RELATIONES ANNUAE INSTITUTI GEOLOGICI PUBLICI HUNGARICI

ANNUAL REPORT

OF THE HUNGARIAN GEOLOGICAL SURVEY

FOR THE YEAR 1991

PART II

RELATIONES ANNUAE INSTITUTI GEOLOGICI PUBLICI HUNGARICI

ANNUAL REPORT

OF THE HUNGARIAN GEOLOGICAL SURVEY FOR THE YEAR 1991 PART II

HUNGARIAN GEOLOGICAL SURVEY, BUDAPEST

1993 JULY

Editor:

ISTVÁN JANKOVICH PH. D.

Translated by

† ÁRPÁD KISS

LORÁND AKÁB

English revised by

SÁNDOR VÉGH PH. D.

Published by the Hungarian Geological Survey
Responsible Publisher:

GÁBOR GAÁL PH. D.
Director General

HU ISSN 1216-819X

Printed in the Hungarian Geological Survey
Budapest, 1993

CONTENTS — TARTALOM

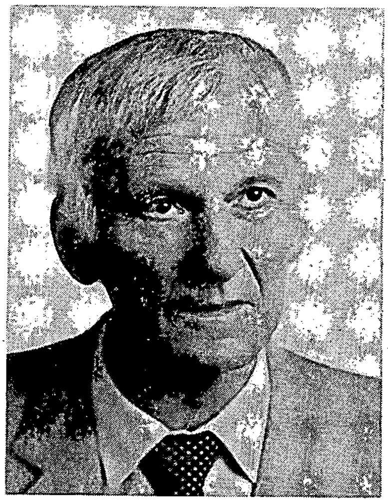
TO THE MEMORY OF ANDRÁS RÓNAI 1906—1991

by

GYÖRGY VITÁLIS

Hungarian Geological Survey
Budapest, Stefánia út 14.
H-1143

UDC: 929:55



DR. ANDRÁS RÓNAI
1906—1991

On 13 August, 1991, after a long disease DR. ANDRÁS RÓNAI an Academic Doctor of Earth Sciences, retired Head of Department and Scientific Counsellor of the Hungarian Geological Institute deceased.

This brief commemoration is not competent to give a full picture of the oeuvre of the excellent scientist of Hungarian geology who devotedly loved his fatherland and the Hungarian earth. It may only attempt to offer a brief summary for the present and future generations.

ANDRÁS RÓNAI was born as son of András Rónai Sr. of Csikdelnek and Berta Pintér-Szabó of Szilágycsehi in Nagyszeben (S Transylvania) on 13 June, 1906. He finished his elementary and secondary school studies in Nagyszeben, completing this latter in Kolozsvár where he passed the final examination with honours.

In the autumn of 1924 he went to Budapest University of Medicine but due to financial difficulties he had to take a job soon, and this is why later he continued his studies at the Faculty of Economics of the Budapest Technical University. Here he made his studies at the Department of Economic Geography then, after obtaining a diploma in economics in 1931, he took his Ph. D. in geography, statistics and traffic policy in 1935.

In 1928 he joined the Institute of Politics of the Hungarian Statistical Society where he was engaged in collecting and evaluating data related to the geography, population and the economic and cultural conditions of Central European countries.

In 1933 he married Klára Harbuth, a teacher of geography and chemistry, who, at the same time, became also a professional associate. Of this marriage three children were born, Klára (1934), Pál (1940) and András (1942).

In 1934 he became a Secretary to the director, then Deputy Director at the Institute of Politics.

After study tours to Austria Czechoslovakia and then to the countries of the Balkan Peninsula he spent a half year in Geneva studying the work of the institutions of the League of Nations.

In the autumn of 1938 he was invited by the Faculty of Economics of the Budapest Technical University as Deputy to Professor Count Pál Teleki to lecture on political geography. In 1938 and 1940, as an expert in geography and in the problem of national minorities, he participated in the elaboration of preliminary scientific studies for solving national border problems under the guidance of Pál Teleki. A detailed account of this work is given in his volume "Térképezett történelem" (A Mapped History) published in 1989.

In December, 1940 he became Professor at Kolozsvár University, but still in the very same year he was invited as Professor to the Department of Political Geography at the Faculty of Economics of the Budapest Technical University. After Pál Teleki's death in 1941, he was also in charge of the Department of Economic Geography where as Head of the Department and Institute he worked till the end of 1948.

Beside his work at the University he also headed the Institute of Politics where he was appointed director in 1940. Here he compiled and, in the Institute's printing shop, published the Central European Atlas with a generalizing account of the geology, geography, population and economic conditions of nine countries, with 171 maps and ample references.

In 1949, when reorganizing the Department of Economy, he was moved to the Széchényi Library of the Hungarian National Museum, and then, following the winding-up of the Department, he retired at the age of 43 at the end of 1949.

In February, 1950, as Head of the Department of Map Plotting, he joined the Hungarian Geological Institute under the directorship of Sándor Vitális. In 1950—1955 he took part in the mapping of the country's lowland areas. In 1954 he became Head of the Department for Lowland Research, and in 1956 he published the summary of the results of exploration of the phreatic water table in lowland-type areas. For making a display of high-quality work in this field, he won the "Bogdánfy Ödön Medal" by the Hungarian Hydrological Society in 1955.

Between 1957 and 1968 he started the remapping of the lowland-type geological surveys. As a result, the first Atlas on a scale of 1:200 000 of the Eger region was published, which was followed by the publication of other map sheets of the Great and Little Hungarian Plains.

The series was completed in 1974. In the explanatory notes edited and attached to maps a comprehensive geological description of the area of the Great Hungarian Plain is given. In appreciation of his work he gained the badge. "Distinguished Record in Geoexploration" two times, and in 1965 he was rew-arded with the "Silver Degree of the Order of Labour", issued by the State. In 1964, under his direction, a new complex mapping of the Great Hungarian Plain was commenced. This mapping, exceeding the surface geological conditions, was aimed at the complex exploration of the Quaternary sequence of the basin of the Great Hungarian Plain. The results of the first nine years of these investigations were described in "Quaternary sedimentation and climatic history in the basin of the Great Hungarian Plain", published in 1972. The geological key boreholes were converted into artesian water check-wells, and thus the systematic monitoring of the subsurface water movement for the whole territory of the Great Hungarian Plain was started. As the first volume describing the results of this work, the "Szolnok Atlas" was published in 1969, on the occasion of the Centenary Celebrations of the Hungarian Geological Institute.

The following volumes, Csongrád, Heves, Tiszafüred, Hódmezővásárhely, Püspökladány, etc. were continuously published after each other.

In appreciation of his work, he was rewarded with the "Koch Antal Medal" by the Hungarian Geological Society in 1969, and with the "Vásárhelyi Pál Prize", the highest decoration of his by the Hungarian Hydrological Society in 1971. He was declared Academic Doctor of Earth Sciences by the National Postgraduate Degree Granting Board of the Hungarian Academy of Sciences in 1975. His scientific work, according to his own listing, brought new results in the following fields:

1. The conveyance of general information on the geology, geographysics, population and economic potentials of Central Europe to the public at large, dealing with a region of changing fate but of importance, on which no summarizing overlook had been given because of the high variety of languages, the changing national borders, the unlike public administration and registration, the censuses held at different dates and by applying different methods, and also owing to political hostilities and isolation, is first mentionable.

2. The working out of the way now to get at a better understanding of the following the trends laid down by Béla Inkey, Peter Treitz, Henrik Horusitzky, Ferenc Nopcsa and József Sümeghy. Concerning the new results achieved in this field, the modern and several-dimensional geological maps, the extension of the scope of the observed and mapped phenomena, and the improvement of plotting techniques through the introduction of new methods, can be mentioned.

3. The study of the groundwater conditions of the Great Hungarian Plain, including the description of the position, flow and hydrochemistry of the subsurface waters are of pioneering importance.

4. The meeting of on old requirement by the construction of ground-water table checkwells and the processing of the obtained data.

5. The sedimentological description of the Quaternary layers of the basin of the Great Hungarian Plain, the recognition of the sedimentary cycles and their interpretation are also important.

6. By plotting geological and hydrogeological profiles, a comprehensive overlook was first given on the hydrodynamic and temperature anomalies and the water quality changes in the Quaternary complex of the basin of the Great Hungarian Plain.

7. Pollen analyses of the borehole samples were used by him for the indication and description of the climatic periods of the Quaternary. On the basis of these climatic periods, the time sequence of the cycles of subsidence were established in borehole sections.

8. He has demonstrated the Quaternary tectonic movements on profiles and maps, showing the phases of subsidence and uplift, their size, tendency and movement direction, and outlining the mobile and stable areas.

9. He issued a series of subject maps of the lowland areas. Hydrogeological and engineering-geological mapping were demonstrated through practical examples. The geological map series of the Great Hungarian Plain of several versions, on a 1:200 000 scale, and the respective explanatory notes were prepared upon his conception. For one fifth of the territory of the Great Hungarian Plain the complex geological mapping on a 1:100 000 scale was planned and carried out till 1972, comprising six atlases with explanatory notes plotted on a scale of 1:100 000.

10. The representation technique of the subject maps was improved by applying new methods.

11. The foundations of the geological data base of the lowland-type areas were laid in the order of the map sheets of 1:100 000.

12. Accounts of the Quaternary investigations in Hungary were given also abroad and at international conferences.

In 1978 he was elected Honorary Member of the Hungarian Geological Society and the Hungarian Hydrological Society.

He also took part in the edition of the "Geological map of Hungary" scaled to 1:500 000, to be published in the "Geological Atlas of Hungary", with the inclusion of a relief map (1984).

In 1985 he published his monograph "The Quaternary geology of the Great Hungarian Plain" summarizing his whole scope of activities in this field. By this work he won the "Szabó József Medal", the highest honour of the Hungarian Geological Society.

In the course of his public activity he took part in the work of several international and Hungarian conferences representing several Hungarian and international scientific organizations. He visited 17 European countries, travelled to the United States, Canada, the Soviet Union, Egypt, India and Japan.

Till the end of 1991 51 books, atlases, map-booklets and explanatory notes brochures, several map sheets and 132 studies were published by him, several of them in foreign languages.

At the age of 80, on 30 June, 1986 he retired and on this occasion he was rewarded with the "Golden Degree of the Order of Labour". On the occasion of his 85th birthday, as an appreciation of life-work he was honoured with the "Order of Banner of the Hungarian Republic".

When we bend our head as a sign of respect and affection, to A. Rónai, the deceased member of the Hungarian Geological Institute, we may console ourselves with the thought that he did not live in vain. He did his best in serving his country, the Hungarian science and people. His life and work should be a lesson and example for the coming generations.

BIBLIOGRAPHY OF DR. ANDRÁS RÓNAI'S SCIENTIFIC WORKS

A. Books, monographs, maps, atlases

Biographie des frontieres politique du Centre-Est Européen. Budapest, 1936.

RÓNAI, A.—TELEKI P.: The different types of ethnic mixture of population International Studies Conference 1937. Budapest, 1937.

Magyarország nemzetiségi térképe az 1910. évi népszámlálás alapján 1:500 000. Budapest, 1940.

Magyarország történelmi területének néprajzi térképe az 1930—1939 évi népszámlálások alapján 1:750 000. Budapest, 1940.

Hazánk. — Nemzetnevelők könyvtára. Budapest, 1942.

Tableau ethnique du Bassin des Carpates. — Revue d' Historie Comparée. 1:1—26. 1943.

Közép-Európa települési térképe 1:1 000 000. Budapest, 1944.

Közép-Európa Atlasz. — Kiadja az Államtudományi Intézet. Budapest—Balatonfüred, 1945.

Atlas of Central Europe. — Ed. Institute of Political Sciences. Budapest—Balatonfüred, 1945.

RÓNAI, A.—BOGNÁR G.—KÉZ A.—TAKÁCS J.—TALLIÁN F.—TELEKI G.: A Dunavölgy és környéke. Térkép 6 variációban. — A Magyar Földrajzi Intézet Rt. kiadása. Magyar, angol, orosz kiadás 1:1 000 000. Budapest, 1947.

RÓNAI, A.—TELEKI G.: A Dunavölgy. Magyarázó a Dunavölgy egymilliós térképéhez 6 variációban. — Egyetemi nyomda, Budapest, 1948.

A magyar medencék talajvize. Az országos talajvíztérképező munka eredményei 1950—1955. — A MÁFI Évkönyve, XLVI (1): 1—245. 1956.

RÓNAI, A.—BALOGH K.—ERDÉLYI M.—KRETZOI M. et al.: Magyarország földtani térképe 1:300 000. — A MÁFI kiadása, Budapest, 1956.

Az Alföld talajvíztérképe. Magyarázó a talajvíztükör felszínalatti mélységének 1:200 000 méretű térképéhez. (Ground water myp of the Great Plain in Hungary. Explanations to the map of subsurface depth of groundwater, scale 1:200 000). A MÁFI kiadása, Budapest, 1961.

RÓNAI, A.—BALOGH K.: Magyarország földtani térképe 200 000-es sorozat. L-34-III. Eger, 6 változat. — A MÁFI kiadása, Budapest, 1962.

RÓNAI, A.—MOLDVAY L.: Magyarország földtani térképe 200 000-es sorozat. L-34-IV- Debrecen, 5 változat. — A MÁFI kiadása Budapest, 1963.

RÓNAI, A.—BALOGH K.: Magyarázó Magyarország 200 000-es földtani térképsorozatához. L-34-III. Eger. — A MÁFI kiadása, Budapest, 1965.

RÓNAI, A.—MOLDVAI L.: Magyarázó Magyarország 200 000-es földtani térképsorozatához. L-34-IV. Debrecen. — A MÁFI kiadása, Budapest, 1966.

RÓNAI, A.—JÁMBOR Á.—MOLDVAI L.: Magyarázó Magyarország 200 000-es földtani térképsorozatához. L-34-II. Budapest. — A MÁFI kiadása, Budapest, 1966.

RÓNAI, A.—BOCZÁN B.—FRANYÓ F.—FRITS J. et al.: Magyarázó Magyarország 200 000-es földtani térképsorozatához. M-34-XXXIV. Sátoraljaújhely. — A MÁFI kiadása, Budapest, 1966.
Magyarázó Magyarország 200 000-es földtani térképsorozatához. L-34-IX. Szolnok. — A MÁFI kiadása, Budapest, 1967.
RÓNAI, A.—BÓCZÁN B.—FRANYÓ F.—SZŰCS L.—SZEPESHÁZY K.: Magyarázó Magyarország 200 000-es földtani térképsorozatához. L-34-VIII. Kecskemét. — A MÁFI kiadása, Budapest, 1967.
The Quaternary of the Hungarian Basin. — Guide to Excursion Inter. Geol. Congress. Prague, 1968.
Guide to excursion on Hydrology and Engineering Geology. -K.B.G.A. IX. Kongr. Budapest, 1969.
Kirándulásvezető a mérnökgeológiai és hidrogeológiai kiránduláshoz. A Kárpát—Balkán Földtani Asszociáció IX. Kongresszusa, Budapest, 1969.
Az Alföld földtani atlasza 1:100 000. Szolnok. — A MÁFI kiadása, Budapest, 1969.
Magyarázó Magyarország 200 000-es földtani térképsorozatához. L-34-XIV. Kiskunhalas. — A MÁFI kiadása, Budapest, 1971.
Negyedkori üledékképződés és éghajlattörténet az Alföld medencéjében. — A MÁFI Évkönyve, LVI (1): 1—421. Műszaki Kiadó, Budapest, 1972.
RÓNAI, A.—SZENTES F.: Magyarázó Magyarország 200 000-es földtani térképsorozatához. L-34-VII. Székesfehérvár. — A MÁFI kiadása, Budapest, 1972.
RÓNAI, A.—BOCZÁN B.—FRANYÓ F.—KŐRÖSSY L. et al.: Magyarázó Magyarország 200 000-es földtani térképsorozatához. L-34-XV. Szeged—L-34-XVI. Gyula. — A MÁFI kiadása, Budapest, 1974.
RÓNAI, A.—BOCZÁN B.—CSÍKY G.—FRANYÓ F. et al.: Magyarázó Magyarország 200 000-es földtani térképsorozatához. L-34-X. Békéscsaba. — A MÁFI kiadása, Budapest, 1975.
RÓNAI, A.—ALFÖLDI L.—BALOGH K.—RADÓCZ GY.: Magyarázó Magyarország 200 000-es földtani térképsorozatához. M-34-XXXIII. Miskolc. — A MÁFI kiadása, Budapest, 1975.
Az Alföld földtani atlasza. Heves. — A MÁFI kiadása, Budapest, 1975.
Guide to Excursion. International Postgraduate Training Course on the Principles and Methods of Engineering Geology. — A MÁFI kiadása, Budapest, 1975.
Az Alföld földtani atlasza. Tiszafüred. — A MÁFI kiadása, Budapest, 1976.
Guide to Excursion IAH—IASH. International Hydrogeological Conference. — Hung. Geol. Institute, Budapest, 1976.
(ed.): Hydrogeology of Great Sedimentary Basins. Proceedings of the Budapest Conference, May/June 1976, IAH—IAHS. Annales Instituti Geologici Publici Hungarici, LIX/1-4, 829 p. Budapest, 1978.
Az Alföld földtani atlasza. Hódmezővásárhely. — A MÁFI kiadása, Budapest, 1978.
Engineering Geological Mapping. Supplement Internat. Postgraduate Trining Course on the Principles and Methods of Engineering Geology. — A MÁFI kiadása, Budapest, 1979.
RÓNAI, A.—SZEPESHÁZY K.: Az Alföld föltani atlasza. Karcag. — A MÁFI kiadása, Budapest, 1979.
RÓNAI, A.— KŐRÖSSY L.—SZÉLES M.: Az Alföld földtani atlasza. Szeged. — A MÁFI kiadása, Budapest, 1979.
Az Alföld földtani atlasza. Püspökladány. — A MÁFI kiadása, Budapest, 1980.
Az Alföld földtani atlasza. Gyoma. — A MÁFI kiadása, Budapest, 1980.
RÓNAI, A.—KŐRÖSSY L.—SZEPESHÁZY K.: Az Alföld földtani atlasza. Békéscsaba. — A MÁFI kiadása, Budapest, 1981.
A Magyar Állami Földtani Intézet mélységi vízfigyelő kútjainak észlelési adatai 1967—1981. — A MÁFI kiadása, Budapest, 1982.
RÓNAI, A.—KŐRÖSSY L.: Az Alföld földtani atlasza. Hajdúszoboszló. — A MÁFI kiadása, Budapest, 1983.
Az Alföld földtani atlasza. Orosháza. — A MÁFI kiadása, Budapest, 1983.
RÓNAI, A.—FÜLÖP J.—HÁMOR G.—JÁMBOR Á. et al.: Magyarország földtani térképe 1:500 000. — A MÁFI kiadása, Budapest, 1984.

RÓNAI, A.—FÜLÖP J.—HÁMOR G.—JÁMBOR Á. et al.: Geological Map of Hungary 1:500 000. — A MÁFI kiadása, Budapest, 1984.
Az Alföld negyedidőszaki földtana — The Quaternary of the Great Hungarian Plain. — Geol. Hung. ser. Geol. tom. 21:1—446. *Műszaki Könyvkiadó*, Budapest, 1985.
Térképezett történelem. — Magvető Könyvkiadó, Budapest, 1989.

B. Studies

Image Statistique d'un État dont le territoire est composé avec harmonie. — Journal de la Soc. Hong. de Statistique. 1:68—88. 1936.
Egy harmonikus államterület statisztikai képe. — Földr. Közl. LXIV (1—5): 9—28. 1936.
Les bases géographiques des territoires des états. — Nouvelle revue de Hongrie. Mars. 1937.
A nemzetiségi kérdés területi megoldásai. — Magyar Szemle. 3: 201—209. 1937.
Magyarok elterjedése a Földön. — Földr. Közl. LXVI (4—5): 83—104. 1938.
The peoples of Transylvania. — The Hungarian Quaterly. 2: 229—242. 1939.
Románia néprajzi viszonyai. — Földr. Közl. LXVIII (2): 86—109. 1940.
A hazatért országrészek népessége. — Földrajzi Zsebkönyv, Budapest, 36—45. 1941.
A nagyhatalmak erőforrásai. — Földrajzi Zsebkönyv, Budapest, 36—47. 1948.
Statisztika és térkép a mezőgazdaság szolgálatában. — Magyar Statisztikai Szemle. (1—6):79—83. 1948.
Újabb adatok a Duna—Tisza közi talajvizekről. Hidr. Közl. 33 (5—6): 211—222. 1953.
Talajvíz tanulmányok a Duna—Tisza közén. — Földt. Int. Évi Jel. 1952-ről: 127—134. 1954.
A Nyírség, Hajdúság és Hortobágy talajvízviszonyai. — Hidr. Közl. 35 (7—8): 221—236.
Biharnagybajom és Pusztaecseg környékének földtani térképezése. — Földt. Int. Évi Jel. 1954-ről: 127—140. 1956.
Magyarország talajvizeinek vegyi jellege. — Hidr. Közl. 38 (1): 42—54. 1958.
RÓNAI, A.—BALOGH K.—HORUSITZKY F.—KRETZOI M.—NOSZKY J.—SZENTES F.: Magyarázó Magyarország 1:300 000-es földtani térképéhez. — A MÁFI kiadása, Budapest, 1958.
Adatok a folyók üledékképző munkájának ismeretéhez. — Hidr. Közl. 39 (1):1—16.
Az Ócsa—Bugyi—Majosháza környékén végzett síkvidéki térképezés. — Földt. Int. Évi Jel. 1955—1956-ról: 299—316. 1959.
Vízföldtani tanulmány a Kisalföldről. — Hidr. Közl. 40 (6): 470—484. 1960.
Magyarország felszínalatti vizei. — Földt. Közl. XC (4): 419—423. 1960.
Hydrogeologie der Quartärschichten in der Kleinen Ungarische Tiefebene. — Geologické Práce, Bratislava, Zošit 59: 161—214. 1960.
Stand der Ungarischen Quartärforschung... INQUA VI. International Congress. Warszawa. — Institut Geologiczny Práce, tom. XXXIV: 241—246; 247—262; 263—286; 333—334. 1961.
RÓNAI, A.—FEHÉRVÁRI M.: Kisérlet az Alföld részletes földtani térképezésére Szabadkígyós környékén. — Földt. Int. Évi Jel.1957—1958-ról: 135—163.
Negyedkori képződmények tanulmányozása a Bódva—Hernád közén. — Földt. Int. Évi Jel. 1957—1958-ról: 165—200. 1961.
A Kisalföld talajvízviszonyai. — Földr. Közl. X (LXXXVI) (2): 175—182. 1962.
Javaslat az alföldi artézi kutak vízszolgáltatási viszonyainak rendszeres méréséről. — Hidr. Táj. IV: 9—10. 1962.
Debrecen város talajvízviszonyai. — Hidr. Táj. VIII: 27. 1962.
A talajmechanikai vizsgálatok felhasználása a földtani térképezésben. — Hidr. Közl. 43 (2): 130—138.
A kondorosvölgyi belvízgyüjtő mintaterület földtani jellemzése. — Földt. Int. Évi Jel. 1960-ről: 35—57. 1963.
Az Alföld negyedkori rétegeinek vízföldtani vizsgálata. — Hidr. Közl. 43 (5): 378—391. 1963.
Etudes sur les couches fluviatiles dans le Grand Bassin Hongrois. — Lodz: 301—307. 1963.
A dunántúli és alföldi negyedkori képződmények érintkezése Paks és Szekszárd között. — Földt. Int. Évi Jel. 1961-ről: II.: 19—30. 1964.

Hydrogeological study on the Quaternary deposits of the Great Hungarian Plain. Bulletin de l'Assoc. Intern. d'Hydrologie Scientifique, Gendt—Brugg, 3: 24—30. 1964.

Les eaux souterraines et le probleme de l'irrigation sur la Grande Plaine hongroise. In Colloque de géographie franco-hongrois. Guide d'excursion. — Academia Scientiarum Hungarica, Institutum Geographicum, 123—125. Budapest, 1964.

Negyedkori képződmények térképezése a Magyar Állami Földtani Intézetben. — Földt. Közl. XCV (2):205—216. 1965.

Neotectonic subsidences in the Hungarian Basin. — International Studies on the Quaternary, New York, 219—232. 1965.

A felszín alatti vizek minőségének változása a mélységgel az Alföldön. — Hidr. Közl. 45 (9):419—425. 1965.

Some observations concerning the Quaternary sedimentation in Hungary. — Acta Geol. Hung. IX (1—2):17—32. 1965.

Subsurface Waters in deep Quaternary Basins. — Acta Geol. Hung. IX (3—4):433—442.

RÓNAI, A.—BARTHA F.—KROLOPP E.: A kulcsi löszfeltárás szelvénye. — Földt. Int. Évi Jel. 1963-ról: 167—187. 1965.

Földtani és geofizikai térképezés Szolnok környékén. — Földt. Int. Évi Jel. 1964-ről: 503—511. 1966.

Mélységi vízfigyelő kutak telepítésének földtani feltételei medenceterületeken. — Hidr. Közl. 48 (1): 17—25. 1968.

The Pliocene—Pleistocene boundary in the Hungarian Basin. — Acta Geol. Hung. XII (1—4): 219—230. 1968.

Időszakos nyomásváltozások a mélységi víztartó rétegekben. Hidr. Közl. 49 (3): 106—114. 1969.

A negyedkori és síkvidéki képződmények tanulmányozásának áttekintése. — In FÜLÖP J.—TASNÁDI KUBACSKA A. szerk. 100 éves a Magyar Állami Földtani Intézet. A MÁFI kiadása, Budapest, 174—209. 1969.

A review of Quaternary and lowland researches. — In FÜLÖP J.—TASNÁDI KUBACSKA A. ed.: One Hundred Years of the Hungarian Geological Institute. Headquartes of the Hung. Geol. Institute, Budapest, 182—217. 1969.

The Geology of Lake Balaton and surroundings. — Mitt. Internat. Verein Limnol., Stuttgart, 275—281. 1969.

A medencebeli pleisztocén sztratigráfia hazai eredményei. — Földr. Közl. XVII (XCIII) (3): 218—229. 1969.

Sovremennoje sostojanic neotektoniceskih isledovanii Vengrii. — Izdateljstvo Nauk, Moskau, 104—108. 1969.

Eine vollständige Folge quartärer Sedimente in Ungarn. — Eiszeitalter und Gegenwart. 20: 5—34. 1969.

Lower and Middle Pleistocene Flora in the Carpathian Basin. Paleography, Palaeoclimatology, Palaeoecology. — Elsevier Publ. Comp., Amsterdam, 8 (2/3): 265—285. 1970.

Geological and Hydrological investigations in Hungary. 100 years celebration of the Hung. Geological Institute. Annales Inst. Geol. Publ. Hung. LIV: 141—149. 1970.

Dr. Schréter Zoltán 1882—1970. — Hidr. Közl. 50 (6): 241—242. 1970.

