10$\bar{1}$) : ($\bar{1}$10)	122° 17'	122° 20½'	— 3½'
m	: (110)	57° 49½'	57° 39½'	+ 10'
h m	(221) : (110)	19° 36'	19° 57½'	—21½'
Θ'	: (10$\bar{1}$)	74° 25'	74° 39½'	—14½'

Auf diesem Kristall erschien auch die Fläche (10$\bar{1}$) mit starkem Glanze, die Flächen von {221} gaben aber schwache, schlechte Reflexe.

Der Azurit wird von maximal 1 mm erreichenden, meistens abgerundeten, aufgewachsenen Calcitkriställchen begleitet.

Der Kalkstein in welchem Horusitzky den Azurit fand, gehört zur anisischen Stufe der mittleren Trias. Der Steinbruch selbst, aus welchem der Fund stammt, liegt nebst anderen Kalksteinbrüchen 6 km nördlich von Pécs, in der Nähe des Höhenpunktes 483 m der Spezialkarte 1:75,000, in der Umgebung des „Hegerhauses von Kozár", uzw. nach der mündlichen Mitteilung von Vadász in dem Teile des erwähnten Kalksteines, welcher an die Wengener Schichten (ladinische Stufe) angrenzt.[7] Nach einer mündlichen Mitteilung von Horusitzky findet sich die den Azurit enthaltende Kalksteinbrekzie in einer steinmarkartigen Substanz von grüner, oder rötlichbrauner Farbe, die in der Hauptmasse des Kalksteines einen Hohlraum ausfüllt.

Aus dem Mecsek-Gebirge ist eine dem neogenen pazifischen Vulkanismus (der hier die Pyroxenamphibolandesit-Masse in der Gemarkung von Komló-Budafa erzeugte) angehörende Vererzung nicht bekannt.[8]

Das Vorkommen von Azurit im Mecsek-Gebirge ist deshalb interessant, weil dieses Kupfererz, bezw. das vorläufig noch unbekann-

[7] Über die geologischen Verhältnisse des Mecsekgebirges siehe: Elemér Vadász, A Mecsekhegység, 1—148, mit deutschem Auszuge: Das Mecsekgebirge, 149—180, mit 1 geologischen Karte und 55 Figuren auf S. I—XXV. (Geologische Beschreibung ungarischer Landschaften I, herausgegeben von der „Königl. ung. geologischen Anstalt", Budapest, [1935]).

[8] Miklós Vendel, Studien aus der jungen karpathischen Metallprovinz, Mitteilungen der berg- und hüttenmännischen Abt. an der ung. Palatin-Joseph Universität für technische und Wirtschaftswissenschaften, Sopron, Ungarn, 16, 93, [1944—47].

tes Primärerz, als erste Indikation auf die Möglichkeit hinweist, dass sich auch in diesem Gebirge eine eventuell mit dem obengenannten jüngeren Vulkanismus verknüpfte hydrothermale Erzbildung abspielen konnte.

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