Vízföldtan. In FRANYÓ F.: Magyarázó Magyarország 200 000-es földtani térképsorozatához. L-33-VI. Győr. — A MÁFI kiadása, Budapest, 94—111. 1971.

Bewegung des Grundwassers und die Änderung der im Wasser gelösten Stoffe in lockeren Gesteinen. — Proceedings of the 4. Conf. of Soil Mechanics. Budapest, 489—494. 1971.

A Tiszavölgy felszíni üledékei. — Hidr. Közl. 51 (8—9): 368—375. 1971.

Az Alföld kutatás újabb eredményei. — Földt. Int. Évi Jel. 1970-ről: 55—66. 1972.

Hydrogeological maps of lowland territories. — Intern. Assoc. of Hydrogeologists Memoires. Vol. IX. Congress of Tokyo. Tokyo, 45—47. 1972.

Az alföldi sekély vizek ingadozásai. — II. Anyag- és Energia Áramlási Ankét, Budapest 1971. Akadémiai Kiadó, Budapest, 95—105. 1972.

Nizsne i srednepleistocenovaja flora Karpatskovo Bassena. — Akademia Nauk USSR, Moskva, 123—142. 1972.

Hydrogeological and engineering geological lowland mapping in Hungary. — IX. Congress of Carpatho-Balkan Geolog. Association, Budapest, Vol. IV: 419—428. 1972.

On the near surface cyclic phenomena. Water level fluctuation in shallow aquifers of the Great Hungarian Plain. Map of Quaternary crustal movements of Hungary. — Studies on the Material and Energy Flows of the Earth. Ed. E. SZÁDECZKY, Budapest, 157—163; 182—189; 379—383. 1973.

Vízföldtani szelvény az Alföld észak-déli tengelyében. — Hidr. Közl. 53 (9—10): 396—400. 1973.

Dr. Horusitzky Ferenc emlékezete. — Földt. Int. Évi Jel. 1971-ről: 13—20. 1973.

Megfigyelések a mésztartalom eloszlásáról a talajban és a talajvízben. — Földt. Int. Évi Jel. 1971-ről: 123—139. 1973.

Negyedkori kéregmozgások térképe Magyarországon. — MTA X. Oszt. Közl. 6 (4): 241—243. 1973.

Proportion and character of Quaternary tectonic movements in the Hungarian Basin. — Földr. Közl. XXI (XCVII) (2): 153—160. 1973.

Dr. Schmidt Eligius Róbert emlékezete. — Földt. Közl. 104 (4): 388—396. 1974.

Size of Quaternary Movements in Hungary's area. — Acta Geol.Hung. 18 (1—2): 39—44. 1974.

Vízföldtan. In MOLDVAY L.: Magyarázó magyarország 200 000-es földtani térképsorozatához. M-34-XXXV. Kisvárda—L-34-V. Mátészalka. — A MÁFI kiadása, Budapest, 70—96. 1975.

A talajvíz és rétegvizek kapcsolata az Alföldön. — Hidr. Közl. 55 /2/: 49—53. 1975.

Classification des sediments fluviatils de grain fin au point de vue géotechnique. — Proceedings of the Xth Congress C.B.G.A., Bratislava, 223—230. 1975.

Adatok az Alföld negyedkori vízadó rétegeiről. — Földt. Közl. 105 (3): 275—296. 1975.

Ciklusos nyomásingadozások az Alföld medencéjében és ezek kémiai kapcsolatai. — MTA X. Oszt. Közl. 8 (3—4): 333—342. 1975.

Dr. Schmidt Eligius Róbert. — Földt. Int. Évi Jel. 1973-ról: 11—20. 1976.

Az Alföld-kutatás helyzete 1973-ban. — Földt. Int. Évi Jel. 1973-ról: 121—132. 1976.

Review on the present state of art in the knowledge Neogene-Quaternary boundary in Austria—Hungary—Czechoslovakia. — Neog.-Quat. Boundary Proc. II. Syposium 1975, Bologna, 203—213. 1977.

Negyedidőszaki kéregmozgások a magyar medencében. — Földt. Közl. 107 (3—4): 431—436. 1977.

Az alföldi mélységi vízfigyelés eredményeinek elemzése. — Hidr. Közl. 58 (2): 49—67. 1978.

Caractere hydrogéologique essentiel de la Grande Plaine Hongroise. - Hydrogéologie des grands bassins sédimentaires. — Conference de Budapest 1976. Mai/Juin. Annales Instituti Geologici Publici Hungarici LIX (1—4): 462—483. 1978.

Vízjárás a magyar Alföld mélységi víztartóiban. — Vízügyi Közlemények. 3: 374—400. 1978.

Beszámoló jelentés a M. Áll. Földtani Intézetben 1976. május 31—június 5 között rendezett IAH-IAHS nemzetközi hidrogeológiai konferenciáról. — Földt. Int. Évi Jel. 1976-ról: 47—53. 1978.

RÓNAI, A.—SZEMETHY A.: Paleomagnetic investigation of the 1110 m sediment core from the Dévaványa borehole. — Guide book for Conference Budapest—Szeged, 63—82. 1979.

RÓNAI, A.—COOKE H. B. S.—HALL J. M.: Paleomagnetic, sedimentary and climatic records from boreholes Dévaványa and Vésztő—Hungary. — Paper for IGCP project 128. Budapest, 28—31 August, 1—28. 1979.

Fundamentals of engineering geological maps. — Bulletin of the Internat. Association of Engin. Geology, Krefeld. 19: 62—68. 1979.

Lowland barrages and reservoirs on the Great Hungarian Plain. — Bulletin of the Internat. Association of Engin. Geology, Krefeld. 20: 260—264. 1979.

RÓNAI, A.—SZEMETHY A.: Az Alföld kutatás újabb eredményei. Paleomágneses vizsgálatok laza üledékeken. — Földt. Int. Évi Jel. 1977-ről: 67—83. 1979.

A nagytáji földművelés földtani alapjai — Agrárföldtan. — Földt. Int. Évi Jel. 1978-ról: 159—166. 1980.

Development of principles related to subsurface water prospecting in Hungary. — Földt. Közl. 110 (1): 42—44. 1980.

Ground water level and fluctuation. — In HALASI—KUN G.J.:Pollution and Water Resources. Pergamon Press, New York — Oxford, 1980. 1—20. 1981.
Outlines of geological structure and evolution of Hungary: Quaternary. — In BALÁZS E. et al.: Excursion guide of molasse formations in Hungary. Hungarian Geological Institute, 78—80. Budapest, 1981.
Bugac puszta (Pleistocene—Holocene). — In BALÁZS E. et al.: Excursion Guide of Molasse Formations in Hungary. — Hungarian Geological Institute, 141. Budapest, 1981.
Magyarország szerkezetének és földtörténetének vázlata: negyedidőszak. — In BALÁZS E. et al.: Földtani kirándulások magyarországi molassz területeken. A MÁFI kiadása, 74—78. Budapest, 1981.
Bugac puszta (pleisztocén—holocén). — In BALÁZS E. et al.: Földtani kirándulások magyarországi molassz területeken. A MÁFI kiadása, 136—137. Budapest, 1981.
Teleki Pál és a korabeli földtani tudomány. — Földt. Tud. tört. Évk. 1979. (8): 185—193. 1981.
RÓNAI, A.—COOK H. B. S.—HALL J. M.: Paleomagnetic sedimentary and climatic records from borehole of Dévaványa and Vésztő, Hungary. — Acta Geol. Hung. 22 (1—4): 89—109. 1981.
A 2. Nemzetközi Mérnökgeológiai Továbbképző Tanfolyam. — Földt. Int. Évi Jel. 1979-ről: 33—37. 1981.
A földtani ismeretek fejlődése az Alföld medencéjéről. — Alföldi Tanulmányok. V: 7—33. Békéscsaba, 1981.
Task of engineering geological mapping in Lowland territories. — Proceedings of the 11th Congress of Carpathian—Balkan Geological Association. Hydrogeology and Engineering Geology, Kiev 1980. 124—142. 1981.
Geological mapping of the Great Hungarian Plain. — Acta Geol. Hung. 22 (1—4): 355—365. 1981.
Komplex síkvidéki kutatások és agrogeológiai kapcsolataik. — MTA X. Oszt. Közl. 15 (1—2): 183—188. 1982.
Coherency between the water supply and water level fluctuation in Quaternary underground aquifers. — Quaternary Studies in Hungary. INQUA 1932—1982, 217—184. 1982.
Magnetostratigraphy of Pliocene—Quaternary sediments in the Great Hungarian Plain. — Earth Evolution Sciences, Braunschweig, (3—4): 265—267. 1982.
Stages of the Quaternary in Hungary. — Biuletin Institutu Geologicznego, Warszawa, 1981. (23): 59—62. 1982.
Neogene/Quaternary boundary in the Great Hungarian Plain. — Proceedings Field Conference N/Q Boundary, India 1979. Calcutta, 151—152. 1982.
The development of Pliocene and Quaternary depression in the Great Hungarian Plain. — In Shoji Horie: Paleolimnology of Lake Biwa, Japan. 9: 3—25. 1982.
Dr. Szalai Tibor emlékezete. — Földt. Int. Évi Jel. 1980-ról: 31—40. 1982.
A negyedidőszaki és felső-pliocén süllyedés menete a Körös-medencében. — Földt. Int. Évi Jel. 1980-ról: 77—80. 1982.
Vertical movements in the Great Hungarian Plain (Exemples of magnetostratigraphic correlation). — Proceedings 17th Assembly of the ESC 1980, 435—440. 1983.
A vízszintingadozások többéves irányvonala az alföldi artézi víztartó rétegekben. — Hidr. Közl. 63 (7): 289—300. 1983.
A Körös-medence földtörténete a negyedkorban. — Földt. Közl. 113 (1): 1—25. 1983.
The development of the Quaternary geology in Hungary. — 7 Acta Geol. Hung. 27 (1—2): 75—90. 1984.
Quaternary stratigraphy and the N/Q boundary in the Pannonian Basin. — A case study in continental stratigraphy. 27th Internat. Geol. Congress. Abstracts. Izd. Nauka, Moskow, I: 412—413. 1984.
Ballenegger Róbert kapcsolata az agrogeológiával. — Agrokémia és Talajtan. 32 (3—4): 634—636. 1984.
Teleki Géza 1911—1983. — Földt. Közl. 114 (2): 240—241. 1984.
Osnovü csetvertichestnoj stratigrafii Pannonskovo basszejna. — Mezsdunarodniy Geol. Kongress, Sectio 03, Doklady, Moskva. 27: 31—37. 1984.

A plio-pleisztocén határ a nemzetközi és hazai irodalomban. — Föld. Int. Évi Jel. 1982-ről: 167—172. 1984.

Limnic and terrestrial sedimentation and the N/Q boundary in the Carpathian basin. Abstracts. — VIIIth Congress of the RCMNS. Symposium on European Late Cenozoic Mineral Resources 15—22 September 1985 Budapest. A MÁFI kiadása, Budapest, 469—497. 1985.

The Quaternary of the Great Hungarian Plain. Loess and the Quaternary. — Chinese and Hungarian case studies. — Ed. M. Pécsi. Akadémiai kiadó, Budapest, 51—63. 1985.

Geological investigations in the lowland type regions. — VIII. RCMNS Congr. Neogene Mineral resources in the Carpathian Basin. Historical Studies on their Utilization. Ed. J. HÁLA. Budapest, 45—68. 1985.

RÓNAI, A.—ELSTON D. P.—HÁMOR G.—JÁMBOR Á.—LANTOS M.: Magnetostratigraphy of Neogene strata penetrated in two deep core holes in the Pannonian Basin: preliminary results. — Geophysical Transactions 31 (1—3): 75—88. 1985.

RÓNAI, A.—GROSZ A. E.—LOPEZ R.: Contribution to the determination of the Plio-Pleistocene boundary in sediments of the Pannonian Basin. — Geophysical Transactions 31 (1—3): 89—99. 1985.

RÓNAI, A.—HÁMOR G.—JÁMBOR Á.—LANTOS M.—ELSTON D. P.: Magnetostratigraphic correlations of some Neogene strata of the Pannonian Basin, Hungary. — In Abstracts VIIIth. Congress of the RCMNS 15—22 Sept. 1985. Budapest, 257. 1985.

Ballenegger Róbert (1882. nov. 11.—1969. nov. 13.). — Földt. Közl. 115 (3): 330. 1985.

A magyarországi kvarter képződmények kifejlődése és szerkezeti helyzete. — Földt. Közl. 116 (1): 31—43. 1986.

Hozzászólás dr. Juhász József: A mérnökgeológia jelene és jövője c. előadásához. — Földt. Közl. 116 (1): 83—84. 1986.

Zárójelentés a komplex Alföldkutatás programjának teljesítéséről (1964—1985). — Földt. Int. Évi Jel. 1985-ről: 89—125. 1987.

Az Alföld komplex földtani térképezése és annak eredményei. — Mérnökgeológiai Szemle, 36: 85—90. 1988.

Teleki Pál, a geográfus. — Földrajzi Múzeumi Tanulmányok, Magyar Földrajzi Múzeum, Érd. 6: 3—8. 1989.

Teleki Géza (1911—1983). — Földrajzi Múzeumi Tanulmányok, Magyar Földrajzi Múzeum, Érd. 7: 65—66. 1989.

The development of principles related to subsurface water prospecting in Hungary. — In History of Mineral Exploration in Hungary until 1945. Annals of the History of Hungarian Geology Special issue 2. Ed. G. CSÍKY and GY. VITÁLIS. Budapest, 87—89. 1989.

Eolikus aleuritok. — In BALOGH K. szerk.: Szedimentológia II. kötet. Akadémiai Kiadó, Budapest, 158—180. 1991.

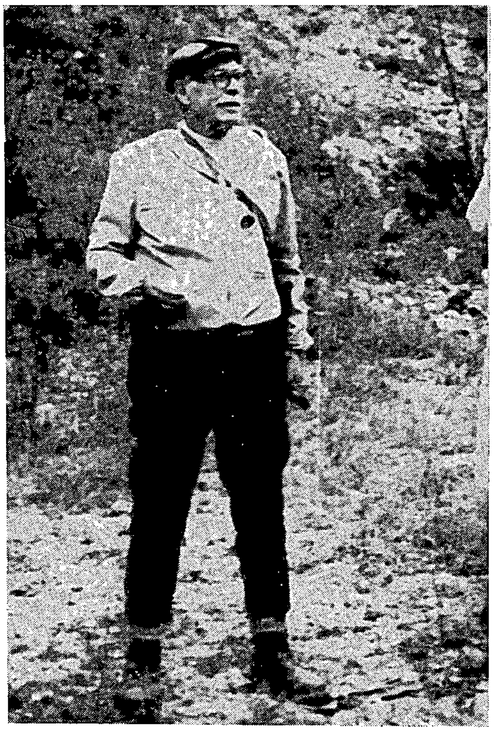
TO THE MEMORY OF BÉLA JANTSKY 1908—1991

by

BÉLA NAGY

Hungarian Geological Survey
Budapest, Stefánia út 14.
H-1143

UDC: 929:55



DR. BÉLA JANTSKY
1908—1991

BÉLA JANTSKY was born in Beregkisalmás on 2 March, 1908.

His mother was Emma Masanecz, while his father, Béla Jantsky Sr. was a village school-master. Following World War I, after the Trianon Treaty his native village was attached to Czechoslovakia. Finishing primary school he was educated at the Hungarian State Secondary School at of Beregszász where achieved a first-class school-leaving certificate in 1927. After the completion of his secondary school studies he became a student of the Charles University of Prague, continued his studies in Czech language and took his doctor's degree in geology in 1931. His dissertation was written on the granite massif of the Teletin region and on its contact metamorphic mantle.

In summer of 1932—1933 he mapped the granite-metamorphic crystalline group of Pop Iván, and prepared his first study to be published in "Karpathica". Here he was the first to recognize the high-extent diaphtoresis of the rocks of the region.

In 1933 he obtained the secondary school teacher's certificate in chemistry and natural history, authorizing him to teach in Hungarian, Russian and Czech languages. On 1 September,1933 he began his educational work as teacher of the State Secondary School at Munkács where the languages of the education were Czech and Russian. In a year, from 1 September, 1934, he became the teacher of the Beregszász Secondary School where the languages of education were Hungarian and Ukranian. In 1936 he established a close professional friendship with Gyula Kulhai, geologist of the Royal Hungarian Geological Institute with whom they mapped the andesite-volcanic areas of Buzsora in the Vihorlát Mts in 1939 and 1940. An account of their work was given in a joint study published in the Annual Report of the Royal Hungarian Geological Institute. In 1937 he married the teacher Erzsébet Budaházi and of this marriage four children were born: Agnes (1939), Erzsébet (1941), Zsuzsanna (1943) and György (1947).

From 1 February, 1940 till October, 1944 he was a teacher of the Hungarian-Russian language Secondary School and then of the teachers' Training-College at Munkács.

In October, 1944 he moved to Hungary where first he worked at the Mineralogical-Geological Department of the Budapest Technical University, and then at the Royal Hungarian Geological Institute. From December, 1945 till November, 1948 he was Director of the State Teachers' Training-College at Jászberény.

In Februar, 1948, on the basis of made-up charges he was interned but was released and reinstalled in his position in six months. From November, 1948 till 3 October, 1949 he was teacher of the Kemény Zsigmond Secondary School in Budapest. In the summer of 1949 he was commissioned by the Hungarian Geological Institute to explore the refractory clay deposits at Bánk-Felsőpetény. On 3 October, 1949 he became a permanent employee of the Hungarian Geological Institute. In the very same year he started his fruitful investigations in the Velence Mts, up to 1955. In the spring of 1953 the National Chief Administration for Geology was organized and here he became the Head of the Geological Department. Of the event of his appointment to this position he remarked in his popular volume "Searching for ores with geological hammer in hand", p.130.:

"I had to undertake this mission although I felt that this, to some extend, would knock the hammer out of my hand". Let us admit, in retrospect, that for the benefit of all of us it did not come true.

In a short time he returned to the Hungarian Geological Institute where he became Head of the newly organized Department of Non-Ferrous Ores. From this time on he carried out and coordinated all the ore-geological explorations in the Mátra Mts, and the mining-geological investigations in the Velence Mts.

As an appreciation of his merits in the ore exploration in the Velence Mts, he was awarded with the Golden Class of the Order of Labour in 1952, and in 1953 he received the Silver Class of the Kossuth Prize. In 1955 he submitted his dissertation for the degree candidate" (for D. Sc. Ac.), entitled Geology of the "Velence Mts" to the National Postgraduate Degree Granting Board and defended his Thesis in 1957. The study was later published in the series "Geologica Hungarica".

From 15 July, 1956 within the project "Ore exploration in the Mátra Mts" he worked for the Ministry of Heavy Indrustries as Chief Geologist of the commencing uranium industry in Hungary. This appointment, including the work with classified data did not permit for him at that time to publish the results of uranium geological explorations. That is why, during this period he wrote and edited methodological and comprehensive geological studies. In this period he participated in the writing and editing of the "Atommaglexikon" "Encyclopaedia of atomic nucleus" and the "Ásványtelepeink földtana" ("The geology of mineral resources in Hungary"). The "Geológus kalapáccsal az ércek nyomában (Searching for ores with geological hammer in hand)" was also a product of this period, and he also wrote a chapter in the textbook "Bánya-földtan" (Mining geology).

From 1 January, 1966, as the Head of the first Hungarian geological expedition to Mongolia he worked in that country for nearly five years. On 21 June, 1971 he defended the 750-page final report of the Hungarian Expedition prepared in five copies, and it was greatly appreciated by the international professional jury. For his successful work in Mongolia he was awarded the Order of Mongolian Polar Star.

On 1 April, 1971 he retired, however, as a retired expert he returned to his beloved institute, the Hungarian Geological Institute where he worked till 1988 when the disease seized upon him.

In the Institute he was able to continue the exploration of the crystalline basement of the Mecsek Mts, started by him as early as in 1950. He completed his monograph in 1974, and submitted it to the National Postgraduate Degree Granting Board taking then his D. Sc. Ac. (Doctor of Geology and Minralogy of the Hungarian Academy).

BÉLA JANTSKY Ph. D. devoted his whole carreer as a geologist to the study of the eruptive and metamorhic rocks and of the pertaining endogenetic and exogenetic mineralizations. In an autobiography dated in 1962 he stated with gould reason: "I consider my job as my profession; geological exploration is the main source of pleasures for me".

His outstanding professional resoults, beside his love of the profession, are due also to his enormous will-power, vitality, and knowledge of a wide range of languages. His Russian, Ukranian, Czech, Slovakian and German was excellent, reading the literature also in French, Polish, Bulgarian, Serbian and Croatian. Due to his professional knowledge and proficiency in languages he took part in the work of several international conferences and in the related field excursions. As one of his immediate colleagues at some Comecon meetings and at the session held within the framework of the Bulgarian-Hungarian bilateral-agreement I had the possibility to become also personnally familiar with his human qualities and professional knowledge.

Until the setting in of his disease, till 1987, he regulary came in the Institute and worked. After he was hindered in regular communication by his disease he worked at home with an incredible willpower. His great dream came true with the assistance of Margit Pellérdy, and he left to us the "picture atlas of the granite formation of the crystalline basement of the Mecsek Mts" in a redy-for-press state. The task of the publication of this both professionaly and aesthetically wonderful work has remained to us.

This has been the professional biography of BÉLA JANTSKY Ph. D. His life was as eventful and varied as the period he lived in.

The mournful news that BÉLA JANTSKY Ph. D., Kossuth Prize Winner Chief Geologist, the Academic Doctor of Geology and Mineralogy deceased after a grave and long suffering at the age of 84, was received at the beginning of December, 1991. His was buried on 17 December, 1991. Beside his family in deep mourning a large crowd of his students, Hungarian geologists, his friends and followers both from Hungary and abroad took part at the ceremony.

With the death of Béla Jantsky we have lost one of the most dynamic and outstanding personality of the Hungarian geology. His humanity, love for the profession and devotedness will be remembered for ever.

His several published and manuscript studies survive in the profession.

BÉLA JANTSKY Ph. D. and his exemplary life will always be remembered by us.

Béla Jantsky's published scientific studies and educational papers

JANTSKY, B. 1931: A Teletin környéki granodiorit bázisos zárványai (doktori értekezés cseh nyelven). — Prága.

JANTSKY, B. 1940: A Máramarosi kristályos masszívum földtani-kőzettani vizsgálata (cseh nyelven). — Carpathica I.

KULHAY, GY.—JANTSKY, B. 1943(?): A Borló—Gyil- és Háthegység földtani felépítése. — Földt. Int. Évi Jel. 1941—42-ről.

JANTSKY, B. 1950: A Bánk-Felsőpetény és Szendehely környékén előforduló tűzálló agyagok. — Földt. Int. Évi Jel. 1949-ről.

JANTSKY, B. 1950(?): A Velencei-hegység aplitjai és kerámiai felhasználhatóságuk. — Földt. Int. Évi Jel. 1949-ről.

JANTSKY, B. 1950: Az európai Szovjetunió hidrogeológiai viszonyai. — Hidrogeológiai Közl. XXX.

JANTSKY, B. 1951(?): A demjéni limonitos mangánérc települési viszonyai. — Földt. Int. Évi Jel. 1950-ről.

JANTSKY, B. 1951(?): A mecseki kristályos alaphegység földtani viszonyai. — Földt. Int. Évi Jel. 1950-ről.

JANTSKY, B. 1953:(?) Adatok Ugod és Homokbödöge környékének viszonyairól, tekintettel a kőszénelőfordulásra. Földt. Int. Évi Jel. 1952-ről.

JANTSKY, B. 1952: A Velencei-hegység hidrotermális ércesedése. — Magy. Tud. Ak. Műsz. Közl.

JANTSKY, B. A Velencei-hegység földtana (kandidátusi disszertációs dolgozat). — Geol. Hung. T. 10. 1957.

JANTSKY, B. (megjelenés éve?): A magyar uránérc nyomában. — Élet és Tud. 12. évf. 872—874.

GEORGIEV, D. T.—JANTSKY, B.—SISKA, V. 1958: Az uránércek teleptana és kutatási módszerei. — Bányászati Lapok 9.sz.

GEORGIEV, D. T.—JANTSKY, B.—SISKA, V. 1958: Az uránércek teleptana és kutatási módszerei (folyt.) 9. — Bányászati Lapok 12.
GEORGIEV, D. T.—JANTSKY, B.—SISKA, V. 1959: Az uránércbányászat sajátosságai. — Bányászati Lapok 10.sz.
JANTSKY, B. 1958: Uránásványok. — Kémikusok Lapja.
JANTSKY, B. etc. 1958: Fluoritos-bitumenes urántartalmú mészkő genetikai vizsgálata. — Genfi nemzetközi atomenergia konferencia értekezései. Genf.
JANTSKY, B. 1958: Radioaktív ásványtelepek genetikai típusai. — Természettud. Közl.
JANTSKY, B. 1960: Geológus kalapáccsal az ércek nyomában. — Gondolat Könyvkiadó.
JANTSKY, B. 1960: Zárójelentés a szabadbattyáni ólomércleIőhely földtani felépítéséről. — Kézirat OFI.
JANTSKY, B. 1962: Atommaglexikon ásvány-kőzettani, földtani és geofizikai szövege. — Magy. Tud. Ak.
JANTSKY, B. 1962: Radioaktív ásványi nyersanyagtelepek. — TIT előadói füzetek.
JANTSKY, B. 1962: Magyarország földtana (cseh nyelven Vadász E. műve alapján az újabb adatok kiegészítésével). — Prága.
JANTSKY, B. 1963: A kincses Mecsek. — Élet és Tud. 18. évf. 916—919.
JANTSKY, B. 1964: Atommag Lexikon ásványtani-teleptani címszavai.
JANTSKY, B. (?): A Mecseki urános ércesedés ásványparagenetikai vizsgálata. (BARABÁS, A.—KISS, J. közös francia nyelvű közlemény. Svájci Nemzetközi Atommag Kongresszus Közleményei).
JANTSKY, B. 1966: Ásványtelepeink földtana. Budapest (mint a mű szerkesztője és társszerzője).
JANTSKY, B. 1969: Ásványkutatás-bányaföldtan. Budapest (mint a felszíni ásványkutatás fejezet szerzője).
JANTSKY, B. 1969: A Mongóliai Magyar Földtani Expedíció munkálatainak zárójelentése. — Ulán Bátor. (Orosz nyelven, 750 old. szöveges részből és mellékletekből álló mű.)
JANTSKY, B. 1973: A Mongóliai Magyar Földtani Expedició müködésének tanulságai. — Földtani Kutatás.
JANTSKY, B. 1974: Geologische Entwicklungsgeschichte des prakambrischen und paleozoischen Untergrundes im Pannonischen Becken. — Cossmat Symposium anyagai. Karl. Marx Stadt.
JANTSKY, B. 1974: Der präkambrische Untergrund des Pannonischen Beckens. — PICG-Précambrien des zones mobiles de l' Europe, Conference Liblice 1972. Praha.
JANTSKY, B. 1978: Dr. Wein György emlékezete. — Földt. Int. Évi Jel. 1976-ról 37—43.
JANTSKY, B. 1978: Wavrik Péter emlékére. — Földt. Int. Évi Jel. 1976-ról 45—46.
JANTSKY, B. 1978: A Mecseki gránitosodott kristályos alaphegység földtana. — Földt. Int. Évikönyve LX. kötet.

Béla Jantsky's Ph. D. manuscript reports in the National Geological Archives

JANTSKY, B. 1950: Jelentés a Nagyszál DNy-i oldalán végzett újabb mészkő- és agyagkutatás eredményeiről. Ter. 4413.
JANTSKY, B. 1950: Jelentés a Nagyszál-hegy ÉK-i szélén végzett földtani kutatások eredményéről. Ter. 4486.
JANTSKY, B. 1950: Festékföldek nyersanyagkatasztere (21 lap) Ter. 4720.
JANTSKY, B. 1950: Mecseki kristályos alaphegység földtani térképe. Dd. T. F. Sz. 761
JANTSKY, B. 1950: Újabb adatok a Velencei-hegység földtani és kőzettani viszonyaihoz. T/144
JANTSKY, B. 1950: A Velencei-hegység földtani és kőzettani viszonyai. Szulfidos érc/42.
JANTSKY, BÉLA—SZÉLES, LAJOS 1950: Velencei-hegységi kutatási tervezet fontossági sorrendben (5 lap) Ter. 6975.
JANTSKY, B. 1950: A Mecseki kristályos Alaphegység földtana. A Mecseki kristályos Alaphegység és a vele szomszédos területeken mélyített, alaphegységet ért fúrások földtani szelvényei. (297 lap) Ter. 10 285.

JANTSKY, B. 1950: A Nagyszál DNy-i oldalán végzett újabb mészkő- és agyagkutatás eredményeiről. Cm/l.

JANTSKY, BÉLA—PAPP, FERENC 1950(?): Jelentés a Nagyszál ÉK-i végének földtani viszonyairól. Cm/2.

JANTSKY, B. 1950: Jelentés a Szentendrétől ÉNy-ra végzett cementgyártáshoz alkalmas andezit és riolittufa felkutatása tárgyában. Cm/3.

JANTSKY, B. 1950: Jelentés a Bánk, Felsőpetény és Szendehely környékén előforduló tűzálló agyagokkal kapcsolatos földtani kutatásaim eredményeiről. C/X. 72.

JANTSKY, B. 1950: Jelentés a Weiss-Manfréd Acél és Fémművek számára Ebszőnybánya környékén végzett kvarchomok vizsgálatáról. Homok/18.

JANTSKY, B. 1950: Jelentés a Demjén község határában előforduló kaolin festékföld és kovaföld települési viszonyairól. Kaolin/20.

JANTSKY, B. 1950: Jelentés a Demjén község határában található limonitos mangánérc települési viszonyairól. Mn/17.

JANTSKY, B. 1950: Jelentés a Nagyszál DNy-i oldalán végzett újabb mészkő és agyagkutatás eredményeiről. Mészkő/17.

JANTSKY, B.—PAPP, F. 1950: Jelentés a Nagyszál ÉK-i végének földtani viszonyairól. Mészkő/18.

JANTSKY, B. 1950: Jelentés a malachit és azurit előfordulásokról (kozári vadászház). Ritkafém/6.

JANTSKY, B. 1950: Jelentés Ugod község környékén végzett ásványi nyersanyagkutatás eredményeiről. Szén/94.

JANTSKY, B. 1950: A Mecseki kristályos alaphegység. Vas/46.

JANTSKY, B. 1950: Jelentés Érsekvadkert községben telepítendő községi kút helyének kijelölése tárgyában. Viz/88.

JANTSKY, B. 1950: Jelentés az Alsópetény községben létesítendő községi kút telepítése tárgyában. Víz/89.

JANTSKY, B. 1950: Jelentés a létesítendő cementgyár nyersanyagellátásához szükséges tartalékok megállapítása céljából a Nagyszál D-i oldalán folyó munkálatok megtekintéséről. Ter. 4412.

JANTSKY, B. 1950: Jelentés a Velencei-hegységben 1949. évi december hónapban végzett aplitkutatás eredményéről. (6 lap) Ter. 4523.

JANTSKY, B. 1950: Jelentés a Velencei- és Mecsek-hegységben végzett aplitkutatások eredményéről. B. A. F. 3.

JANTSKY, B. 1950: Aplitok nyersanyagkatasztere (Jelentés a Velencei- és Mecsek-hegységben végzett kaolin-, továbbá tűzállóagyagkutatás eredményéről): (15 lap) Ter. 4429.

JANTSKY, B. 1950: Baritok nyersanyagkatasztere. Fluorit. B. A. F. 2.

JANTSKY, B. 1950: A Velencei-hegység aplitjai, és kerámiai felhasználhatóságuk. B. A. F. 4.

JANTSKY, B. 1950: Jelentés A Velencei- és Mecsek-hegységben végzett kaolin, továbbá tűzállóanyag kutatás eredményeiről. Kaolin/21.

JANTSKY, B. 1950: Természetes és mesterséges túlfolyó források a Velencei-hegységben. Viz/90.

JANTSKY, B. 1951: A Velencei-hegység hidrotermális ércesedése. Szulfidos érc/54.

JANTSKY, B. 1951: Jelentés a Nagyszál D-i lejtőjén telepítendő agyagkutató fúrások telepítésének és a mészkőfejtés irányának kijelöléséről. Cm/5.

JANTSKY, B. 1951: Jelentés a Bánk, Felsőpetény és Szendehely környékén előforduló tűzálló anyagokkal kapcsolatos földtani kutatások eredményéről. Tü.agy/18.

JANTSKY, B. 1951: A Mecseki kristályos alaphegység. T/219.

JANTSKY, B. 1952: Beszámoló a Velencei-hegység bányászati eredményeiről és új feladatairól. Szulfidos érc/59.

JANTSKY, B. 1952:

1. Előzetes jelentés a Velencei-hegységben 1952-benvégzett kutatások eredményeiről. (1952. XII. 16.)
2. Jelentés a Velencei-hegységben 1952-ben végzett földtani eredményeiről. (1953. I. 24.) Su/61.

JANTSKY, B. 1952: Radioaktív anyagok felkutatásának földtani vonatkozásai a Velencei-hegységben. T/279.

JANTSKY, B. (1952. III. 31.) Előzetes jelentés a Velencei-hegységben újabban előforduló molibdenitről. Ritka-fém/10.

JANTSKY, B. 1954: Zárójelentés a Velencei-hegység 1953. évi fluoritkutatásról. A Velencei-hegység fluoritja és a fluoritkutatás perspektivikus irányelvei. Zárójelentés az 1953.évi kutatásokról. Szulf.érc/69.

JANTSKY, B. 1954: Zárójelentés az 1953. évi Sukoró—Ördöghegyi bányászati kutatásokról. Szulf.érc/70.

JANTSKY, B. 1954: Nadap környéki pirites kaolin kutatási eredményei 1954-ben. Kaolin/35.

JANTSKY, B. 1954: Zárójelentés a Velence I. és II. sz. fúrások földtani kiértékeléséről. Szulf.érc/77.

JANTSKY, B. 1954: Ipari mennyiségű pirit előfordulásának lehetőségei Magyarországon. Tokaj-hegység, Mád, Komlóska, Erdőbénye, Regéc, Telkibánya, Nagybörzsöny, Velencei-hegység. Szulf. érc/79.

JANTSKY, B. 1954: Velencei-hegység földtani térképe. Dd. T. F. Sz. 762.

JANTSKY, B.—SCHERF, E. 1955(?): (1955. VIII.) Telkibányai bányaföldtani dokumentáció 1955. év augusztus hónapra. Szulf.érc/87.

JANTSKY, B. 1955: Az 1955. évi Nadap-környéki földtani kutatás indoklása.

JANTSKY, B.—VARGA, GY. 1955: Jelentés a pázmándi kvarcitbányászat fejlesztési lehetőségeiről. Ter. 6971.

JANTSKY, B. 1955: A Nadapi kaolintáró. (14 lap, 2 térkép) Ter. 6978.

JANTSKY, B. 1956: A Velencei-hegység földtana. Su/93.

JANTSKY, B. 1956(?): (1956. IV. 16.) A Velencei-hegység földtani és bányászati kutatási tervezete fontossági sorrendben. Szinesérc/95.

JANTSKY, B. 1956: Asztagkő és környékének földtani felépítése. Kvarcit/14.

POLNER, J.—JANTSKY, B.—SZILAS, G. 1960: Zárójelentés a szabadbattyáni (falubattyáni) ólomércelőfordulás földtani viszonyairól, valamint az érc bányászatáról és hasznosításáról. Ércbányászati Feltáró Vállalat. 260 lap szöveg, 45 melléklet, 17 térkép, 14 szelvény, 11 ábra I—II kötet. Ter. 15 134

JANTSKY, B. 1957: Ásványi nyersanyagaink. NIM 3 kötet. I.kötet 281 lap, II.kötet 250 lap, III.kötet 304 lap. Ter. 2013.

JANTSKY, B. 1957: Magyarázó a Bánk—Felsőpetényi tűzállóanyagelőfordulások tartalékosztályainak és készleteinek megállapításához. Tü. agyag/19.

JANTSKY, B. 1957: Jelentés a M. Áll. Földtani Intézet Igazgatóságától kapott külföldi kvarcithoz hasonló nyersanyag felkutatásáról. Kvarcit/9.

JANTSKY, B. 1957.) Az európai Szovjetunió hidrológiai viszonyai. Egyéb/42.

JANTSKY, B. 1955: Zárójelentés a Velencei-hegység fluoritról. (Pákozd, Szüzvár, Székesfehérvár, Szabadbattyán 25 db fénymásolat, 14 db fénykép) B. A. F./6

JANTSKY, B. 1967: Az első mongóliai földtani térképező expedíció tapasztalai. (16 lap) Ter. 865.

JANTSKY, B. 1968: A mongóliai földtani expedició összegző tanulmányai. (15 lap) Ter. 1255

JANTSKY, B. 1968: Jegyzőkönyv az IGCP Regionális Bizottságának (Kárpátok-Keleti Alpok) első ülésszakáról. (6 lap) Ter. 5662.

JANTSKY, B. 1968: A Mongól-Magyar Földtani Expedíció 1967. évi kutatási eredményeinek értékelése. Ter. 10 911

JANTSKY, B. 1969: A Mongol-Magyar Ásványbányászati Vállalat létesítésének földtani és nyersanyag gazdasági szempontjai. Ter. 864.

HETÉNYI, R.—FÖLDI, M.—NAGY, I.—BILIK, I.—JANTSKY, B. 1973: Ófalu 10 000-es földtani térkép és mellékletei. 3 térkép, 3 szelvény, 4 jelkulcs, 74 lap magyarázó. Ter. 3967.

HETÉNYI, R.—HÁMOR, G.—FÖLDI, M.—NAGY, I.—JANTSKY, B.—BILIK, I. 1973: Földtani alapadatok a Mecsek-hegység 1:10 000-es méretarányu térképsorozatához Ófalú. 6 kötet, 11 füzet 1374 lap. Ter. 3968 I—IV. kötet.

JANTSKY, B. 1974: Mecseki kristályos alaphegység szelvényei és szerkezetföldtani térképei. 5 lap, 7 térkép, 9 szelvény. Dd.T.F.Sz.344

JANTSKY, B. 1975: A Pannóniai medence prekambriumi és paleozói aljzatának földtani fejlődéstörténete. 14 lap. Ter. 5102.

CSALAGOVITS, I.—DIENES, I.—FÜGEDI, P.—HETÉNYI, R.—HETÉNYI, R.-NÉ—JANTSKY, B.—ZENTAY, P. 1976: A Dél-Dunántúli érckutatás geokémiai előkészítése. B-téma, 229 lap, 19 melléklet+térkép. Ter. 5873.

JANTSKY, B. 1977: A magyarországi varisztikum földtani jellemzése. 8 lap. Ter. 11 761.

BALLA, Z.—HORVÁTH, I.—CSILLAG, P.-NÉ—CSONGRÁDI, J.—KORPÁS, L.—JANTSKY, B.—NAGY, B.—BALOGH, K.—BÖJTÖS, Á.-NÉ—PELIKÁN, P.—SZALAY, I.—VARGA, GY. 1978: Koncepció vázlat a Börzsöny—Dunazúg, a Velencei-hegység Balatonfő és a Darnói övezet színesérckutatásra. MÁFI—MÁELGI. 4 füzet mellékletekkel (táblázatok, térképek, szelvények). Ter. 6922

JANTSKY, B.—NAGY, B. 1978: Velencei-hegység és környékének ércprognózisa. 40 lap, 2 térkép. Ter. 7564

JANTSKY, B. 1978: A magyar földtan nyitott kérdései (18 lap) Ter. 11 741

JANTSKY, B.—BALÁZS, E.—CSEREPES-MESZÉNA, B. 1982: Megalectonic units of the crystalline besament of the Pannonian Block. (20 lap) Ter. 11 945

GEOLOGY OF THE HIGH BLOCK OF SZÁR-HEGY—DURROGÓS-TETŐ (UGOD, VESZPRÉM COUNTY)

JÓZSEF KNAUER—GYULA MAROS—ERIKA BODNÁR

Hungarian Geological Survey
Budapest, Stefánia út 14.
H-1442

UDC: 551.243.(439.117)

Keywords: Senonian, Pannonian, paleoenvironment, biofacies, lithofacies, stratigraphic units (Ugod, Jákó, Kisbér Formations), tectonics, horizontal displacement, Bakony Mts.

For bauxite exploration purposes a more detailed mapping was carried out in the area in question. It was accompanied by the facies analyses of the Senonian base sequences that are paleomorphologically, and thus bauxite-geologically important. The investigations verified our views, amplified with many details our knowledge concerning the Senonian transgression. On the top part of the local Early Senonian elevation rocks deposited near the abrasional zone can be found at the base of the rudistid limestone (Ugod Formation). Local subsidences are indicated by calmer aquatic (with foraminifers and scarcely rudistid shell fragments) or transitional molluscan facies belonging to the Jákó Formation.

In the course of the mapping several new exposures of Pannonian conglomerates were found with a spatial arrangement outlining an abbrasional stripe.

Tectonic measurements indicate three zones of transcurrent faulting. One sinistral and one dextral Riedel system can be recorded with repeated movements in both directions.

Based on the results of former prospecting for bauxite in the "Bakonyjákó—Nagytevel—Bakonybél" region completed in 1985 the Bauxite Exploration Company did the necessary preparations for continuing the work in certain areas at a follow-up level. Related to this, the Company ordered a detailed mapping and facies analyses of the Szár-hegy—Durrogós-tető area (Fig. 1). From these investigations the results related to the Senonian, Pannonian and the structure-geological setting are described according to our report (KNAUER—MAROS, 1987) and on the basis of E. BODNÁR's investigations.

Main features of the geological makeup of the area

The Senonian transgression took place on a SSE-descending paleo-slope of Dachsteinkalk. On this slope, in the south the Csehbánya Formation and, in a NNW-trending order, first the Jákó Formation then the Ugod Formation were deposited. The slope flattens in NNW and here almost everywhere the Ugod Limestone is resting on the basement (Fig. 2). The slope was not monotonous, because the present-day areal extent of i.e. its boundaries towards NNW and the arrangement of the exposures refer to the pre-existent local depressions of

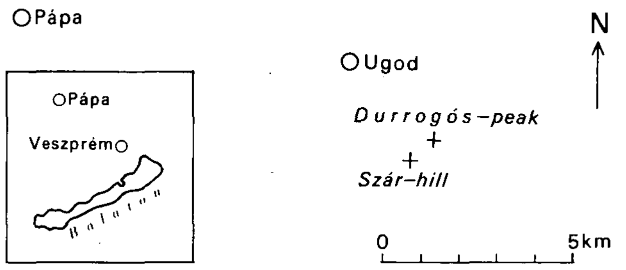


Fig. 1. Geographical setting of the locality — *1. ábra.* A terület földrajzi helyzete

paleosurface. On the pre-Senonian surface redl marl (borehole Ug113, 13.2—13.5 m, Al_2O_3/SiO_2=0,4 L.o.I.=31,2%) also occur respectively. The formerly not mapped bauxite in the ravine Poros-lejtő and its vicinity most probably is also pre-Senonian and so it must have been covered originally by Ugod Limestone. (This type of bauxite, according to E. JUHÁSZ is markedly resilicified). Some boreholes and numerous exposures give us the key of outlining the transitions of the Ugod Formation and the basin facies in both horizontal and vertical directions.

Today no Paleogene units can be found in the region. The one-time local or not distant occurrence of Eocene rocks is indicated by a large boulder of Nummulites perforatus limestone (27A; the codes here and afterwards refer to Fig. 5.) A quartz-sandstone boulder also containing many sand grains of the Dachsteinkalk and some grains of the Ugod Limestone is probably originating from the Iharkút Formation (Uppermost Eocene—Lowermost Oligocene). Based on data from the neighbouring areas the Oligocene Csatka Formation must have also covered the area during a certain period.

The conglomerate containing, at certain places, sandstone lenses and beds that can be classified into the Kisbér Formation can be detected in the form of formerly not mapped stand-up rock and detritus autcrops arranged in a NNW—SSE trending strip of land of the W—NW flanking zone.

This strip is 10—40 m wide and 1.3 km long with a level difference of max. 10—15 m so that the southernmost exposure in the S corner of Szár-hegy is situated higher by some 25 m than the group of exposures in the northernmost part of the stripe (Fig. 3).

The conglomerate rests on Ugod Limestone in the S, while it does on Dachsteinkalk in the N. Its occurrence is mainly related gently sloping surfaces less steep than the neighbouring ones or is associated with terrace-like morphological forms. All these refer to a wave-cut zone. In the N, in the SW side of the lower stretch of ravine Poros-lejtő (Fig. 4) more significant exposures can be found, and their petrological description is given by D. BIHARI (1980). The western occurrence shows similar features.

In the area of Fehér-kőhányó there is an outcrop of red to variegated clay that can be found beside a depression permanently covered by water. Since in the neighbourhood of the depression Triassic, Cretaceous and Pannonian (con-

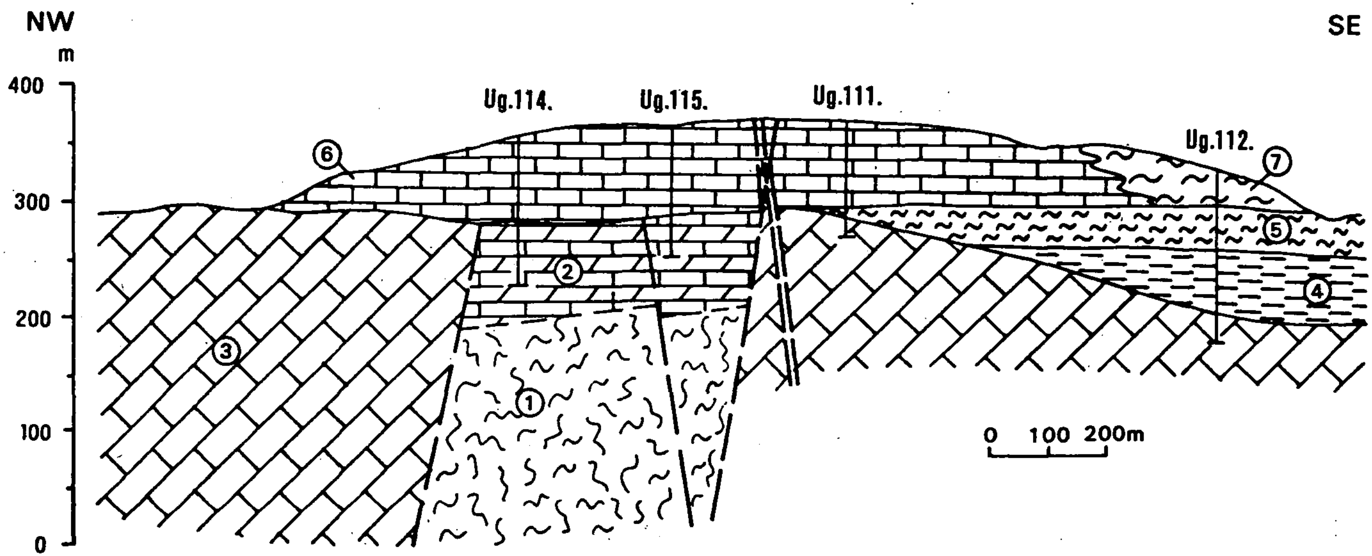


Fig. 2. Geological section across the Ugod Szár Hill after GY. HUSZÁR—T. BAKÓ (in: GY. HUSZÁR—J. KNAUER, 1986)

1. Haupdoloimit F., *2—3*. Dachstein Limestone F., (*2*: the "transitional layers" member, *1—3*: Norian), *4*. Cseh-bánya F., *5*. Jákó Marl F., *6*. Ugod Limestone F., *7*. Polány Marl F., (*4—7*: Senonian)

2. *ábra*. Földtani szelvény az ugodi Szár-hegyen át. HUSZÁR GY.—BAKÓ T. (in: HUSZÁR GY.—KNAUER J. 1986) nyomán

1. Fődolomit F., *2—3*. Dachsteini Mészkő F., (*2*: az „átmeneti rétegek" tagozat, *1—3*: nóri), *4*. Csehbányai F., *5*.Jákói Márga F., *6*. Ugodi Mészkő F., *7*. Polányi Márga F., (*4—7*: szenon)

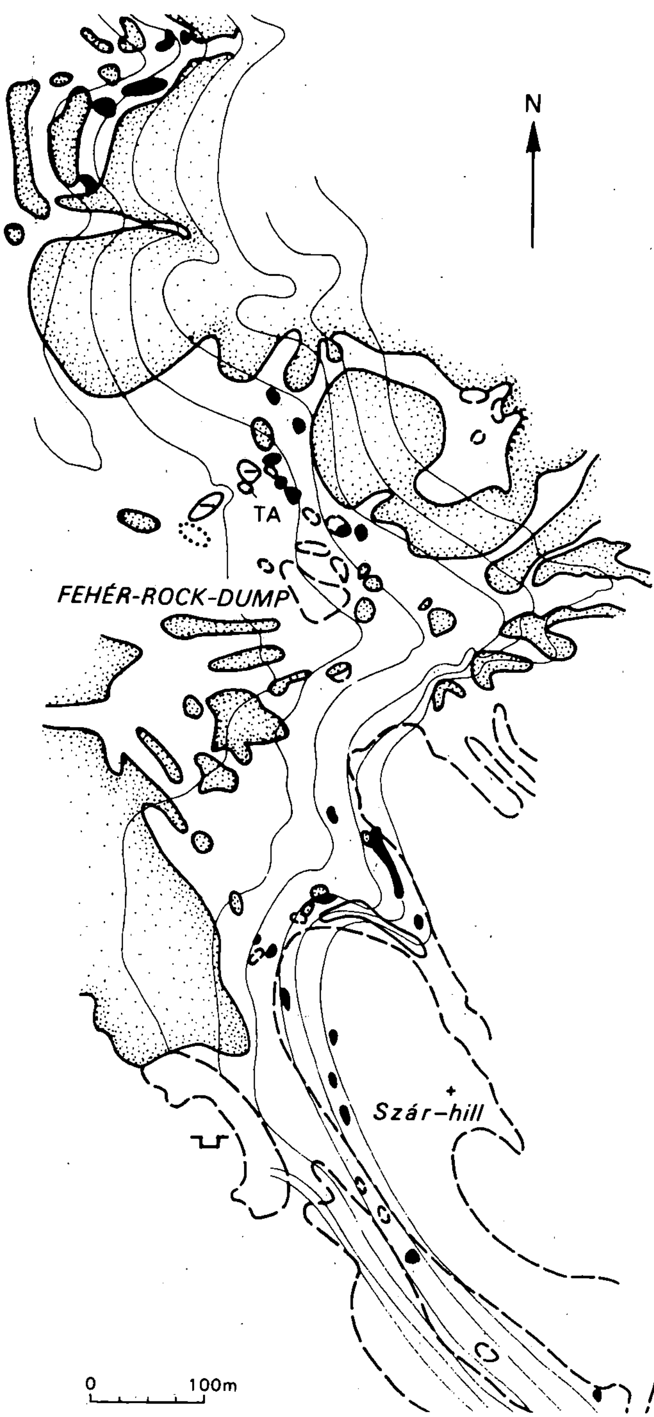


Fig. 3. Exposures of Pannonian conglomerate in the Fehér Quarry—Szár Hill strip (For symbols see Fig. 4)

3. ábra. Pannon konglomerátum feltárások a Szár-hegy — Fehér-kőhányó sávjában (Jelmagyarázat a 4. ábrán)

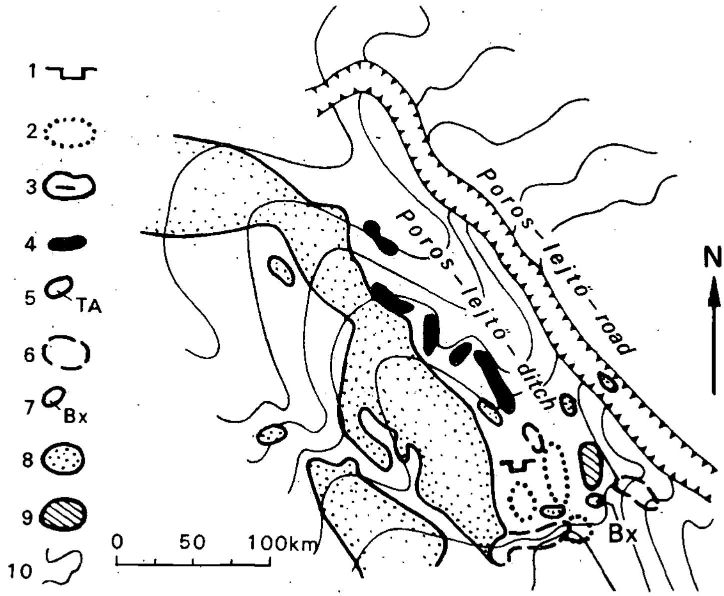


Fig. 4. Geology of the lower part of the Poros-lejtő valley

1. abandoned quarry, *2.* deadrock, *3.* temporary lake, *4.* conglomerate (Kisbér Formation), *5.* variegated clay, *6.* Ugod Limestone F., *7.* bauxite, *8—9.* Dachstein Limestone F. *(9:* the "transitional layers" member), *10.* contour line, basic line interval is 5 m

4. ábra. A Poros-lejtő-árok alsó szakaszának földtani viszonyai

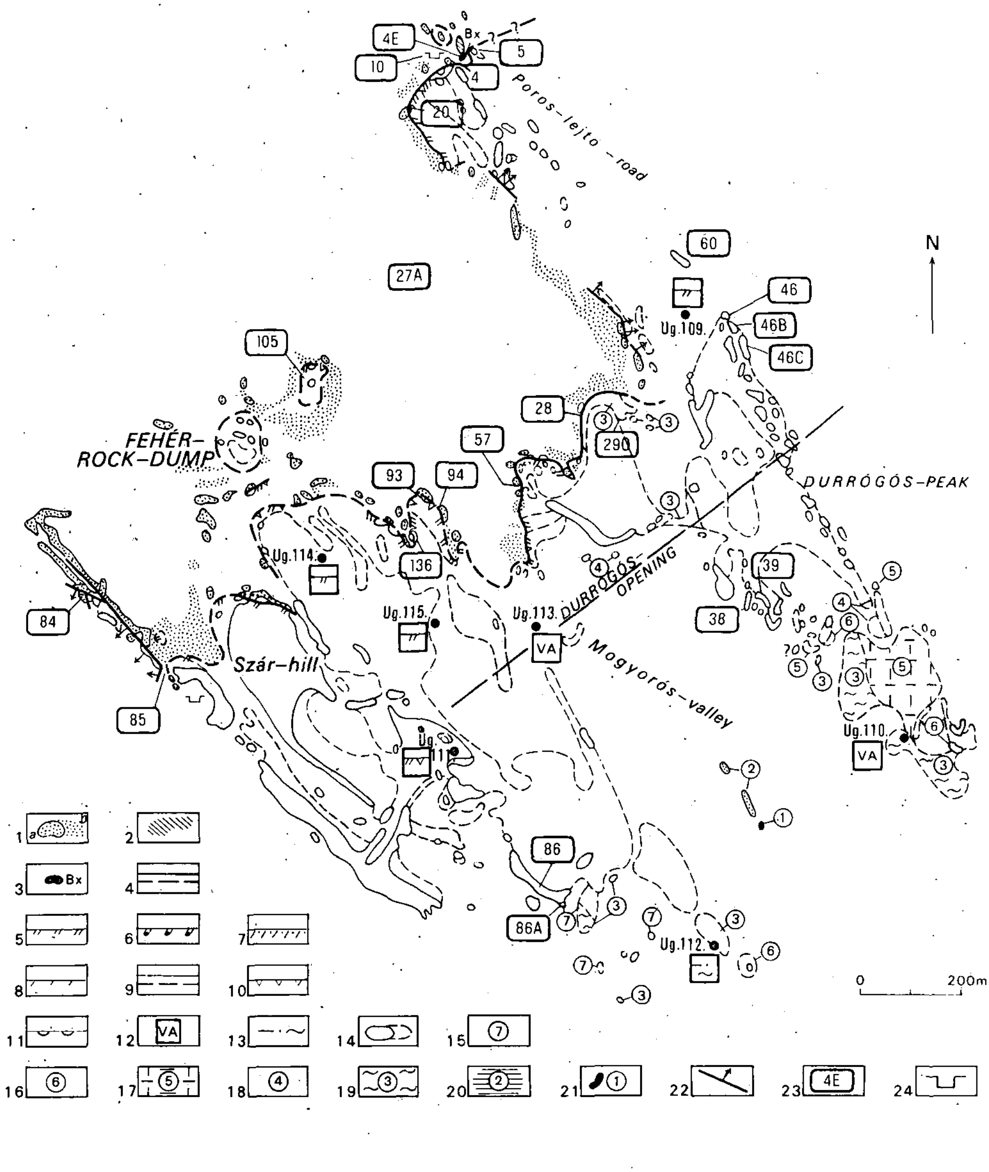
1. felhagyott kőbánya, *2.* meddőhányó, *3.* időszakos tó, *4.* konglomerátum (Kisbéri Formáció), *5.* tarka agyag, *6.* Ugodi Mészkő F. *7.* bauxit, *8—9.* Dachsteini Mészkő F. (9: „átmeneti rétegek" tagozat) *10.* szintvonal, alapszintvonalköz 5 m.

glomerate) are also cropping out at the surface, and their arrangement must be indicative of the original pans of the Triassic surface, thus the variegated clay may be not only Quaternary but also Pannonian, or even older.

Facies conditions of the Upper Cretaceous units

Constitution of the basal sequence

The Senonian—Triassic boundary can be observed along a well-trackeable but capriciously running line marked, however, by stand-up rocks at a few places only as well as (in Fig. 5) the arrays of rock No. 49 and 93, 84 and 85 and a buried locality at the NNW margin of Szár-hegy (J. HAAS, 1979, Fig 9., profile A.). Generally, next to the Triassic limestone foresets and blocks Senonian rocks and their debris can be found at a distance of some dm to 1—2 m, as lying closely but separately from each other. The initial bed of the Senonian, as seen along the surface boundaries, frequently contains detritus or pebbles from Triassic limestone, while advancing towards the interior of the basin the quantity of the clastic material is decreasing i.e. abrasion platforms were formed during a relatively late period of the transgression. The dimension and quantity of the clastic material is varying. Only the pebbles and boulders indicate a close action of abrasion, as observable along and near the rock arrays mentioned above. On the plain crest pebbles 10—15 cm large in diameter are found in Cretaceous limestone which lies on the slightly uneven surface of the Triassic limestone. (The unevenness is attested to by the fact that it can be found among the Ugod Limestone in a strip 10—15 m wide; this is not justified by the sloping of the surface at all).



In the zone of abrasion bored pebbles (57, 93) are also found in the lowermost beds of the Ugod Limestone.

A facies with much less limestone detritus can be found in the E side of the valley, along the marginal line of the Dachsteinkalk (57). The most finely grained rock type contains scarce fragments of rudistids (2), thin lamellibranch shells (3) and echinoid test elements (2) with one or two thick ostracod valves, solitary coral and benthonic foraminifer. A part of the bioclasts is worn. Towards E (26) the base rock bears coarse fragments of rudistids. A unit like that, at places with Actaeonellae (near the site marked 4G), appears in the north-east, too.

The extraclast-free, greatly pseudo-ooidic units are frequent indicating shallow, strongly agitated water but a relatively plain shore, or a more significant distance from the rocky shore, or even a bottom elevation at a greater distance from the shoreline. The foraminiferous clastic facies of the region, rarely with rudistid shell fragment found only at one site (5) probably is bound to a more significant basement depression. This unit was studied in more details by E. BODNÁR (Fig. 6). Here the base material is exclusively micrite-microsparite, at some places with recrystallization. Primary sparite could not be found only even in a single thin section. 40—50 per cent of the components are mostly bioclasts, predominantly rudistid shell fragments, at certain places with other molluscs, mainly gastropod shell pieces. The bioclasts, in certain samples show no signs of worn in the main, consisting of fibrous, splitted calcirudite. A characteristic standard microfacies type is the bioclastic wackestone (in Fig. 6 SMF9: larger bioclastic micrite with the fragments of different organisms), which, according to WILSON's facies belt classification, indicates a shallow-water depositional environment of open circulation (Fz7). Micrite with rudistid shell fragments coarser than 2 mm (SMF5: with grainstone, packstone, or float-

Fig. 5. Geological map

1—2. Dachsteinkalk, (*a:* in autcrops, *b:* in debris, *2.* "transitional layers" member), *3.* bauxite, *4.* denudational wedging boundary of the Senonian units of today's surface or near-surface, determined, supposed, *5—13.* facies type of the Senonian base layers at the wedging boundary and in the boreholes, respectively, *5:* bioclastite, micritic bioclastite, *6:* pseudooidic micritic bioclastite, *7:* foraminiferous biomicrite, *8:* biomicrite and fine crystaline limestone, *9:* clayey limestone, marl striped limestone, Mollusc-bearing biomicrite, micritic bioclastite, *(10—11.* extraclast contents, *10:* limestone contents, *11:* limestone gravel and boulder stones), *12.* red clay and marl, *13.* fine sandy clay and clay marl with organic matter colouring, *14.* Senonian unit in autcrops and in debris, *15.* interfingering of the Ugod and Jákó Formations, *16.* Ugod F., nodular limestone, *17.* Jákó—Ugod transitional facies, *18.* Jákó F., Mollusc bearing limestone, *19.* Polány Marl F., *20.* Jákó and/or Csehbánya F., clay marl-marl facies, *21.* Csehbánya F., sandstone facies, *22.* fault, *23.* mentioned and sampling site, respectively, *24.* abandoned quarry

5. ábra. Földtani térkép

1—2. Dachsteini Mészkő (*a:* szálban, *b:* törmelékben, *2:* „átmeneti rétegek" t.), *3.* bauxit, *4.* a szenon képződmények denudációs kiékelődési határa a mai felszínen, vagy ennek közelében, megállapított, feltételezett, *5—13.* a szenon alaprétegek kifejlődési típusa a kiékelődési határnál ill. a kutatófúrásokban, *5:* bioklasztit, mikrites bioklasztit, *6:* pszeudooidos mikrites bioklasztit, *7:* foraminiferás biomikrit, *8:* biomikrit ill. finomkristályos mészkő, *9:* agyagos mészkő, márgasávos mészkő, molluszkás biomikrit, mikrites bioklasztit, *(10—11.* extraklaszt tartalom, *10:* mészkőtörmelék, *11:* mészkő kavics és görgeteg), *12.* vörös agyag és márga, *13.* szerves festődésű, finomhomokos agyag és agyagmárga, *14.* szenon képződmény a felszínen, szálban, törmelékben, *15.* az Ugodi F. és a Jákói F. összefogazódása, *16.* Ugodi F., gumós mészkő, *17.* Jákói—Ugodi átmeneti kifejlődés, *18.* Jákói F., molluszkás mészkő, *19.* Polányi Márga F., *20.* Jákói F. és a Csehbányai F., agyagmárga-márga kifejlődés, *21.* Csehbányai F., homokkő kifejlődés, *22.* vető, *23.* említett, ill. mintavételi hely, *24.* felhagyott kőbánya

Table 1 — *1. táblázat*

Foraminifers of the layer sequence of the Ugod Limestone of exposure No. 5 (Fig. 6)
Az 5. feltárás (6. ábrán bemutatott) Ugodi Mészkő rétegsorának foraminiferái

	agglutinated											with calcareous shell																
							shelf-background favouring																					
STRATUM IDENTIFIER	Gaudryinopsis	Bolivinopsis	Pseudogaudryinella	Nezzazata	Polychasmina	*Valvulammina picardi* HENSON	*Moncharmontia appenninica* DE CASTRO	Cuneolina	*C. parva* HENSON	Dicyclina	*D. schlumbergeri* MUNIER-CHALMAS	*Quinqueloculina* sp. 1	*Q.* sp. 2	*Q.* sp. 3	*Hauerinidae* sp. 1	*H.* sp. 2	*H.* sp. 3	Ophthalmidium	Conorbina	Nummofallotia?	*Nummofallotia* cf. *apula* SINNI	Idalina	*I.* cf. *antiqua* (D'ORBIGNY)	Involutinidae	Vidalina	*V.* cf. *hispanica* SCHLUMBERGER	*V. carpathica*	No. of taxa
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	29	20	21	22	23	24	25	26	27	
1	2	1	1	1	1		3	1	2	1	1	1	3	1	1	1		1	1	1							1	19
2					1	1	1					3	3															5
3	2		2		1							3												1				5
A												3	1				2						1		1			5
B		2		1									3				1				1	1						6
C			2						1			3	1		1													5
D	1	1	1														1	1										5
E					1				1																			2
F	1				1																							2
G																									1	1		1
H	1	1							1			1																4
J	1		1																									2
K									1																			1
L1													1					1						1				3
L2	1														1	1												3

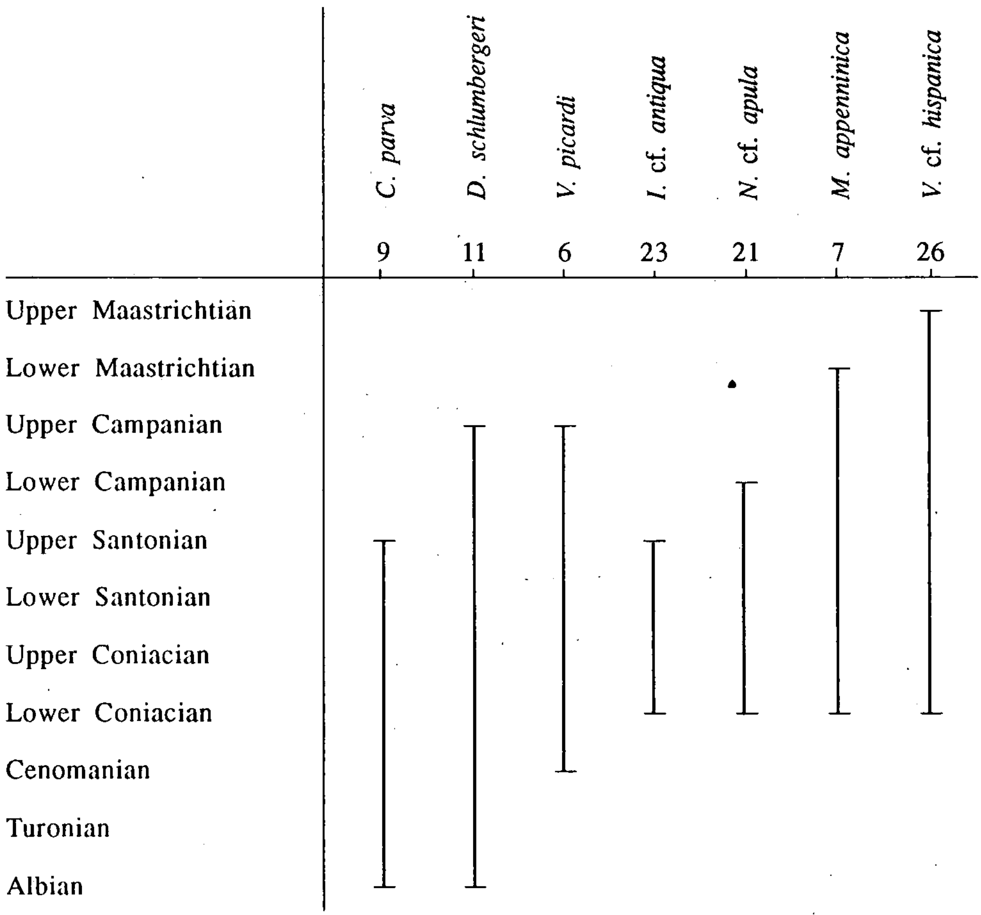
Frequency: 1 = 1— 2 specimens, 2 = 3— 6 specimens, 3 = 7—30 specimens, 4 = more than 30 specimens

Gyakoriság: 1 = 1— 2 pld., 2 = 3—6 pld., 3 = 7—30 pld., 4 = több, mint 30 pld.

Table 2 — 2. táblázat

Life span of the biostratigraphically important foraminifers of exposure No. 5

Az 5. feltárás biosztratigráfiailag fontos foraminifera fajainak fajöltője



tone bioclasts, mainly with debris of reef building materials) can be interpreted as reef slope (Fz4). The microfaunal picture is rich and varied consisting mainly of well-preserved tests of microfossils (Table 1). In the uppermost sample (1) there are more fragmented foraminifers as well as the number of agglutinated Moncharmontiae is greater. By the way, as considering the number of specimens, the quantity of the forms of calcareous test is greater in the upper stage, especially that of the Quinqueloculinae and the Hauerinidae (formerly Miliolidae; LOEBLICH-TAPPAN, 1988).

Evidences of micrite encrusting which refers to a more intense water motion, were not seen in the thin sections. In a small quantity but regularly, thin

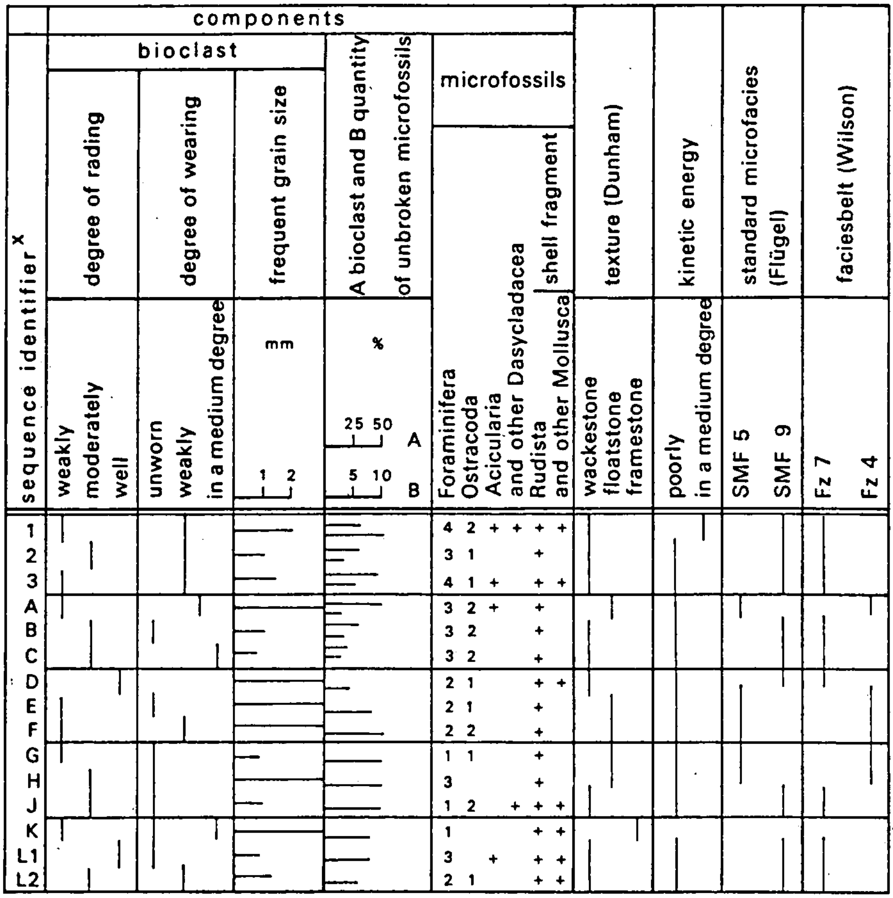


Fig. 6. Sedimentary geology of the limestone sequence of exposure No. 5 (In the collection marked as USD 5) 1—3. from surface outcrops, A—L2. from the exploratory shaft No. USD 5

6. ábra. Az 5. feltárás (a gyűjteményben USD 5) mészkő rétegsorának üledékföldtani képe, 1—3. felszíni rétegfejekből, A—L2. az USD 5 jelű kutatóaknából

and thick-walled ostracod valves, several times valve couples can also be found. Rarely but regularly Acicularia and other Dasycladaceae also occur.

From the above facts the following conclusions can be drawn:

— The sedimentation took place in a quiet environment of low energy;

— The presence of Dasycladaceae proves the photic zone, and their living space is often bound to back reef;

— From the richness in species of benthic foraminifers we can conclude the presence of open water connections, a water of normal salinity;

— The faunal assemblage, contains in a great quantity foraminifers of back reef;

— The constant presence of rudistid shell fragments verifies the neighbourhood of patch reefs;

— The frequence of SMF9 indicates a shallow carbonate shelf environment under the tidal belt.

Regarding the broader paleogeographical relations, connections could be indicated with microfaunas from Slovenia (K. DROBNE et al. 1988), from Italy (L. SINNI—E. G. RICCHETTI, 1978) and from Greece (ST. TESILA-MONOPOLIS, 1975).

Time range of the stratigraphically evaluable benthic foraminifers was taken into consideration, beside the above literary source, also by using the materials of the workshop of the IGCP-262 projects and table of Working Group on Benthic Foraminifera (1992) (Table 2). Literary data close the time range of *Cuneolina parva* and *Valvulammina picardi* in the Santonian. In the table prepared by IGCP the extinction of *C. parva* is not unambiguous and *V. picardi* is not even mentioned. For this reason the stratigraphic position of our profile is somewhat uncertain, and according to that said above it may not be younger than Late Santonian, however this statement is not in harmony with the earlier wiews. This northern zone had been depicted formerly as delimited by tectonic boundaries. The latest mapping has showed the boundaries of the strip between localities (5) and (20), and perhaps also of that stretching towards SSE from (20) to be constituted by denudational wedging out along which the Ugod Limestone immediately rests on the Triassic.

In the strip coded (28), by the boundary, detritus of less pachyodontic, Ostraea- and Pycnodonta-bearing limestone can be found that probably is a transition towards the Jákó Marl Formation; its appearance indicates a nearby deepening in the basement. At its E side the marl appears (29C), with shell fragments and here and there, with rudistids and argillaceous limestone containing also some foraminifers and red algae ($CaCO_3$=95%). From the marl *Ceratostreon matheronianum* was determined by L. MÓRA-CZABALAY. In her opinion their presence refers to the upper part of the Jákó Formation being heteropical with the Ugod Limestone (Campanian). The typical rudistid limestone appears on the bench behind them. Debris of limestone to classified into the Jákó Formation can be found here, WNW of the place, in the form of an isolated patch (105): it is shell-fragmented containing enchinoid spines and test elements, spots of microsparite and sparite and a few rudistid shell rubble.

The occurrence of these rocks at base of the Senonian or in its immediate vicinity may indicate a major depression in the basement, opened towards the basin. (This unit, for tectonic reasons, can be found in one of the highest part of the present-day land surface). From the above-described facies distribution of the Senonian basal beds, moreover from the occurrence of bauxite and from the twisting of the Createceous-Triassic boundary that cannot be explained by the present-day surface it can be read the ruggedness of the basement. The dipping of the Triassic surface is also varying.

Regarding its present-day position, the Triassic surface is presumed to have been horizontal or gently sloping (N of the Ug109, and S of the Ug113).

In the west, however, the dip presumably averages 14° according to exposed by valley cuts around Ug114.

The relation of the Ugod Limestone and the basin formations is shown in Fig. 12 of J. HAAS's study already cited. Description of the transitional units is given in the conclusions of Chapter 3. These theories, based on our observations and J. HAAS's study, and on the newly deepened bauxite exploratory boreholes, can be complemented as follows.

The exposure found SE of borehole Ug112 (Fig. 5) represents the joint occurrence of the nodular Ugod Limestone and the "regular" Ugod Limestone, forming a mass butte rising over a marly-calcareous marly environment. Both the nodule and the base rock, though different in texture, are limestone with Pachyodonta shell fragments. The surface of the nodules is frequently attached by solving so that they may be mistaken for detrital grain. The same type of formation can be found on the elevation situated E of borehole Ug110, detectable everywhere as lying on calcareous marl and being overlain, as commonly, by rudistid limestone.

Seemingly the calcareous marl is Jákó Marl, as formerly mapped. Nevertheless, upon the results of study of borehole sections Ug110 and Ug112 (M. GELLAI, 1983), this unit can be assigned to the Polány Formation, with a thickness of 28 and 37 m, respectively. Farther on to the NNW, however, without any significant change in the outlook of the rock, typical faunal elements of the Jákó Formation appear, so that the interfingering of the Ugod and Jákó Formations is observable even in a single cliff (86A). Going on towards NNW, in addition, thin bedded intercalations of Ugod Limestone type, more liable to weathering, can be found. That is why, at certain places (86) rock ledges are formed with little "supporting columns". The profile shown in J. HAAS' cited study (Fig. 10) belongs also to this unit. In an interesting type of the small-nodular limestone the nodules are lesser but coarser and there are several fine shell fragments in the nodule interspace.

Both the exposures of the SW margin of Durrogós-tető, and the beds drilled by borehole Ug109 include more or less pelagic argillaceous limestone and, less frequently, "fingers" of calcareous marl. Two facies types can be distinguished:

— Laminary, clayey limestone ($CaCO_3$=97%). Micritic matrix of uneven distribution, with relatively well-sorted calcitic detritus. The identifiable fossil remains are rich in corroded fossil Echinoidea test fragments, and several planctonic foraminifera, benthonic foraminifera, Calcisphaerulidae, a few single valves of Ostracoda and *Conocella ugodensis* HAAS.

— Limestone with small nodules containing planktonic foraminifera fragments, a small amount of Calcisphaerulidae, at places Cadosina, Echinodermata test fragments, small amounts of Pachyodonta shell fragments, some benthonic foraminifera, calcareous sand grains with some planctonic and Pachyodonta shell debris.

The facies distribution model (J. HAAS), accordingly, is only slightly modified. Not only the transitional Polány—Ugod facies but also the Polány Formation itself protruded beneath the main mass of the Ugod Formation where it soon becomes wedged out. The Jákó Formation gets into contact, directly and then by a lithological—biofacial transition with the Ugod Limestone. Towards Szár-hegy, in a short distance, the Jákó Formation is also wedged out. Along the valley Mogyoró-völgy, however, the molluscan limestone stretches a long way towards SW, and at certain places it is directly deposited on the basement. Consequently, in the SE part of the region the nodular limestone facies appears at the bottom of Ugod Formation, like in the Csabrendek area. Around Csabrendek, however, it is thicker and is divided by marl beds. In the E part of the Ugod region, however, also this nodular limestone "protrudes" by 250—300 m, as compared to its expectable position determined by the strike in strata (this may be caused by the paleorelief and/or by tectonic reasons). Finally, we are to mention that no beds assignable to the Jákóhegy Breccia Member were found.

Tectonics

In addition to mapping a tectonic survey by reading dips, joints and slickensides was carried out. From this point of view, the exposedness of the area is satisfactory to good, although because of the exposures being "point-like" the related systems may be rendered only probable.

Dips

Dipping of the Dachsteinkalk seems to be homogeneous. The Dimitryevich-type average is 154/16°. Dipping of the Ugod Limestone is more complicated because of the facies of this formation. The graphic peak values are 5:225/15°, 3:62/16° and 120/30° (Fig. 7).

Conclusions drawn from Fig. 7

A. Between the two formations there is an angular unconformity.

B. The mode of occurrence of the Ugod Limestone reflects the synclinal structure of the Central Range, or at least, there is a coincidence incidentally.

Lithoclases

Representing the results in a rose diagram, no sector without data (in a division by 10°) can be found. These do not offer information for the displacements, that is why they are not informative for depicting the strain systems.

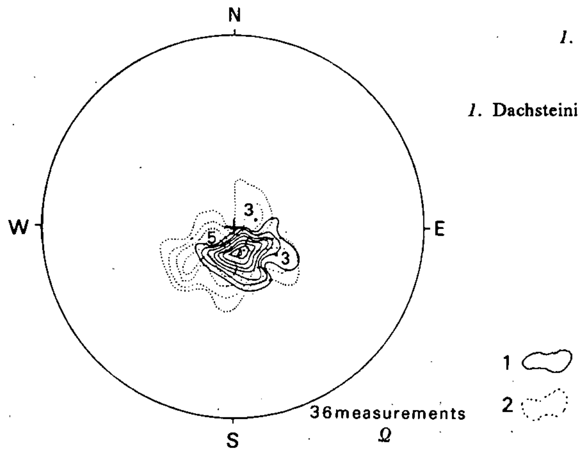


Fig. 7. Dipping data

1. Dachsteinkalk, *2.* Ugod Limestone

7. ábra. Dőlésadatok

1. Dachsteini Mészkő dőlésképe, *2.* az Ugodi Mészkő dőlésképe

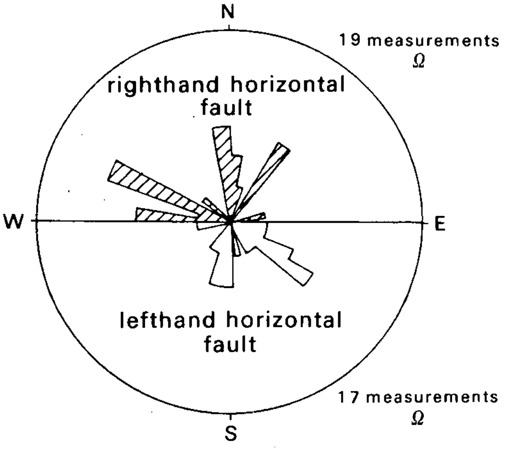


Fig. 8. Distribution of the righthand and lefthand fault scraps according to tracks

8. ábra. A jobbos és balos vízszintes vetőkarcok csapás szerinti eloszlása

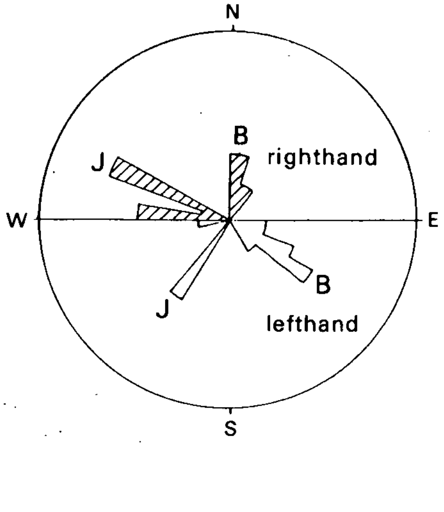


Fig. 9. The righthand and lefthand Riedel systems

9. ábra. A jobbos és balos Riedel rendszerek

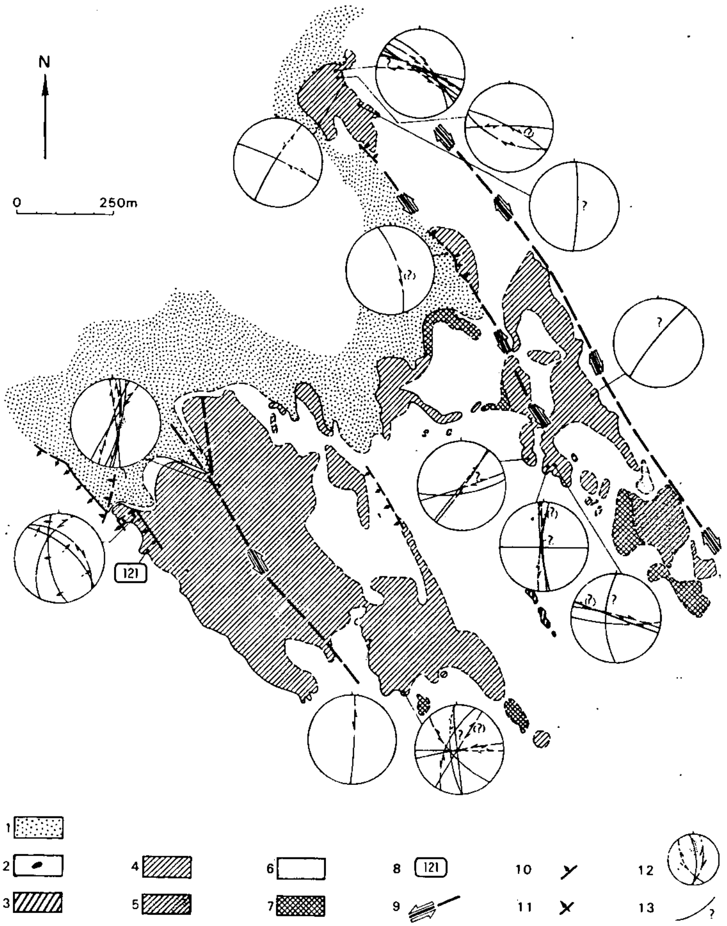


Fig. 10. Tectonic observation map and structural scheme

1. Triassic, *2.* Csehbánya F., *3.* Jákó—Csehbánya F., *4.* Ugod Limestone F., *5.* Ugod—Jákó "transitional sequences", *6.* Jákó Marl F., *7.* Polány Marl F., *8.* No. of referred exposures, 9. main lefthand dislocation zone, *10.* observed fault, *11.* inverse dislocation with scratches, *12.* stereographic projection of fault scratch in upper hemisphere (continuous, broken, dotted: increasing uncertainty), *13.* reason of the displacement can not be determined

10. ábra. Észlelési tektonikai térkép és szerkezeti vázlat

1. triász, *2.* Csehbányai F., *3.* Jákói—Csehbányai F., *4.* Ugodi Mészkő F., *5.* Ugodi—Jákói „átmeneti rétegek", *6.* Jákói Márga F., *7.* Polányi Márga F., *8.* hivatkozott feltárás száma, *9.* balos fő elmozdulási zóna, *10.* észlelt vető, *11.* inverz elmozdulás karccal, *12.* vetőkarc sztereografikus projekciója felső félgömb vetületben (folyamatos, szaggatott, pontozott: növekvő bizonytalanság), *13.* az elmozdulás értelme nem határozható meg

Slickensides

Slickensides offer spot-type but concrete information on the structure. The traces of faults are shown in Fig. 10 as observed faults. Slickenside of reverse fault was observed at the NW side of exposure No. 121, where the slightly curved strata are indicating compressive stress fields. The relatively high number of strike-slip slickensides refer to horizontal displacements breaking the region. These exposures can be seen in two main zones shown in Fig. 10. Stereographic projections of the measurement results are shown in upper hemisphere projection close to the exposures indicating also the localities by arrows. Distribution according to strike is illustrated in Fig. 8, showing in the upper part dextral and in the lower part sinistral scratches. This led to the interpretation of Riedel's systems (Fig. 9). Accordingly, a sinistral and a dextral system can be recorded the succession of which, however, cannot be determine. The dextral direction striking 175°—355° (Fig. 9) represents the predecessor of the sinistral system (Fig. 7), its renewal, or its second rehabilitation, secondary related system. In the NE zone basically dextral, and in the SW zone fundamentally sinistral systems prevail. It can also be seen that on the fault planes motions must have taken place back and forth. The marked of the dextral system is proved by the appearance of auxiliary fault planes lying 15° of the main direction of displacement. It can be supposed that our area falls into the branching zone of the so-called Telegdi Roth line. Between the sinistral and dextral zones there may be present strips of minor displacements, though a possibility of rotation of the rock mass between the two zones cannot be excluded.

On account of the smallness of the area and to the absence of younger deposits we have not been able to furnish data on the dimension and age of the displacements. According to the map, the dextral zone may reach an amplitude even of some kilometres. In the Pannonian formations no traces of displacement are observable. Accordingly, the upper age limit can be determined by the Pannonian.

REFERENCES — IRODALOM

BIHARI, D. 1980: Az Ugod—Bakonykoppány bauxitkutatási terület földtani térképe és felszíni feltárásainak leírása — Kézirat, Geoprospect, LTD., Földt. Int.

DROBNE, K. et. al. 1988: Maastrichtian, Danian and Thanetian Beds in Dolenja vas (NW Dinarides, Yougoslavia) mikrofacies, Foraminifera, Rudists and Corals. — Razprave IV. Razreda sazn XXIX. 6. 147—224. Ljubljana 1988.

GELLAI, M. 1983: Az Ug. 109., 112. és 114., 115. sz. fúrás földtani vizsgálati jelentései — Kézirat, Geoprospect LTD.

HAAS, J. 1979: A felsőkréta Ugodi Mészkő Formáció a Bakonyban — Földt. Int. Évk. 61. 1—171.

HUSZÁR, GY.—KNAUER, J. 1986: Az Ugod—Bakonykoppány reménybeli bauxitterület felderítő kutatási programja — Kézirat, Geoprospect, LTD., Földt. Int.

KNAUER, J. et al. 1977: A Bakonyjákó—Nagytevel—Bakonybél reménybeli bauxitterület előkutatási programja 1—92. — Kézirat, Geoprospect, LTD., Földt. Int.

KNAUER, J.—GELLAI M. 1978: A szenon képződmények elrendeződése és kapcsolata az ősdomborzattal a Sümeg—Káptalanfa bauxitkutatási területen — Földt. Közl. 108. (4): 444—475.

KNAUER, J.—MAROS GY. 1987: Részletes bauxitföldtani térképezés, fáciesvizsgálat és speciális tektonikai mérések az ugodi Szár-hegy és Durrogós-tető körzetében — Kézirat, Geoprospect LTD., Földt. Int.

LOEBLICH, A. R.—TAPPAN, H. 1988: Foraminiferal genera and their classification —Van Nostrand Reinhold, New York.

LUPERTO SINNI, E.—RICCHETTI, G. 1978: Studio micropaleontologico-stratigrafico di una successione carbonatica del Cretaceo superiore rilavata nel sottosuolo delle Murge sud-orientali — Riv. Ital. paleont. 84. (3): 561—666. Milano.

T. MONOPOLIS, ST.—CHRISTODOULOU, G. 1975: Eastern Hellenic zone microfacies — Athens.

VIALON, P.—RUHLAND M.—GROLIER, J. 1976: Elements de tectonique analitique — 1—118. Paris.

A SZÁR-HEGY—DURROGÓS-TETŐI MAGASRÖG FÖLDTANI VISZONYAI (UGOD, VESZPRÉM M.)

KNAUER JÓZSEF—MAROS GYULA—BODNÁR ERIKA

Magyar Állami Földtani Intézet
Budapest, Stefánia út 14.
H-1143

ETO: 551.243.(439.117)

Tárgyszávak: Szenon, pannóniai, őskörnyezet, biofácies, litofácies, formációk (Ugodi F., Jákói F., Kisbéri F.), szerkezetföldtani, horizontális elmozdulás, Bakony

A szenon transzgresszió az ugodi Szár-h. és Durrogós-t. térségében egy preszenon aljzatkiemelkedés DDK-i lejtőjén ment végbe, ez a szenon formációk egymáson való ÉÉNy-i irányú túlterjedésében mutatkozik meg. A lejtőtől ÉÉNy-ra fennsík-szerű, de egyenetlen térszínen abráziós sávok, csöndesebb vízű kis lagunák és a kettő közötti különféle átmeneti fáciesövek alakultak ki, amelyek az aljzaton fekvő Ugodi Mészkő bázisrétegeinek kifejlődésében tükröződnek. A két szélső fácies a triász mészkő görgeteges, Rudista-héj törmelékes mészkő, ill. a foraminiferás, gyéren héjtörmelékes mészkő. A foraminiferák között szantoniban záruló fajöltőjű fajok is vannak. Az Ugodi Mészkő és a pelágikus márga-formációk kapcsolata különféle átmeneti kifejlődésekben és összefogazódásban látható.

A térképezés számos új pannon konglomerátum feltárást talált (Kisbéri Formáció). Ez a magasrög jelleg „öröklődésére”utal.

A terület ÉÉK-i sarkában talált, eredetileg valószínűleg szenon bauxit erősen reszilifikált anyag, amely többé-kevésbé megőrizte a bauxitra jellemző alakos elemek nyomait.

Plate I — I. tábla

1—10. Sections of different directions of *Moncharmontia apenninica* DE CASTRO in the layer No. 1

11. *Quinqueloculina* sp.$_1$ in the layer No. 2
64 x

12—13. *Hauerinidae* sp.$_1$ and sp.$_2$ in the layer No. 1
64 x

14. *Ophthalmidium* sp., in Drobne et al. 1988, in the layer L_1
54 x

15. *Gaudrynopsis* sp. (*"Textularia"*) in the layer No. 1
64 x

16. *Valvulammina picardi* HENSON in the layer No. 2
64 x

(Photo: I. Laky)

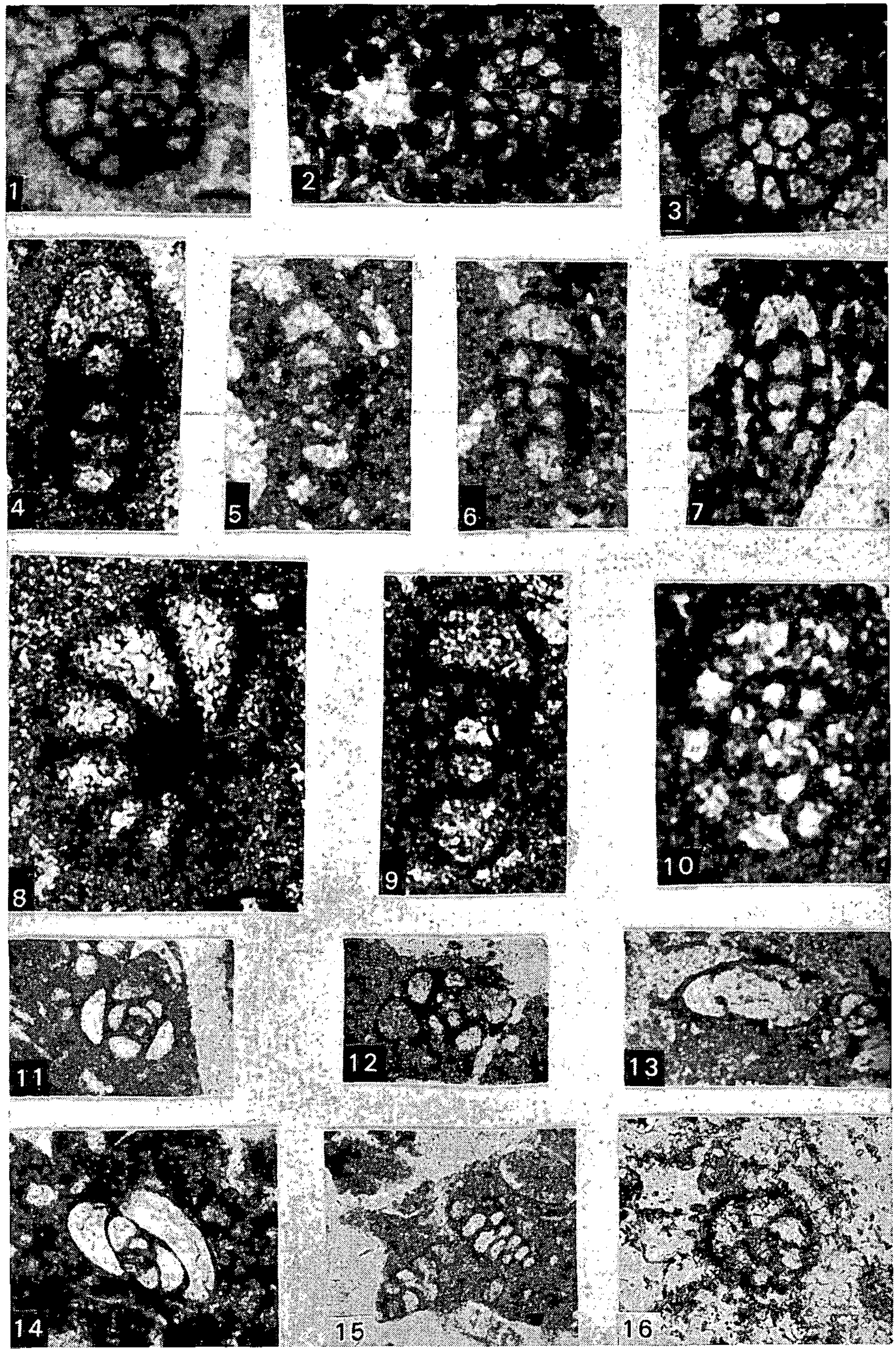

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

Plate II — II. tábla

1. Foraminiferous, rudistibioclastic biomicrite. Wackestone
40 x
A. *Quinqueloculina* sp.2, B. *Nezzazata* sp., C. *Gaudrynopsis* sp., D. Acicularia green alga (in the layer No. 1)

2. *Bolivinopsis* sp. in the layer No. 1
100 x

3. *Involutinidaea* gen. et sp. indet. in the L_1 layer
100 x

4. *Pseudogaudryinella* sp. in the layer No. 3
100 x

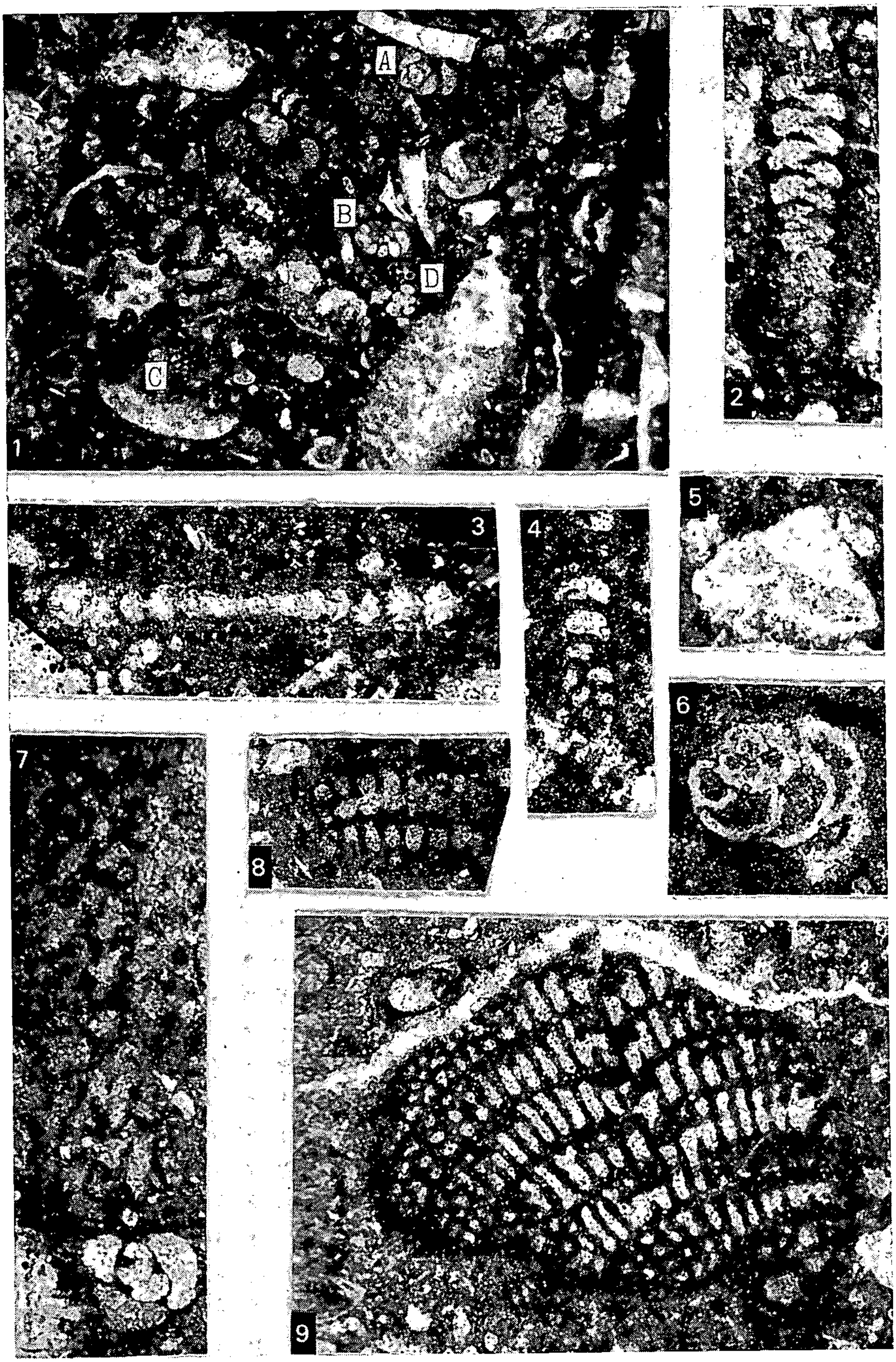
5—6. *Conorbina* sp. in the layer No. 1
100 x

7. *Dicyclina schlumbergeri* MUNIER—CHALMAS, and under this the section of *Hauerinidae* sp.2 can be seen in the layer No. 1
64 x

8—9. *Cuneolina parva* (HENSON)
64 x

8. horizontal section from layer No. 1

9. vertical section from layer K
(Photo: I. Laky)


A
B
C
D
1
2
3
4
5
6
7
8
9

MALM AND LOWER CRETACEOUS ROCKS OVERRIDDEN BY KÖSSEN FORMATION IN THE HALIMBA BAUXITE AREA

by

JÓZSEF KNAUER

Hungarian Geological Survey
Budapest, Stefánia út 14.
H-1143

UDC: 553.492.1 (439.117): 553.492.1:551.76

Keywords: bauxite, Mesozoic, stratigraphic units, drill cores

In the footwall of the Halimba bauxite deposit of great extension predominantly Upper Triassic, at certain places Liassic units can be found. At the same time the H 1189 borehole deapened in about the centre of the deposit cut across also Malmian and Lower Cretaceous rocks, i.e. the lower part of the Pálihálás Limestone Formation and the upper part of the Mogyorósdomb Formation, respectively.. The throw of the fault separating the two formations is c. 80—100 m. The identification of the Kössen Formation found above the young Mesozoic portion of the geological profile represents an important contribution to the understanding of the pre-Senonian tectonics of the area concerned.

As already known, the Senonian Halimba bauxite deposit is underlain nearly everywhere by Upper Triassic rocks, namely Hauptdolomit Formation, Dachsteinkalk Formation or Kössen Formation, and by the Hettangian Kardosrét Limestone Formation. However, the occurrence of younger Liassic rocks have also been mentioned (SZANTNER, F—ERDÉLYI, M. 1960; PUSKÁS, J. et al. 1966, SZANTNER, F.—Szabó, E. 1970, KÁROLY, GY. et al. 1970). Between the bauxite deposits (the Halimba Bauxite Formation) and the underlying rocks mentioned above a some-ten-metre-thick unit referred to as Cseres Conglomerate-Breccia Member of the Halimba Formation is frequently present (M. STEFLER, M. 1991). This unit is made of bauxitic-dolomitic siltstone, detritus-bearing, at places bauxitic red clay and breccia. In the underlying units somewhat similar rock types that can be interpreted as karst cavity infillings or karst breccia have also been drilled.

In about the central part of the bauxite deposit, more precisely on the southern margin of part Halimba III (Fig. 1), bauxite exploratory borehole H 1189 was drilled (Company for Bauxite Exploration, 1967). Among the samples from this borehole, GELLAI, M. and GECSE, É. found rocks different from those mentioned above, and I was requested to study more exhaustively these samples.

In the sequence of the borehole the bauxite deposit is covered by a few-metres-thick variegated claymarl and variegated sandy clay beds (Csehbánya

Formation) and is separated from the underlying bed by an argillaceous sequence (172.7—181.9 m) interpreted as fault gouge by J. ZSANKÓ (ZSANKÓ, J. 1967) when giving a first description in the field (Fig. 2). A part of the sequence is pale-red, bauxitic dolomitesiltstone, whereas the other part is a dark olive-brown clay with a greyish shade and a number of slump plates. The former one is assigned to the Cseres Member, whereas the latter seems to correspond to the Senonian Csehbánya Formation. In a sample representing the basal part of the depth interval (180.9—181.9 m), the two rocks are in contact with each other along an irregularly-shaped surface. Of a total of eight samples recovered, only two ones contained coccolith, namely a specimen of *Cyclococcolithus* sp. (GARTNER et SMITH), *Sphenolithus* sp. and *Coccolithus* sp. The presence of Eocene forms in the sample is still problematic, however, it can be attributed to tectonic reasons rather than to a negligence committed in the laboratory. (Calcareous nannoplankton examinations referred to in the paper were carried out by F. BROKÉS and M. K. TÜSKE).

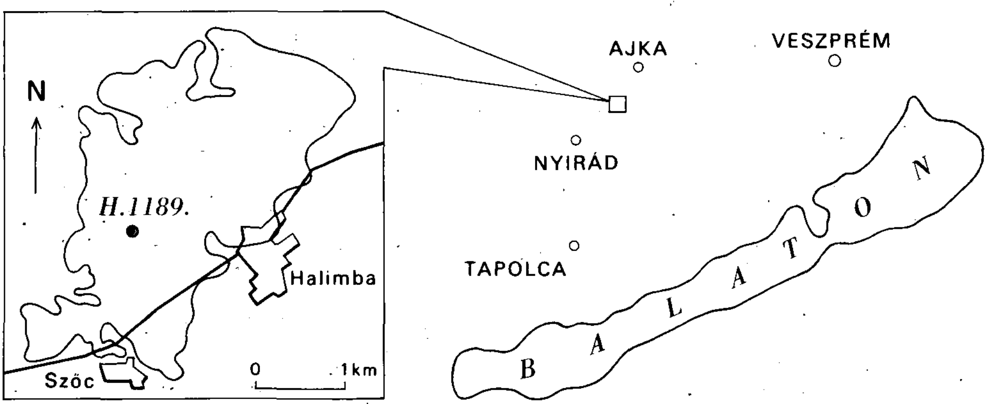


Fig. 1. The location of borehole H 1189. The contour shows the boundary of the "stratiform" Halimba bauxite deposit

1. ábra. A H. 1189. sz. fúrás helyzete. A kontúr a halimbai rétegszerű bauxittelep határa

The sample from the interval ranging from 181.9 to 182.9 m is evenly coloured, slightly pale brownish-red limestone seeming to be evenly fine-grained when examined by the unaided eye. In the thin section of this limestone sample a few Ammonite whorl fragments, a few gastropod shell fragments and echinoderm test fragments, and a tiny lumachelle layer were observed in the micritic groundmass containing calcite grains of even size and only sporadically corresponding to the size range of microsparite (Photos 1 and 2). A single specimen of *Gsolbergella spiroloculiformis* ORAVECZ-SCHEFFER (det. A. O.-SCHEFFER) identified in the sample indicates Carnian age. In my opinion, the sample is a component of the Cseres Conglomerate-Breccia.

In the range from 182.9 to 197.9 m an extremely tectonized limestone — dolomitic limestone assignable to the Kössen Formation can be found (Table I). As observed in 13 thin sections, this rock has a usual texture type: relict

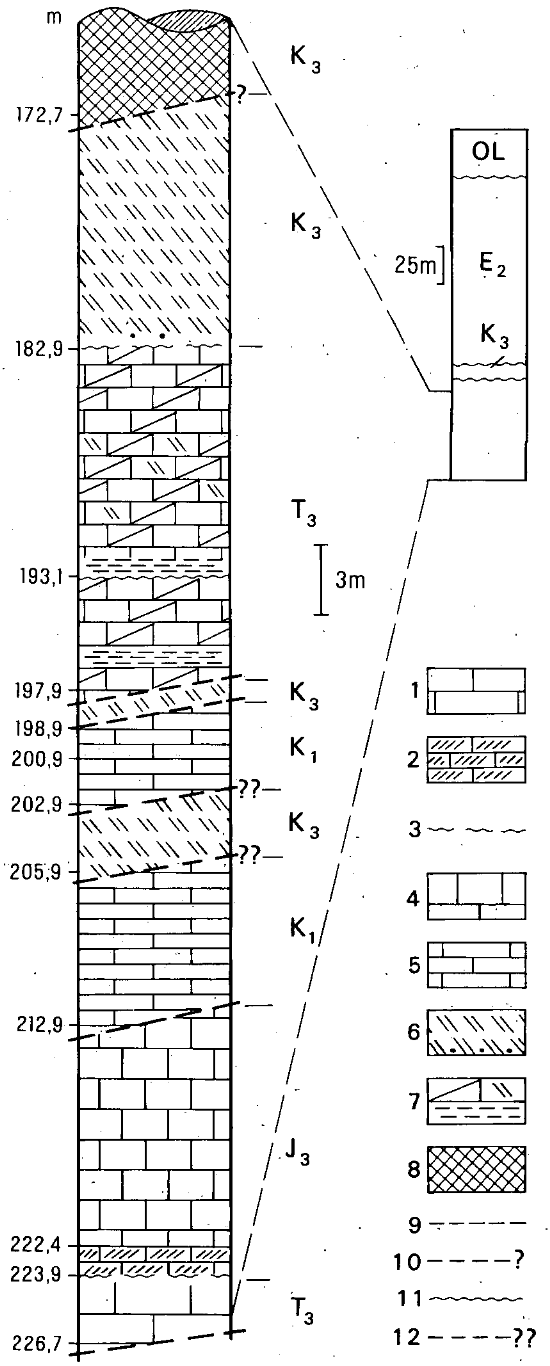


Fig. 2. A sketchy geological column of the described interval of borehole section H 1189

1. Dachsteinkalk (Dachstein Limestone) Formation, or possibly Kössen Formation, 2. Oxfordian (?Lower Kimmeridgian) crinoidal—Globochaeta-bearing limestone, *3.* assumed unconformity, *4.* Kimmeridgian Lombardia limestone (2 and 4 Pálihálás Limestone Formation) *5.* ?Hauterivian "biancone" (Mogyorósdomb Limestone Formation), *6.* clay and bauxitic dolomite-siltstone, with clasts from Liassic limestone at the bottom, *7.* Kössen Formation, here and there with red clay, limestone detritus and gravel bearing red clay infillings, *8.* bauxite deposit, *9.* fault, *10.* contact along fault, or depositional, *11.* dissolved, karstic surface, *12.* contact, tectonic or along a karstic surface.

2. ábra. A H. 1189. sz. fúrás ismertetett szakaszának vázlatos rétegsora

1. Dachsteini Mészkő Formáció, esetleg Kösseni Formáció; 2. oxfordi (alsó-kimmeridgei ?) crinoideás—globochaetés mészkő; *3.* feltételezett diszkordáns ráteleplülés; *4.* kimmeridgei lombardiás mészkő (2. és 4. Pálihálási Mészkő Formáció); *5.* hauterivi (?) „biancone" (Mogyorósdombi Mészkő Formáció); *6.* agyag és bauxitos dolomitaleurolit, alul liász mészkő törmelékkel; *7.* Kösseni Formáció, helyenként vörös agyag, mészkőtörmelékes és -kavicsos vörös agyag hézagkitöltéssel; *8.* bauxittelep; *9.* törés; *10.* törésmenti érintkezés vagy ráteleülés; *11.* oldott, karsztos felület; *12.* törés vagy karsztos felületmenti érintkezés.

micrite-mottled sparite with uneven grain size; medium-grained (micrite-microsparite) with an even grain size; fine-grained micrite, rarely dolomite-rhombohedral; small-grained dolomite-rhombohedral sparite (Photos 3 and 4). A few Aciculella calcareous algae and Late Triassic foraminifers: *Schmidita* sp., *Gandinella* sp. (det. A. O.-SCHEFFER) were identified. In addition to limestone some samples contain clay, which forms independent samples, too. A part of the clay is of greasy-black or pale-grey colour (192.0—193.1 m and 195.9—196.9 m), whereas another part is red or reddish-brown (in the range from 185.9 to 190.9 m: this part contains, at the bottom, Kössen Limestone pebbles with a size of 1 cm, as well as debris and coal pieces). At a depth of 193.1 m the black clay is in contact with the uneven, pitted surface of the Kössen Limestone. This phenomenon is due to a pressure-supported solution instead of repeated dissolution processes taking place during the period the Kössen Formation was deposited. From a sample of this clay bed (192.9 to 193.0 m) the following Triassic association (relative frequency index in parantheses) has been identified by F. GÓCZÁN:

Cyathidites minor COUPER, *Toroisporis* fsp., *Classopollis classoides* (Pf.) POCOCK et JANS. (5), *Corolina* sp. (2), *Ovalipollis* fsp. (4), *Cycadopytes* fsp., *Botryococcus* sp. (5).

Based on the above floral list, these grey and black clay beds can be identified with the clay intercalations frequently encountered in the Kössen Formation. The red clay "beds" are obviously infillings in fissures or karstic cavities.

The origin of the rock found at a depth interval ranging from 197.9 to 198.9 m and originally described as a grey, bauxite fissure filling material is somewhat more difficultly interpretable. According to its lithological features, it may have originated from a carbonate-bauxitic (karst-cavity-filling) rock group and, as with a rock having a similar composition and found in the range from 202.9 to 205.9 m, it appears in the section in a tectonic position or as fissure filling material. (Table I and II).

Table 1 — 1. táblázat

Rock composition — Kőzetösszetételi adatok

Position of the sample (m)	From chemical analysis (%)				Based on DTG (%)					
	CaO	MgO	calcite	dolomite	calcite	dolomite	kaolinite	"hematite"	pyrite	Σ
188.9—189.9	54.3	0.8	94.1	3.7						
190.9—191.9	54.0	1.0	93.6	4.6						
197.9—198.9	21.7	8.3	17.9	38.2	15.4	39.7	37.2	2.3	2.9	96.5
197.9—198.9'	18.8	6.6	17.0	30.4						
203.9—204.9	31.6	4.2	45.8	19.3	42.7	21.7	26.5	2.0	2.3	95.2
223.9—224.9	54.0	0.6	94.6	2.8						

Analysed by Bauxite Exploratory Company (Laboratory), DTG: Mrs. L. SIKLÓSI (BEC)

Remark: ' original average sample (its chemical data are shown on Table II)

Table 2 — 2. táblázat

Data of chemical analyses — Vegyelemzési adatok

197.9—	Al_2O_3	19.6%	$\left(\frac{Al_2O_3\%}{SiO_2\%}=1.03\right)$
198.9 m	SiO_2	19.1%	
(original	Fe_2O_3	4.8%	altogether 70.9%
average	TiO_2	0.4%	(together with CaO+MgO = 96.3%)
sample)	igniation loss	27.%	

The sequence ranging from 198.9 to 226.7 m represents the most interesting part of the borehole section. At the bottom, based on a typical texture of small limestone fragments observed in three samples taken from the interval ranging from 223.9 to 226.7 m, the borehole has drilled the oncoidal facies of the Dachstein Limestone Formation, or eventually the Kössen Formation in which this kind of facies is also frequently encountered in this region (GELLAI, M. 1974); (Photos 5—8). The foraminifers identified in the samples are also indicative of Triassic time. These forams are as follows: *Spiroplectammina* cf. *hungarica* ORAVECZ-SCHEFFER, Diplotreminidae gen. et sp. ind. (det. A. O.-SCHEFFER). A fracture zone seems to have formed at the bottom. As shown by two samples representing a portion between approx. 222.4 and 223.9 m, the Triassic limestone is overlain by a blurred-spotty limestone bed that has a "cloudy" micritic groundmass, and contains coarse crinoidal ossicles, rarely Globochetae (*G. alpina* LOMBARD) and is heavily interlaced with iron minerals. According to Transdanubian Central Range analogies, this limestone bed represents the Oxfordian stage, or possibly the lowermost Kimmeridgian (Photos 9, 10, 12). When examined with the unaided eye, the limestone bed seems to be dark brownish-red, slightly unevenly coloured, somewhat bright and is of uneven splitting. The fracture surface is scaly at some places. This bed is overlain by a typical dark brownish-red, nodular, Lombardia-bearing limestone (Pálihálás Limestone Formation); (212.9—222.4 m, 9 samples). In some samples *Lombardia arachnoidea* BRÖNNIMANN (sensu KNAUER, J. 1966) is exlusive and rock-forming, even to the whole extent of the rock mass. In some samples a few *Globochaete alpina*, or skeletal elements of sessile crinoids are also included. This part (9.5 m thick) undoubtedly represents the Kimmeridgean—Lower Tithonian Arachnoidea Zone, whereas the frequent occurrences of Lombardia indicate the lower part of the zone (Photos 11, 13).

The subsequent portion (198.9—212.9 m, 11 samples) is, megascopically a pale grey or light grey compact limestone. Owing to an evenly fine-grained micrite groundmass and the presence of fossils (calcified radiolarians, a few aptychi and echinoderm test fragments, a few benthonic forams, some thin ostracodal valves) there is no doubt that it is identical with the Neocomian biancone (Mogyorósdomb Limestone Formation) (Photos 14—20). Due to lack of Calpionella species and siliceous radiolarians, moreover to the irregular occurrence of calcareous radiolarians, I believe that the portion penetrated here may be assigned to a rather high horizon of the rock profile, roughly to the Hauterivian. (*Braarudosphaera* sp., *Watznaueria barnesae* (Black), W. sp., *Coccolithus* sp. and discolith type coccolith identified from the range of 210.9 to 212.9

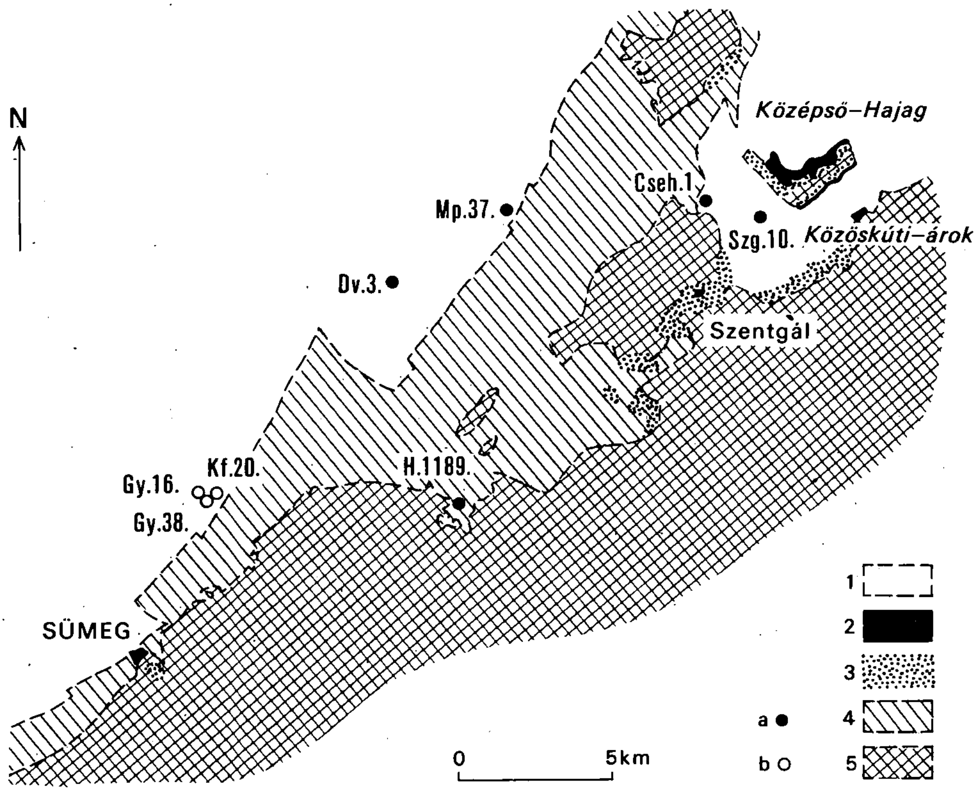


Fig. 3. Upper Jurassic and Lower Cretaceous rocks most adjacent to the area of Halimba, shown on a map of the Mesozoic rocks (after CSÁSZÁR, G. et al. 1978 and HAAS, J.—JOCHA-EDELÉNYI, E. 198O, a slightly modified version and in borehole sections

1. Rocks younger than Senonian overlain by Albian and/or Senonian beds, *2.* Upper Jurassic—Lower Cretaceous rocks cropping out at the surface, *3.* Lower and Middle Jurassic formations on the surface or covered by younger rocks, *4—5.* Upper Triassic rocks (*4.* overlain by Senonian beds, *5.* on the surface or below Cenozoic beds). *a)* according to a detailed study, *b)* on the basis of a primary (field) description

3. ábra. A felső-jura és alsó-kréta képződmények Halimbához legközelebbi előfordulásai a mezozóos képződmények térképén (CSÁSZÁR G. et al. 1978 és HAAS J.—J. EDELÉNYI E. 1980 után, kissé módosítva) és fúrásokban

1. triásznál fiatalabb képződmények albai és/vagy szenon formációkkal fedve; *2.* felső-jura—alsó-kréta képződmények a felszínen; *3.* alsó—középső-jura képződmények a felszínen, vagy fiatal képződményekkel fedve; *4—5.* felső-triász képződmények (*4.* szenonnal fedve, *5.* felszínen vagy kainozóos képződményekkel fedve); a) részletes vizsgálat alapján, b) elsődleges (terepi) leírás alapján

metres point to Cretaceous time but the Neocomian origin is uncertain. Among the Lombardian limestone and biancone samples clay was also identified at several other places, however, here no calcareous nannoplankton was identified). The nearest Malm or Lower Cretaceous occurrences are situated at a distance of approx. 15 km to the west (boreholes at Gyepükaján), at a distance of approx. 13 km to the north (borehole Dv 3 drilled at Devecser), and at a distance of 17 km towards NE (Szentgál, in the vicinity of Tűzköves-hegy). Thus, the fossil identified in H 1189 is also noteworthy as an evidence to prove the one-time areal extent of the Upper Jurassic—Lower Cretaceous deposits (Fig. 3).

As already shown, in this borehole section the entire Calpionellidae — bearing facies, that is, the upper part of the Tithonian, the Berriasian and, entirely or partly, the Valanginian are missing between the Pálihálás Limestone and the upper part of the Mogyorósdomb Formation. Since no sequence with hiatus is known anywhere in these successions, the gap in concern is apparently of tectonic origin.

The vertical throw of this fault is estimated at 80 to 100 m. This estimation is based upon the fact that the thickness of this sequence here missing is 180 m in the profile of Sümeg (approx. 20 km WSW of Halimba), whereas 30 to 40 m in the profiles of Herend (Közöskúti-árok) and Hárskút (Rendkő), situated at a distance of 23 to 25 km to the NNE of Halimba (see also Figs 1, 12 and 14 in FÜLÖP, J. 1964), and even there are also thinner sequences of the respective beds in this region (KNAUER, J. 1989). This attenuation towards WSW—ENE is also evidenced in another biancone profiles of the Bakony Mts.

Most samples representing the depth interval ranging from 182.9 m to 226.7 m are in very poor condition as having been fragmentary, frequently calcite-veined, clay-coated small pieces of the original rock. However, no doubt that they represent an autochtonous sequence, since the arrangement conformable to the stratigraphic order of so many bit samples like that cannot be accidental. The tectonic impact causing the rock to be extremely strongly cracked took place before the Senonian. The Senonian bauxite deposit and its overlying sequence are recorded to have been found in an undisturbed mode of occurrence with rather intact rocks.

When determining the type of development of the sequence ranging from 198.7 to 226.7 m the fundamental question is whether the boundary between the Malm limestone and the Triassic is depositional or tectonic. That is to say, in the Jurassic sequences with different kinds of hiatus, found in the Bakony Mts, the Malm beds directly overlie the Kardosrét Limestone or, at some places, even the Dachstein Limestone in the following localities: the western margin of Középső-Hajag, Alsó-Hajag, Kis-Som-hegy by Porva, Som-hegy by Bakonybél, the Tökvár-tanya area at Borzavár, the Eperkés-hegy of Olaszfalu, and the valley stretching from Kis-Som-hegy to Pénzesgyőr (NOSZKY, J. JR. et al. 1957, FÜLÖP, J. 1964, CSÁSZÁR, G.—KNAUER, J. 1982, CSÁSZÁR, G. 1984, KNAUER, J. 1989). In some other profiles a similar sequence including the intercalation of a thin Liassic bed was developed, for instance in the ravine Kis-Nyerges-árok found at the SW end of Alsó-Hajag (NOSZKY, J. JR. 1957, KONDA, J. 1970). So, if the boundary between the two units is depositional also in borehole section H 1189, then a development similar to that of the above-mentioned areas can be dealt with here. If the contact is tectonic, then it can be correlated with another, more complete Jurassic succession. The nearest, sequence showing completely continuous deposition of a "basin interior" type (KONDA, J. 1970) is found E of Halimba, at a distance of 15 km, at Magyarpolány (borehole Mp 37). Based on the knowledge of the older Jurassic rocks in the Halimba area, I deem that such a complete sequence is not likely to have existed at one time in the region of borehole H 1189. Instead, we can think of a Jurassic sequence with minor hiatuses, mainly with a missing or reducedly developed Dogger. Neither the more precise age of the tectonic displacement causing the Kössen Formation to get here over the Neocomian beds, nor the nature and direction of the concerned dislocation are known. This phenomenon can be best linked with a contraction described earlier (SZANTNER, F.—ERDÉLYI, M. 1960) which brought about the rise of an SW—NE striking fault with SE directed upthrust taking place alongside. Its connection with lateral displacements with roughly NW—SE or WNW—ESE strike and also resulting in apparent upthrusts, verified nowadays NE of the borehole is unlikely, because the young age of these lateral displacements excludes this possibility. This sequence which is tectonically strongly affected — obviously in several phases — is constituted by rocks densely penetrated by argillaceous ones containing also Jurassic and Lower Cretaceous beds known as a basement unfavourable to bauxite formation indicates — as underlying the bauxite deposit — that the concerned bauxite deposit is not karst bauxite in the strict sense.

The bauxitization of this deposit had taken place in the nearer or farther environment of its present-day location, probably resulting in the formation of karst bauxite originally, and then the material accumulated in a large depression formed, mainly but not exclusively, on carbonate-built basement.

REFERENCES — IRODALOM

CSÁSZÁR, G. 1984: Magyarázó a Bakony-hegység 20 000-es földtani térképsorozatához, Borzavár. — Földt. Int. kiadv. 1—138., Budapest.

CSÁSZÁR, G.—KNAUER, J. 1982: A Bakony-hegység földtani térképe, Borzavár M=1:20 000. — Földt. Int. kiadv. Budapest.

CSÁSZÁR, G.—HAAS, J.—J. EDELÉNYI, E. 1978: A Dunántúli-középhegység bauxitföldtani térképe a kainozóos képződmények elhagyásával M=1:100 000. — Földt. Int. Budapest.

FÜLÖP, J. 1964: A Bakony-hegység alsó-kréta (berriázi—apti) képződményei. — Geol. Hung. Ser. Geol. 13.: 1—197.

KÁROLY, GY.—ORAVECZ, J.—KOPEK, G.—DUDICH, E. 1970: Stratigraphic horizons of the footwall and hanging-wall formations of bauxite deposits in Hungary. — Földt. Int. Évk. 54.(3): 95—107.

KNAUER, J. 1966: A Lombardia kérdés — Földt. Közl. 96.(2): 195—199.

KNAUER, J. 1976: A halimbai III., IV. és V. bauxitteleprész fúrási fekü rétegsorainak értelmezése M=1:5000 — Geoprospect adattár, kézirat.

KNAUER, J. 1977: A H. 1189. sz. fúrás fekü rétegsorának vizsgálati eredményei — Geoprospect adattár, kézirat.

KNAUER, J. 1989: Magyarázó a Bakony-hegység földtani térképsorozatához, Lókút. — Földt. Int. kiadv.: 1—101., Budapest.

KONDA, J. 1970: A Bakony-hegységi jura időszaki képződmények üledékföldtani vizsgálata — Földt. Int. Évk. 50. (2): 1—260.

MÉSZÁROS, J. 1980: Szerkezetföldtani vizsgálatok a bauxitkutatás szolgálatában — Földt. Kutat. 23. (4): 9—12.

MÉSZÁROS, J. 1980: A halimbai bauxitelőfordulás sajátos larámi tektonikájának gyakorlati jelentősége —Bány. és Koh. L. Bányászat 114. (51): 301—303.

MÉSZÁROS, J.—TÓTH, I. 1979: Vízszintes eltolódások Ajka térségében és gyakorlati jelentőségük — Földt. Int. Adattár. Kézirat, 1—9.

STEFLER, M. 1990: Javaslat a Cseresi Tagozat felállítására — Földt. Int. Adattár. Kézirat, 1—5.

NOSZKY, J. JR. et al. 1957: A Bakony-hegység É-i részének földtani térképe in: BARNABÁS, K. et al. Bauxitföldtani kutatások Magyarországon 1950—1953 között — Földt. Int. Évk. 46. (3).

PUSKÁS, J.—ERDÉLYI, T.—SZABÓ, E. et al. 1966: Jelentés a Halimba V. bauxitteleprészen végzett kutatómunkálatok és készletszámítás eredményeiről I. — Geoprospect, Földt. Int. Adattár. Kézirat, 1—272.

SZANTNER, F.—ERDÉLYI, M. 1960: Jelentés a Halimbai III. bauxitelőforduláson végzett kutatómunkálatok és készletszámítás eredményeiről — Geoprospect, Földt. Int. Adattár. Kézirat, 1—165.

SZANTNER, F.—SZABÓ, E. 1970: The structural geological conditions and history of development of Hungarian bauxite deposits — Földt. Int. Évk. 54. (3): 109—129.

T. GECSE, É. 1976: A halimbai I. és II. bauxittelepréasz fúrási fekü-rétegsorainak értelmezése és egyes fúrások fekü-vizsgálati eredményei M=1:5000 — Geoprospect adattár. Kézirat.

TÓTH, I. 1981: Halimba III. — Kolontár II., információs jelentés: a) Általános földtani rész. — Veszprémi Szénbányák. Kézirat.

ZSANKÓ, J. 1967: Földtani Adatok a H. 1189. sz. fúrásról — Geoprospect adattár. Kézirat.

MALM ÉS ALSÓ-KRÉTA KÉPZŐDMÉNYEK A HALIMBAI BAUXITELŐFORDULÁS TERÜLETÉN, RÁTOLÓDOTT KÖSSENI FORMÁCIÓ ALATT

KNAUER JÓZSEF

Magyar Állami Földtani Intézet
Budapest, Stefáni út 14.
H-1143

ETO: 553.492.1 (439.117): 553.492.1:551.76

Tárgyszavak: bauxit, mezozoikum, formációk, magminták

A nagykiterjedésű halimbai bauxittelep fekvőjében uralkodóan felsőtriász és hettangi, itt-ott fiatalabb liász képződmények ismertek. A Halimba III. teleprész D-i határánál mélyült H. 1189. sz. bauxitkutató fúrás malm és alsókréta kőzeteket is harántolt, éspedig a Pálihálási Mészkő Formáció alsó és a Mogyorósdombi Formáció felső részét. A kettőt elválasztó törés elvetési magassága 80—100 m-re becsülhető. További érdekes adat a terület senon előtti szerkezetföldtani alakulásához a fiatal-mezozóos szelvényszakasz fölött elhelyezkedő Kösseni Formáció kimutatása.

Plate I — I. tábla

1—2. 181.9—182.9 m. Carnian limestone from a boulder of bauxitic dolomite-siltstone (Halimba Bauxite Formation, Cseres Member, Senonian)
1.: 18 x, *2.*: 10 x

3. 196.9—197.9 m. Dolomitic limestone (Kössen Formation)
194 x

4. 188.9—189.9 m. Limestone, with relict micrite-spotted, microsparite-sparite groundmass; *Frondicularia woodwardi* HOWCHIN (Kössen Formation)
97 x

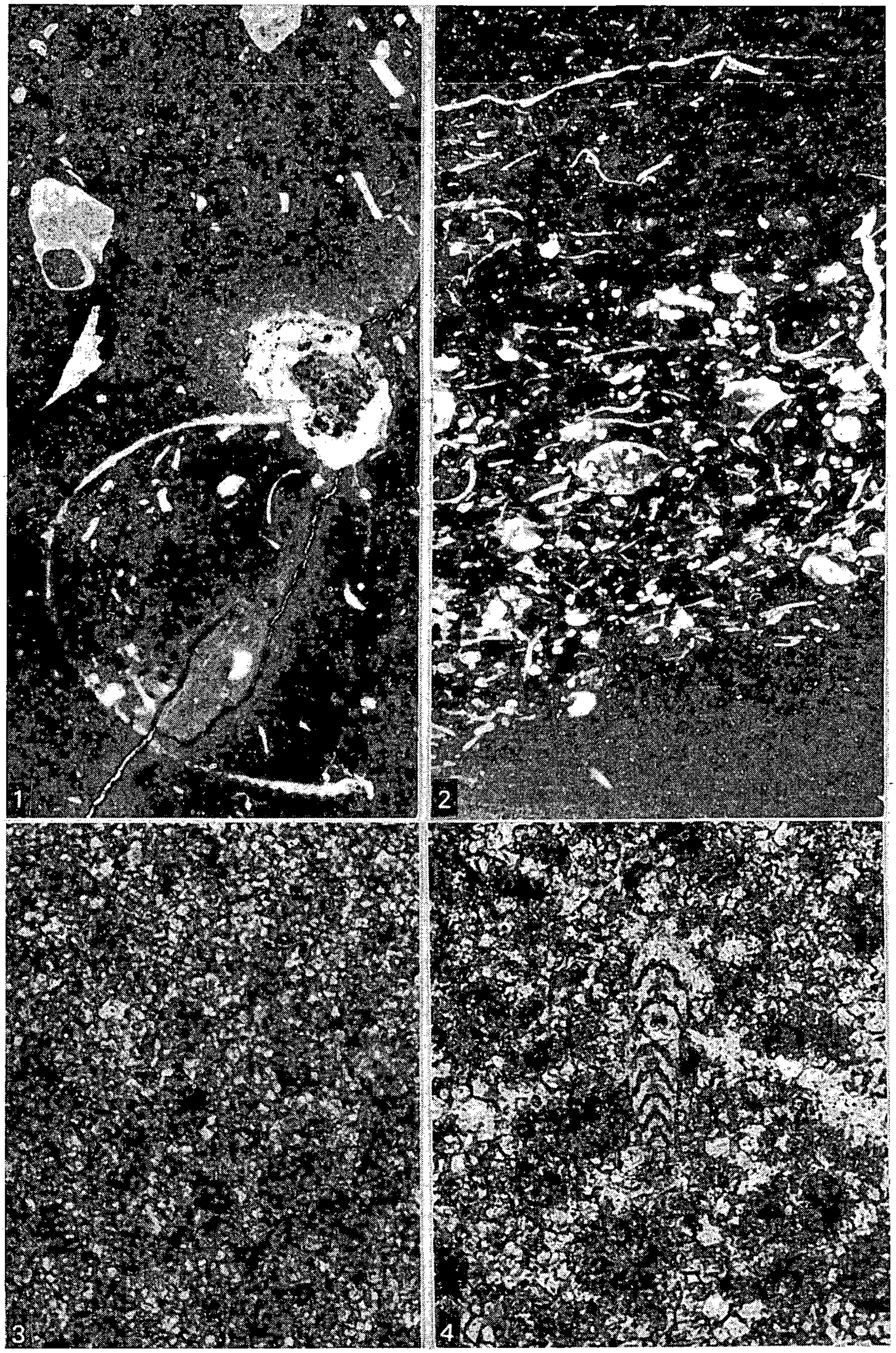

1
2
3
4

Plate II — II. tábla

5. 190.9—191.9 m (Kössen Formation)
40 x

6—7. 184.9—185.9 m (Kössen Formation)
6.: 40 x, *7.:* 100 x

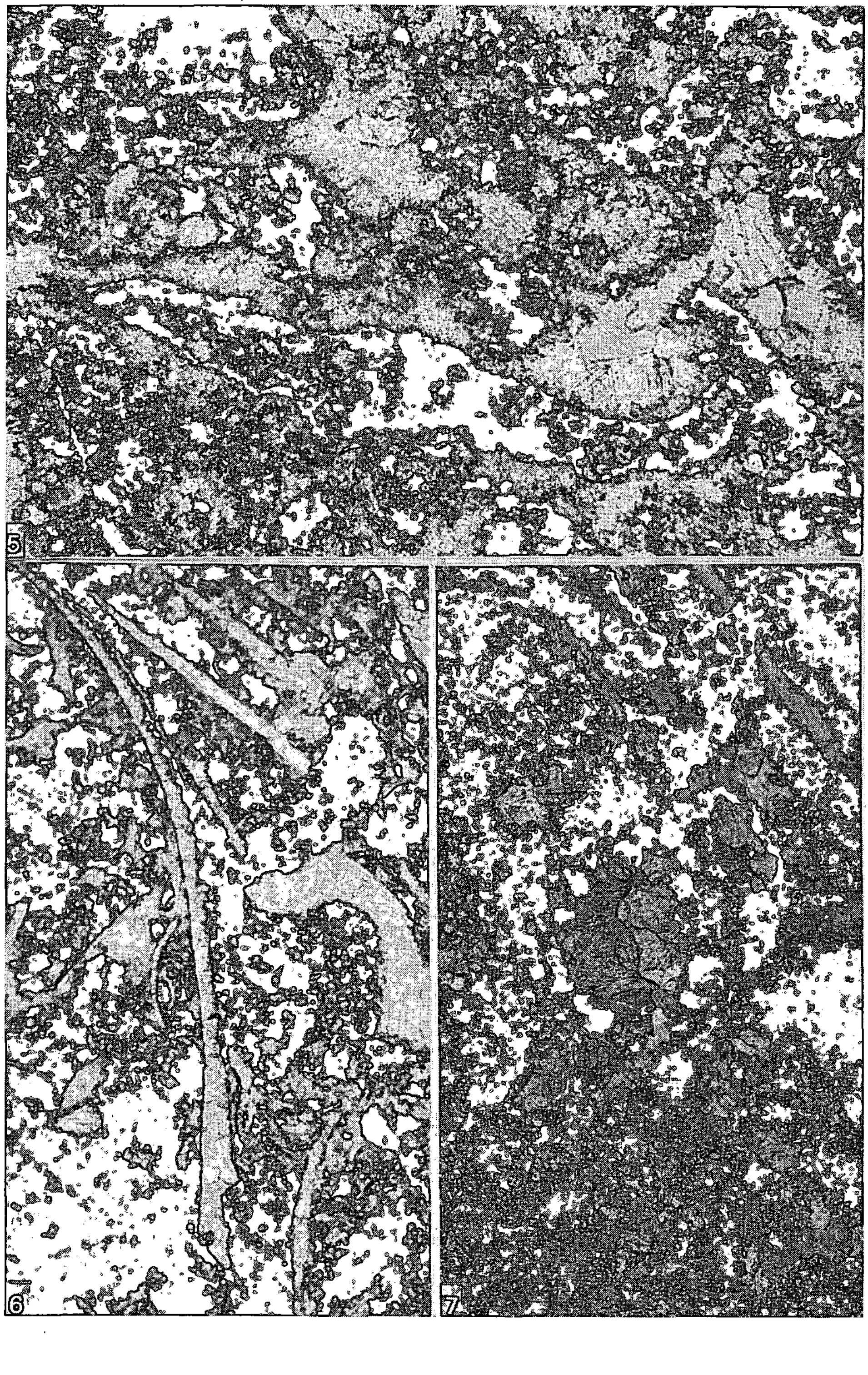

5
6
7

Plate III — III. tábla

8. 223.9—224.9 m. Upper Triassic limestone (Kössen Formation or Dachstein Limestone Formation)
25 x

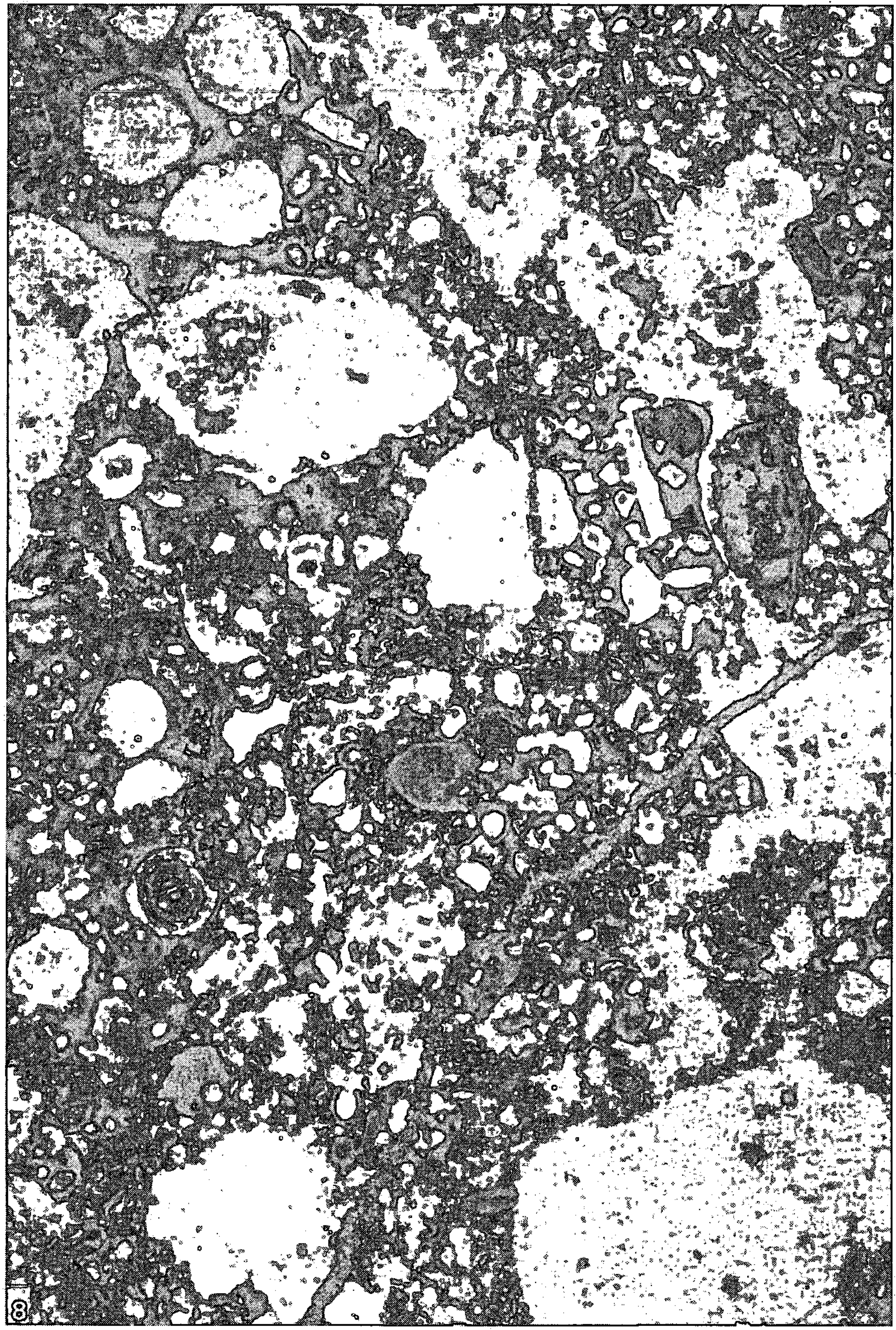
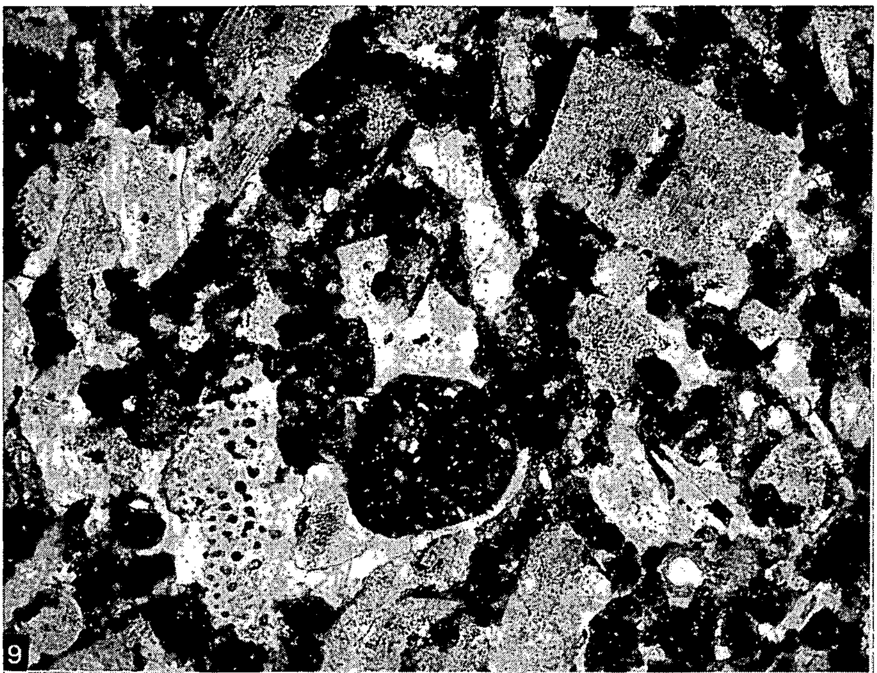

8

Plate IV — IV. tábla

9. 222.4—222.9 m. Limestone, crinoidal, with spots of sparite microsparite lime-mud lumps and micrite groundmass and a calcareous sandgrain (Pálihálás Limestone Formation, Hajósárok Bed, Oxfordian) 39 x

10. 222.4—222.9 m. Same as 6. ostracods, foraminifers, (Pálihálás Limestone Formation, Hajósárok Bed, Oxfordian) 97 x



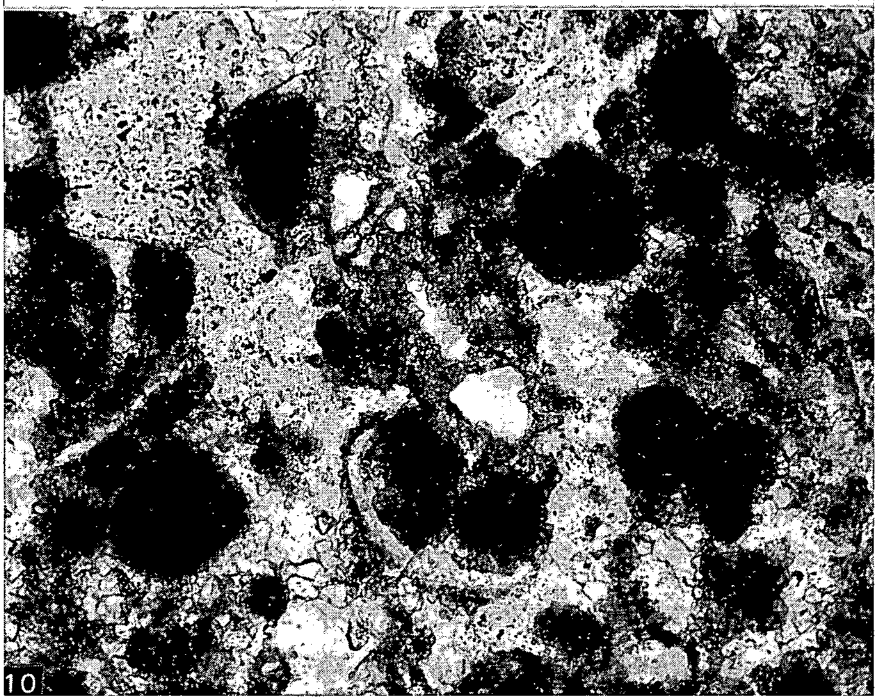


Plate V — V. tábla

11. 217.9—218.9 m. Lombardia-bearing limestone
(Pálihálás Limestone Formation)
40 x

12. 222.9—223.9 m. Limestone with a layer of echinoderm skeletal fragments, Hajósárok Bed
(Pálihálás Limestone Formation)
40 x

13. 214.9—215.9 m. Aptychus-bearing, crinoidal and Lombardia-containing limestone,
(Pálihálás Limestone Formation)
40 x

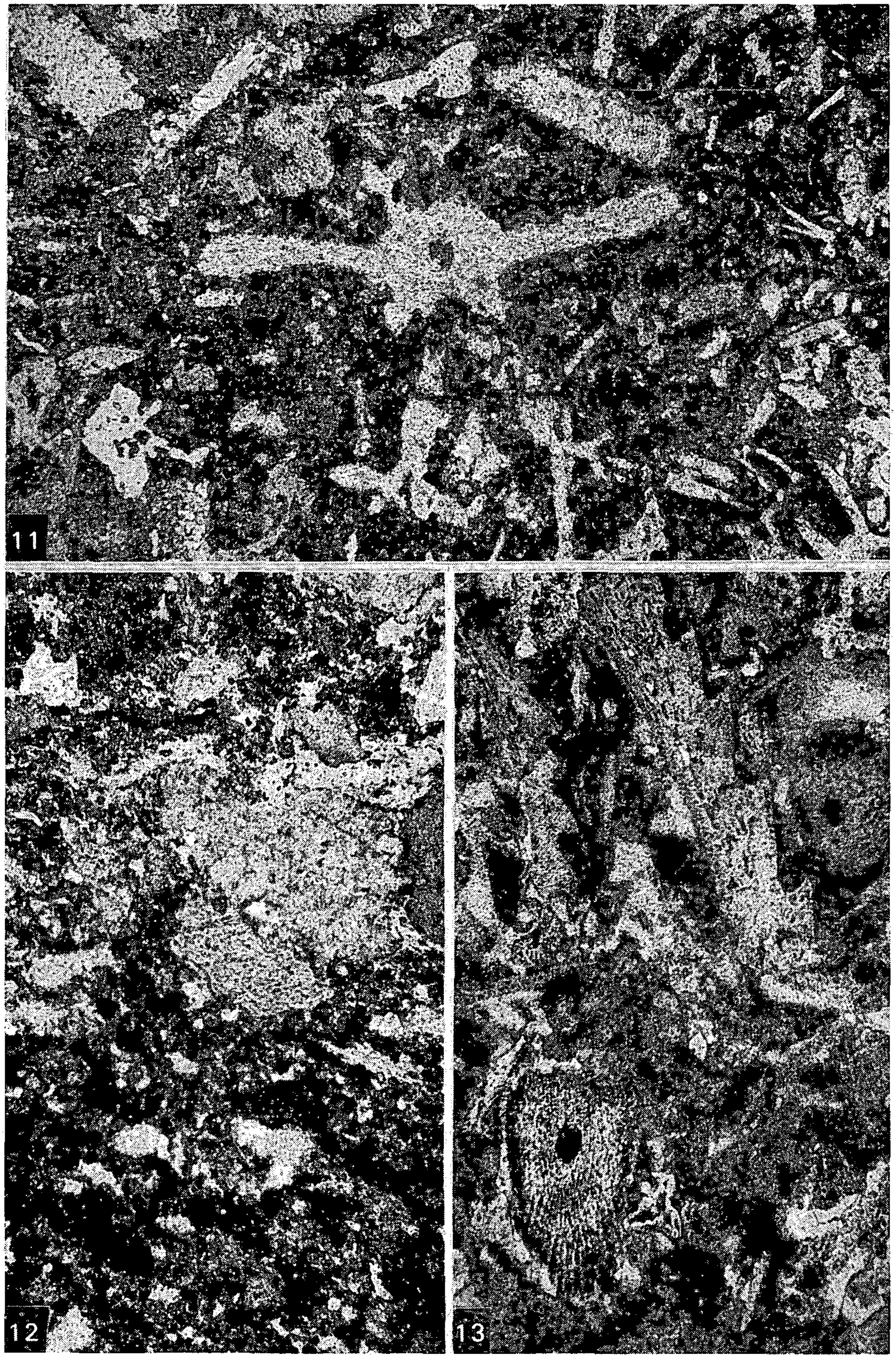

11
12
13

Plate VI — VI. tábla

14. 207.9—208.9 m Limestone containing Aptychus fragment,
(Mogyorósdomb Limestone Formation)
100 x

15. 211.9—212.9 m *Margulina* sp. (det. I. BODROGI)
(Mogyorósdomb Limestone Formation)
100 x

16. 199.9—200.9 m *Stomiosphaera moluccana* WANNER,
(Mogyorósdomb Limestone Formation)
194 x

17. 208.9—209.9 m Limestone containing Aptychus and crinoidal shell fragments
(Mogyorósdomb Limestone Formation)
39 x

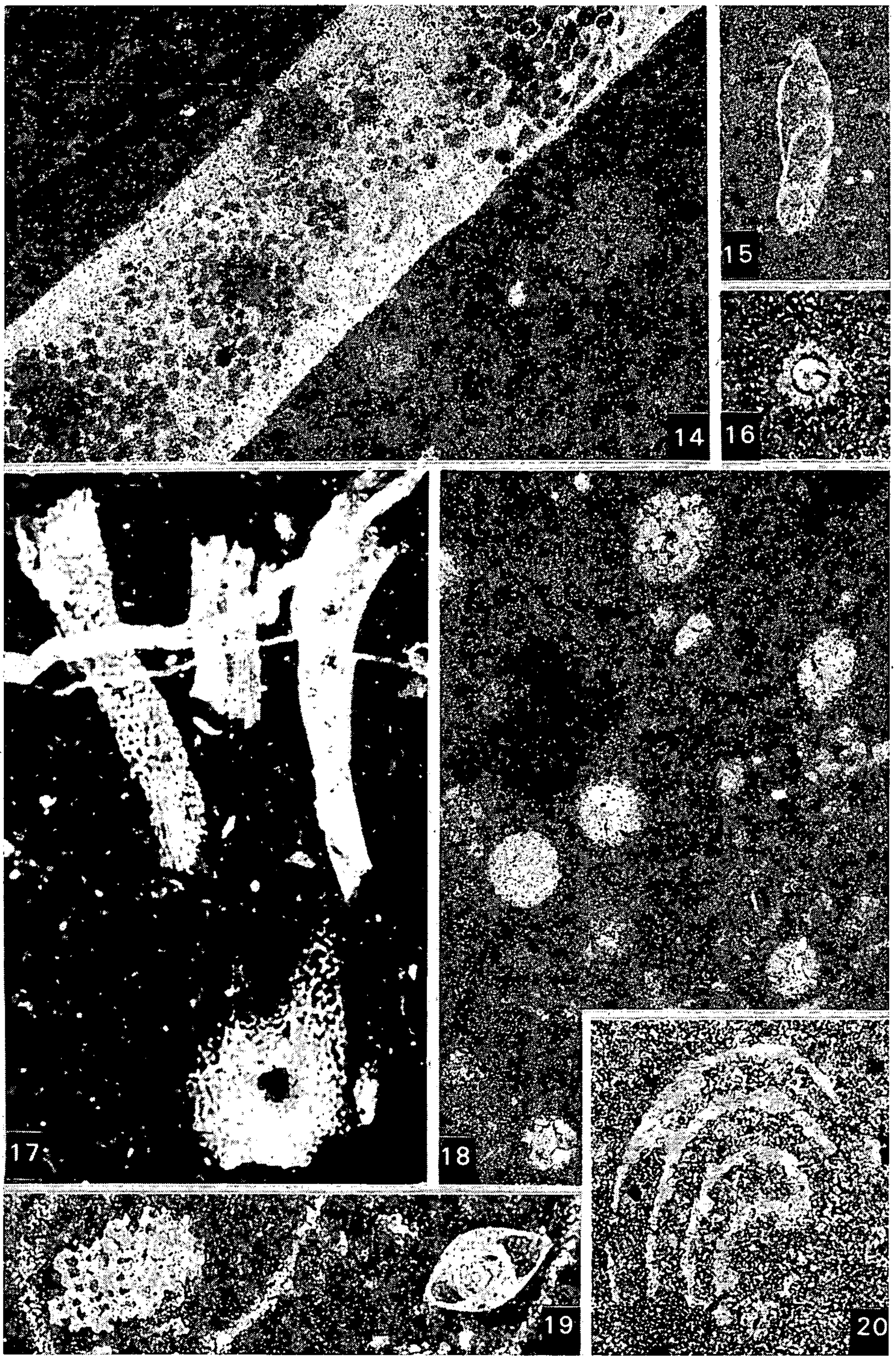
18. 200.9—201.9 m Limestone containing calcareous radiolarians
(Mogyorósdomb Limestone Formation)
100 x

19. 200.9—201.9 m Lenticulina sp. and crinoid fragment
(Mogyorósdomb Limestone Formation)
97 x

20. 198.9—199.9 m Spirillina sp. (det. I. BODROGI)
(Mogyorósdomb Limestone Formation)
194 x

Photos made by: Á. KOVÁCS (Photos 1, 2 and 8), M. GELLAI (Photos 14, 15 and 18.) and the author

Photos elaborated by: Á.KOVÁCS (Photos 1, 2, 8, 14, 15 and 18) and GY. FÖRDŐS



14
15
16
17
18
19
20

THE PRE-SENONIAN PALEOSURFACE AND THE SENONIAN SEDIMENTARY CYCLE IN THE BAKONYJÁKÓ—NAGYTEVEL—UGOD REGION

by

JÓZSEF KNAUER*—MÁRIA GELLAI**

*Hungarian Geological Survey
Budapest, Stefánia út 14.
H-1143

**Geoprospect Kft. P.O.B. 31.
H-8221

UDC: 551.248.1(234.373.1)
551.8: 551.763.33

Keywords: Senonian, paleosurface, faunal assemblage, sporomorphs, paleoenvironment, stratigraphic units, Bakony Mts

The authors who participated in the bauxite exploration done in the region concerned have reconstructed upon reports connected with the topic and their own investigations the basement morphology on which the Senonian deposition took place, with some bearings of the Senonian sedimentary cycle upon paleogeography. Together with communicating new information on the respective Senonian rock units some earlier observations have also been rectified in the present paper.

Introduction

Explorations done in the 1970s have resulted in the general and, at places, more detailed outlining of a pre-Senonian rugged surface on which the Senonian beds of the Bakony Mts are deposited. The morphology of this basement can be reconstructed upon the thickness and facies conditions of the Senonian units and their extent in space showing the advancement of one beyond another during transgression (KNAUER, J. et al. 1977, KNAUER, J.—GELLAI, M. 1978, HAAS, J 1979, HAAS, J.—J. EDELÉNYI, E. 1979, 1980). In the 1980s, within the paleogeographic map series reconstruction was performed for the whole area of the Bakony Mts on the basis of the distribution and relationships of the Senonian units and of the combined thickness of the Ajka and Csehbánya Formations and their facies (J. EDELÉNYI, E. 1988, 1990). In the present study, on the basis of reports on preliminary bauxite explorations in the Bakonyjákó—Nagytevel—Ugod region (KNAUER, J. et al. 1984, NAGY, T. et al. 1986), the results concerning the pre-Senonian basement and the depositional conditions of the Senonian units, have been dealt with. In the course of the work around Bakonyjákó 13 boreholes/km^2, in the area E of Szár-hegy 6 boreholes/km^2, and in other localities 1 borehole/km^2 were deepened (Fig. 1). It is believed that this study based on the data obtained from about 300 boreholes might be a useful tool in carrying out further geological and applied-geological investigations.

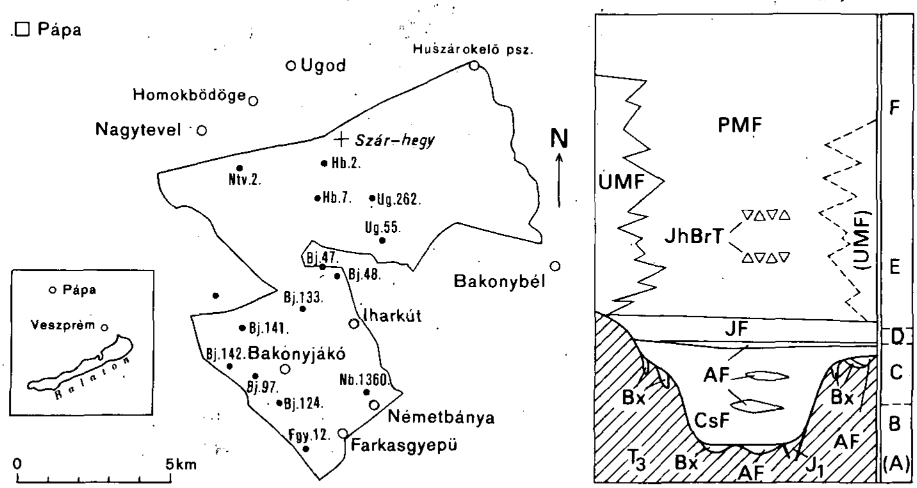


Fig. 1. Location of the area of study with the boreholes referred to and with those marking the lines of geological profiles; model stratigraphic column with marking the palynozones (GÓCZÁN, F. 1964)

(A): redeposited forms of the zone, Bx: bauxite deposit, AF: Ajka Formation, CsF: Csehbánya Formation, JF: Jákó Marl Formation, UMF: Ugod Limestone Formation, (UMF): presumed original development of the formation, PMF: Polány Marl Formation, JhBrT: Jákóhegy Breccia Member. Sporomorph studies: SIEGL-FARKAS, F.—GÓCZÁN, F.—JUHÁSZ, M.

1. ábra. A terület elhelyezkedése a hivatkozott, ill. a földtani szelvények nyomvonalát rögzítő kutatófúrások feltüntetésével; elvi rétegoszlop GÓCZÁN, F. (1964) palynozónáival

(A): a zóna alakjai áthalmozottan, Bx: bauxittelep, AF: Ajkai F., CsF: Csehbányai F., JF: Jákói Márga F., UMF: Ugodi Mészkő F., (UMF): a formáció feltételezett egykori kifejlődése, PMF: Polányi Márga F., JhBrT: Jákóhegyi Breccsa Tagozat. Sporomorfa vizsgálatok: SIEGL-FARKAS, A.—GÓCZÁN, F.—JUHÁSZ, M.

The arrangement and facies of the Senonian units

Concerning the two starting units of the Senonian, here the predominance or perhaps the exclusive presence of the Csehbánya Formation is characteristic of the layer sequences (Fig. 2). Besides the dominant "pelitomorphic" rocks of desiccating flood-plain origin the occurring grey flood plain-lacustrine and swamp sediments are more frequent in the upper 20-30-m-thick part of the unit, and generally they appear in a two-fold division. The variegated rocks are generally sandy and the sand is concentrated in small lenses. The sandstone of river-channel and sandbank origin, the thin gravel and conglomerate beds are comparatively frequent, their basic material is mainly calcareous and less frequently argillaceous.

The Ajka Formation including the lacustrine-swamp layers is represented only by a sequence a few metres thick. Despite this fact, it extends over a surprisingly large area in the region as basic deposit in the cover of the Csehbánya Formation (most frequently) or as being intercalated in the latter. Its thickness averages a few m, but at some places in the northern zone it reaches a thickness of 5—23 m. The unit consists mainly of horizontally stratified coaly clay, grey, darkish-gray, often sandy clay, clayey marl and sandstone with 0.4—0.7-m-thick (at places 1.0—1.2-m-thick) clayey brown coal and rarely brown coal beds coming rarely to a thickness of 0.5—1.6 m. The generally small-sized brackish-water molluscan species and specimens are, at some places deformed because of layer pressure, and their position is orientated according to the stratification. In the clay better preserved *Pyrgulifera* sp., *Natica* sp., *Cerithium* sp. can be indentified (K. Tóth).

The Jákó Marl Formation is mainly deposited on the Ajka, or directly on the Csehbánya Formation but, in accordance with its farther extent, in the NW it rests immediately on the Upper Triassic rocks, as proved by several boreholes deepened at Szár-hegy and by a special map compiled by the Hungarian Geological Survey (Knauer, J.—Maros, Gy. 1987). Probably, in one strip SW of Szár-hegy it is likewise lying on Upper Triassic. The thickness of the unit is relatively constant (40—45 m) while in the Bakonyjákó Basin and in the area N of Iharkut, in some zones, it is as thick as 50—54 m. The average lime content of the concerned rocks is increasing upwards and at the basin margins they pass into limestone. Exogyrae can be generally found in the lower sections. Besides Exogyrae, carbonized drift-wood, coal strings, fish scales, fish teeth, Pectens, Ostreae and traces of bioturbation can also be recognized in these beds.

In certain profiles the Csingervölgy Member can be distinguished in the basal part of the formation in the form of marls with bivalves and gastropods of directed position, in company of thin lumachelle bands and some individual corals. While the thickness of the Member in the type locality is 40—50 m, in these profiles it is generally thinner than 1 m, attaining 5—10 m only exceptionally.

In the former basin area the Jákó Marl Formation is overlain by the Polány Marl Formation made of lightened pelagic marl, calcareous marl and argillaceous limestone, with a transitional interval of interfingering beds. The rocks of the two units are difficult to distinguish and the boundaries within this interval are hardly traceable, and certain rock types in a weathered or detrital state can be mistaken for each other. According to our findings, however, the polishable rock types can be well distinguished. Though both units are described by several planktonic foraminifers and inc.sed. forms (*Calcisphaerulidae*) the reducing type of the Jákó Marl is more expressed and its microfossil assemblage is different. One of its typical representatives is a gracile biserial Foraminafera (genus indet.) of nannoplankton size, generally with pyritic chamber infilling. Further planktons are *Heterohelix* sp., *Globigerina* sp., *Globotruncana* sp., *Globigerinelloides* sp. Besides them benthic foraminifers

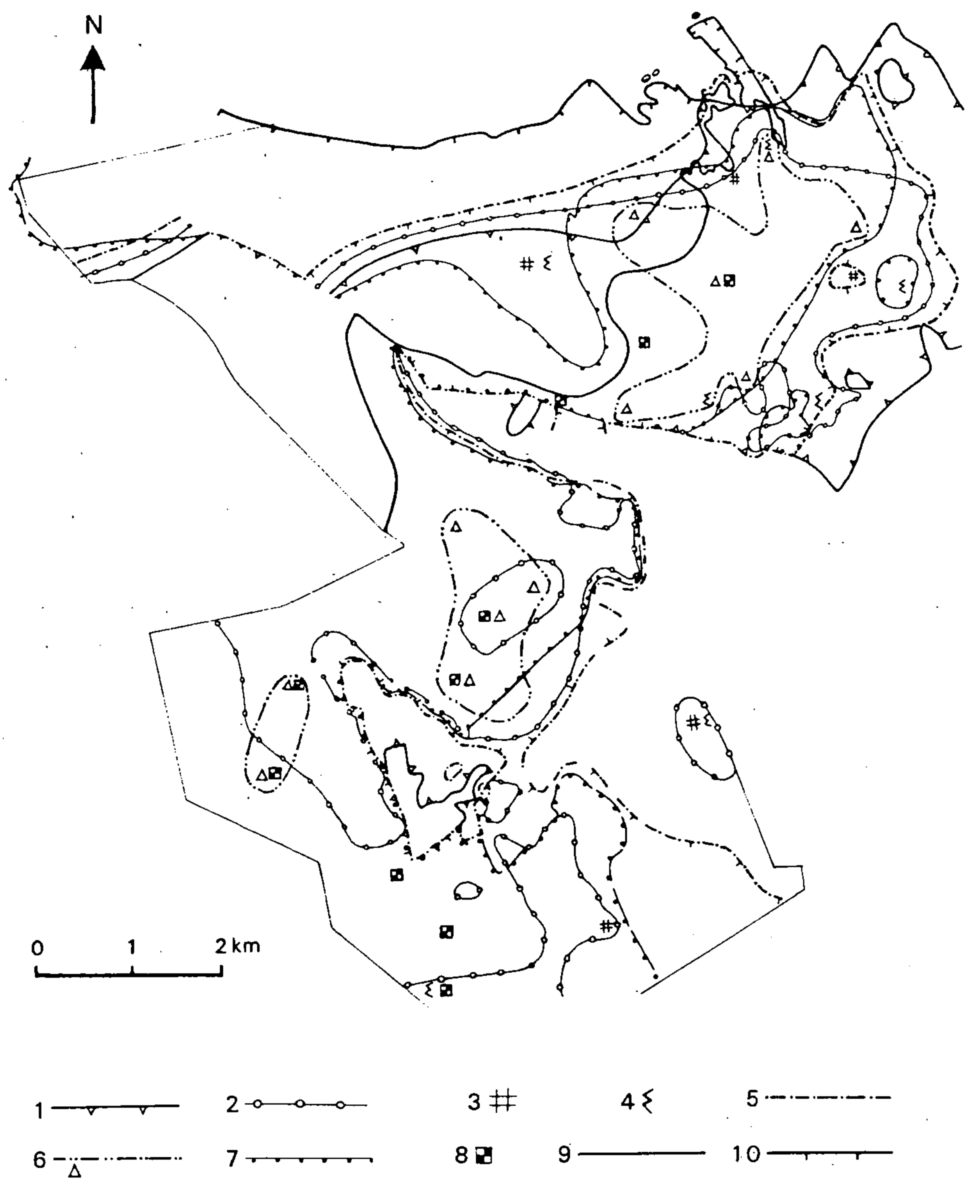


Fig. 2. Arrangement of the Senonian units

1—2, 5—7, 9—10: boundaries of areal extent: (*1.* Csehbánya Formation, *2.* Ajka Formation, *5.* Jákó Marl Formation, *6.* Jákó Formation, Csingervölgy Member, *7.* Polány Marl Formation, *9—10.* Ugod Limestone Formation: 9= boundaries towards the basin units, 10= external, denudation boundary), *3.* Ajka Formation as basal deposit under the Csehbánya Formation, *4.* Ajka Formation interfingering with the Csehbánya Formation, *8.* Jákóhegy Breccia Member (Polány Formation) in borehole (after BAKÓ, T.—KLAJKÓ, K. in NAGY, T. et al. 1986, with some modifications)

2. ábra. A szenon képződmények elrendeződése

1—2, 5—7, 9—10: elterjedési határok: (*1.* Csehbányai F., *2.* Ajkai F., *5.* Jákói Márga F., *6.* Jákói F. Csingervölgyi Tagozat, *7.* Polányi Márga F., *9—10.* Ugodi Mészkő F.: *9*= a medenceképződmények felé, *10*= külső, denudációs határ), *3.* Ajkai F. alaptelepként a Csehbányai F. alatt, *4.* Ajkai F. a Csehbányai Formációba fogazódva, *8.* Jákóhegyi Breccsa Tagozat (Polányi F.) fúrásban., BAKÓ T.—KLAJKÓ K. (in: NAGY T. et al. 1986) után, kissé módosítva and test fragments of echinoids also occur. In the Polány Marl Formation the traces of bioturbation are so frequent that in certain cases they erase the original stratification. At a few places intercalations of clay and intraformational breccia, limey nodules and mud flow structures also occur. Field descriptions mention some Exogyrae, fish scales and carbonized plant remains only.

In its microfauna the planktonic forms are predominating: *Conocella ugodensis* HAAS, *Calcisphaerulidae*, several planktonic foraminifers like *Globotruncana conica* (WHITE), *G.rugosa* (MARIE), *G. stuarti* (LAPPARENT), *G.linneiana* (D'ORB.), *Heterohelicidae*, *Globigerinelloides* sp., a few benthic foraminifers, among others *Arenobulimina* sp. The most frequent and thickest (nearly 50 m) occurrences of the Jákóhegy Breccia Member that is essentially built of the reworked material of a reef limestone (from the Ugod Formation) included in the pelagic Polány Marl (HAAS, J. 1979) are found W of Bakonyjákó and in the Bakonyjákó Basin with a repeated appearance in some individual sections (e.g. Fgy—12, Bj—141).

Simultaneously with the intrabasinal deposition of the Polány Marl rudistid limestone was formed in the more elevated regions (Ugod Limestone Formation). In the upper part of the unit a fine-and-medium-grained, seemingly fauna-free homogeneous is frequently present. In the thickest section (Hb—7, 242.2 m) the typical rudistid limestone is 190 m thick, while at the marginal parts where the sea inrush started later this thickness is reduced to 10—15 m. Among the rudistids *Radiolites* sp. indet., *Hippurites colliciatus* (WOODWARD), *H. bioculatus* (LAM.), *Nerinea (Simploptyxis) pailletteana* (D'ORBIGNY) were identified (L. CZABALAY) and, besides them, gastropods, echinoid spines, small coral colonies and bioturbation traces were also found. Planktonic forms are also part of the microfossil assemblage (M. GELLAI):

Calcisphaerulidae
Calcisphaerula innominata BONET
Conocella ugodensis HAAS
Pithonella ovalis (KAUFMANN)
Nummofallotia cretacea (SCHLUMBERGER)
Gyroidina sp.
Goupillaudina sp.
Miliolidae div. gen. et. sp.
Globotruncana div. sp.
Heterohelix sp.
Pachyodonta shell fragments
Echinodermata test elements
Crinoidea stem element
Pieninia oblonga BORZA et MIŠIK
Globochaete alpina LOMBARD
Rodophyta
Lithothamnium
Bivalvia shell with traces of algal boring

The arrangement and facies of the underlying units on the basis of latest investigations

The Pre-Senonian basement is predominantly built up of Norian formations, in a greater part of the area of Dachsteinkalk, and more subordinately, of the "transitional beds" or Hauptdolomit. The latter are almost encircling the limestone. Neglecting the description of the already well-known units here only some new results of study will be dealt with. From the microfossils of the Dachsteinkalk Formation the following forms can be mentioned here:

	Dachsteinkalk s. str.	Transitional beds (Hb-7)
Thaumatoporella parvovesiculifera (RAINERI)		+
Globochaete cf. *tatrica* RADWANSKI, *G. hronica* BORZA and G. n. sp.	+	
Aulotortus sinuosus WEYNSCHENK	+	+
tumidus (KRIST.—TOLLM.)	+	+
friedli (KRIST.—TOLLM.) (A. sp.)	(+)	+
Glomospira sp.		+
Oberhauserellidae		+
Triasina sp.	+	
Frondicularia woodwardi HOWCHIN (F. sp.)	(+)	+
Agathammina cf. *austroalpina* KRIST.—TOLLM. (A. sp.)	(+)	+
Microgastropod and Bivalvia fragments	+	+
Brachiopoda		+
Parafavriena cf. *thoronetensis* (BR., C. et Z.)		+
Echinodermata test elements	+	+
Ophiuroidea		+

In a downthrown block of the SW part of the concerned region the Liassic Isztimér Formation consisting of cherty limestone and spongiolite also occur (Bj—142) that makes probable the presence of the Kardosrét Limestone, too. In the profile explored in a thickness of 24 m the Isztimér Formation consists of spongiolite of extremely high silica content in which the siliceous sponge spicules mostly are also in a re-silicified state. The SiO_2 content is about 90%, while the CaO and MgO contents attain 1%. In certain parts it is slightly altered, at places pulverizing, and at the base it contains silica-dust-bearing bands 5 to 10 cm thick.

The classification of the underlying sequences dated as Liassic in the literature (BIHARI, D. 1981, after MÜLLER, P.) is still problematic.

The underlying sequence of Bj—16 mentioned as "Dachstein-type Liassic limestone" on the basis of its rock material belongs to the "transitional beds". In thin section a Late Triassic fossil assemblage and microfacies type can be seen which may be indicative of Upper Triassic or Liassic rocks alike.

In the basal clayey rock debris, however, there was a piece of rock derivable from the Liassic: in a micritic matrix crinoid stem element, ?ostracod valve sections, gracile, monoserial foraminifer, *?Globochaete alpina* LOMBARD are seen. From Bj—14 a Brachiopoda-bearing Liassic sequence is mentioned.

In the available 15 samples no brachiopods were found; this rock can also be assigned to the "transitional beds". Microscopically, the part in concern cannot be described properly as "oolitic", for its spherical-subspherical particles are built of a single skin and does not show the characteristics of the Kardosrét Limestone. The higher Jurassic and the Lower Cretaceous units are not known in the area. Borehole Bj—48, however, has intersected calcareous sandstone and small-grained conglomerate as joint-filling materials in the "transitional beds". Their grains are largely composed of Upper Triassic limestone and dolomite, however, there are typical sand grains coming from the Malm-Berriasian limestone. In the grains the following fossils have been indentified: *Calpionella alpina* LORENZ (several specimens), *C.* cf. *elliptica* CADISCH (2 specimens), *?Remaniella* sp.; *Globochaete alpina* (several specimens); calcified; Radiolaria; *Stomiosphaera* sp.
Due to the small size of the grains, the concerned unit can only likely be assigned to the Lower Berriasian.

Morphology of the basement of the Senonian sequence

The basemen relief, on small scale, is depicted by the Senonian sequences reaching the first equalizing horizon and this in our case is the thickness distribution of the Csehbánya Formation. The extensive and very thin upper part of the Ajka Formation can be interpreted as the sediment of a short-lining paralic swamp produced in a phase of filling up. Its surface, i.e. the base level of the Jákó Formation is isochronous and so it can well be used as reference horizon (Figs. 2, 4—5).

It is supported by the deposition of the brackish-water Csingervölgy Member that had been episodic, nevertheless, had produced sediments of considerable areal extent (Fig. 2). The thickness map (Fig. 3) indicates that the fluvial-lacustrine-swampy phase of sedimentation evened up a level difference of 200 m. From the first phase of the marine sedimentation marls were settled down in the basins in a thickness of 40 to 50 m (Jákó Formation). Accordingly, the basement elevations must have been as high as at least 270—300 m, if we consider that the deposition of the Ugod Limestone started already on the slopes and the subsidence of the given region was more or less even. We have attempted to delineate the pre-Senonian surface in Fig. 4—7 using the relevant figures of the report of preliminary investigations (NAGY, T. et al. 1986) so that the concerned figures were cut by the younger fault surfaces and conditions restored to the base level of the Jákó Formation, restoring thereby the original position of the displaced blocks.

If we consider also parts of the pre-Senonian surface, the depth of local subsidences are indicated with max. 10-m-thick bauxite in the basins attaining max. 15 m in the area of the Bakonyjákó basement elevation, while the frequent thickness data range from 2 to 3 m. Comparing this thickness distribution with that of the neighbouring Iharkút—Németbánya area, it can be

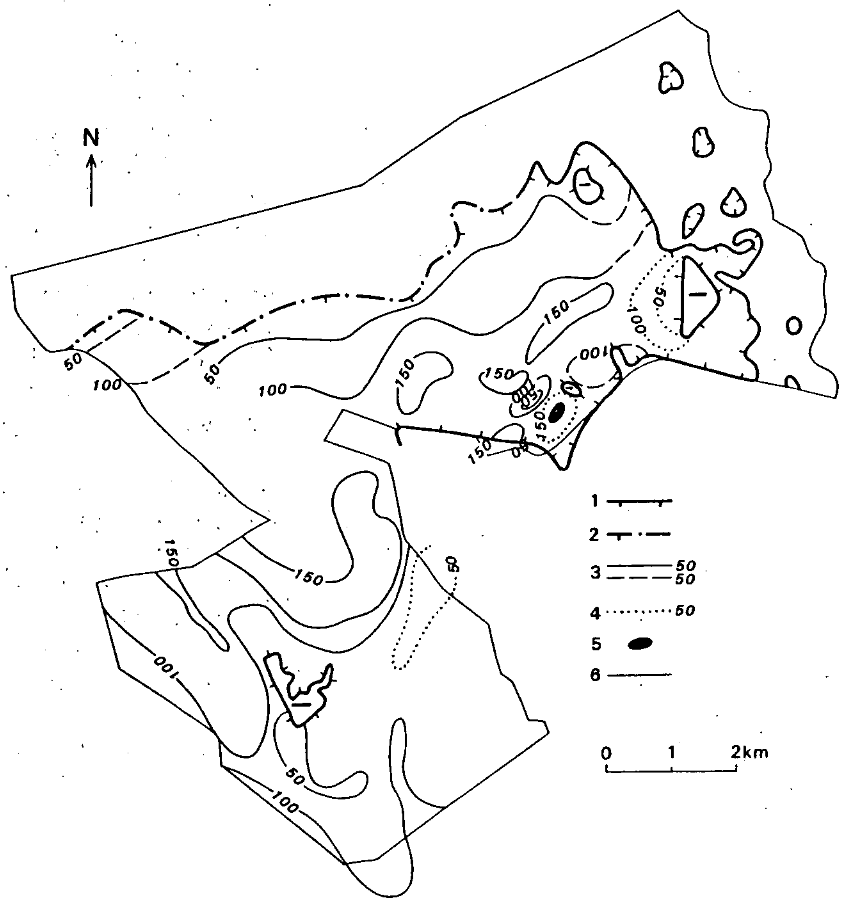


Fig. 3. Thickness of the Csehbánya Formation

1—2. line of the wedging out of the formation (*1.* under younger units, *2.* under Senonian units), *3—4.* equal thickness line of the formation (*3.* under original cover; plotted or inferred, *4.* with original cover lacking), *5.* the thickness of the formation is greater than 200 m, *6.* boundary of the area of study (after KLAJKÓ, K. in NAGY, T. et al., 1986, with minor modifications)

3. ábra. A Csehbányai Formáció vastagsága

1—2. A formáció kiékelődési vonala (*1.* fiatal képződmény alatt, *2.*szenon képződmény alatt), *3—4.* a formáció vastagságvonala (*3.* eredeti fedő alatt; szerkesztett, ill. feltételezett, *4.* eredeti fedő hiányában), *5.* a formáció vastagsága 200 m-nél nagyobb; *6.* a tárgyalt terület határa (KLAJKÓ K. in: NAGY T. et al. 1986 után, kissé módosítva)

seen that these latter verify a significantly greater elevation. Several formation features show the ruggedness of the surface referred to. In most of the bauxite profiles belonging to the NE part of the area carbonate-detritic intercalations can be observed. The combined thickness of these intercalations is remarkable at certain places e.g. in borehole Ug-55 8.2 m, but a thickness of 21 m has also been recorded. Around Bakonyjákó, in spite of the frequency of the re-

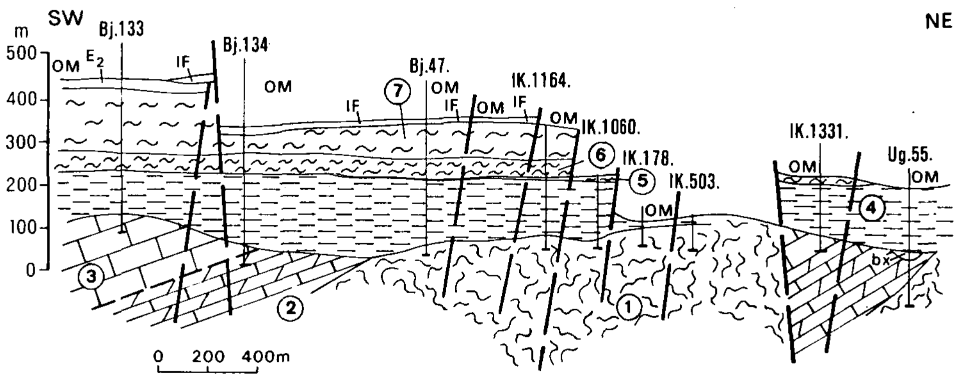


Fig. 4—7. Profiles showing geological conditions restored to the base level of the Jákó Formation (Fig. 4.)

1. Hauptdolomit Formation, *2—3.* Dachsteinkalk Formation (*3.* "transitional beds"), *1—3.* Norian, *4.* Csehbánya Formation, *5.* Ajka Formation, *6.* Jákó Formation, *7.* Polány Formation, *8.* Ugod Formation, *9.* fault, *10.* horizontal displacement, *11.* bauxite and red clay infillings in fissures and/or karstic cavities, bx=bauxite deposit, E2=Szőc Limestone Formation, at places with basal beds of clay or pebbles (Darvastó Formation), IF=Iharkút Formation (Upper Eocene—Lower Oligocene conglomerate and clay), OM=Csatka Formation (Oligocene fluvial sequence)

4—7. ábra. Földtani szelvények a Jákói Formáció talpához visszarendezett állapot bemutatásával (4. ábra.)

1. Fődolomit F., *2—3.* Dachsteini Mészkő F. (*3.* „átmeneti rétegek"), *1—3.* nóri, *4.* Csehbányai F., *5.* Ajkai F., *6.* Jákói F., *7.* Polányi F., *8.* Ugodi F., *9.* vető, *10.* eltolódás, *11.* bauxit és vörös agyag hasadék és/vagy karsztüreg kitöltés, bx=bauxittelep, E_2=Szőci Mészkő F., bázisán néhol agyag vagy kavics rétegek (Darvastói F.), IF=Iharkúti F. (felső-eocén—alsó-oligocén konglomerátum és agyag), OM=Csatkai F. (oligocén folyóvízi összlet)

silicified, possibly redeposited bauxite with non-bauxitic clasts in its texture, in the most protected depressions typical "Iharkút" type bauxite of diagenetic-clast-bearing and "oolitic" texture was preserved. A. MINDSZENTY, on the basis of her own studies and of A. KOPECZKY's investigations describes (in KNAUER, J. et al. 1984) the main features of the two types as follows:

I. In pelitomorphic or pelitomorphic-microclastic matrix poorly segregated accretionary ooids, ooid fragments, iron-rich spherical grains and clasts are embedded. In some sections also well segregated, strongly degraded, kaolinitized allochtonous ooids can be found. The brecciated structure observable here and there indicates a more intensive parautochonous-parallochtonous redeposition.

II. Quartz and other silicate grains (1—2%) of silt particle size in pelitomorphic matrix showing frequently evidences of re-crystallization leaving behind a handwoven-type texture are dealt with here. Carbonate grains reaching sometimes the sand particle size are also present in larger quantities. A greater part of components strange to bauxite have turned to be kaolinitized showing a fine-scaly appearance. Bauxitomorphic textural elements are comparatively few: some poorly segregated, iron-rich ooids, scarcely 1—2 ooid fragments and

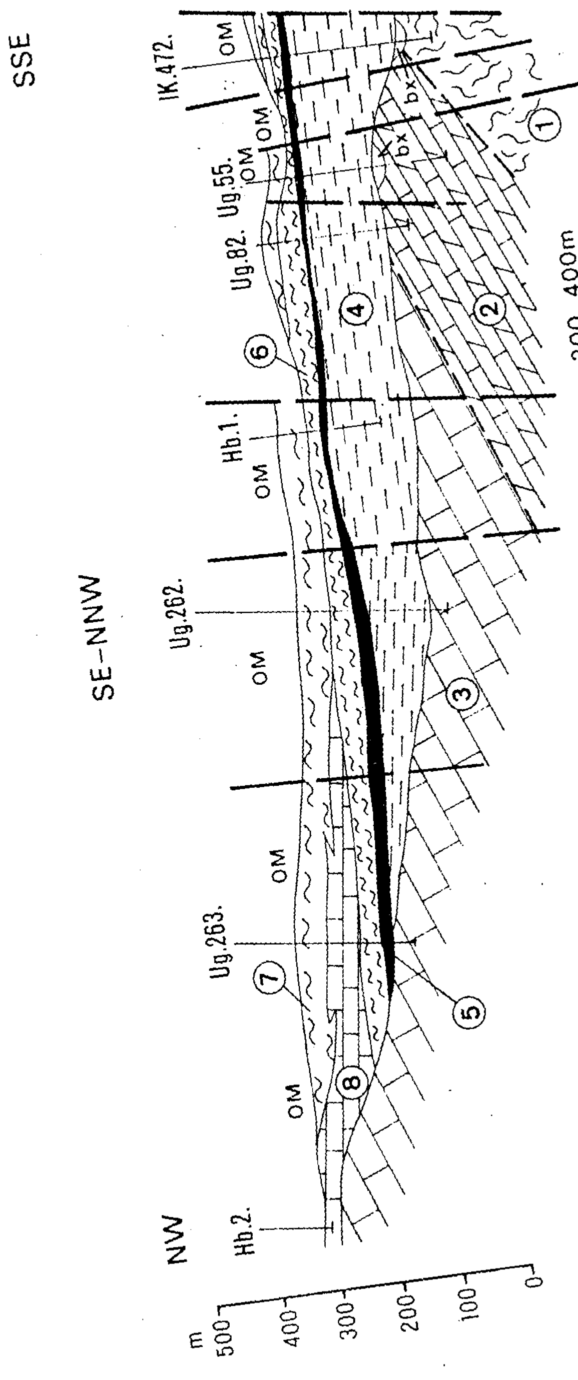

SSE
SE–NNW
NW
IK.472.
Ug.55.
Ug.82.
Hb.1.
Ug.262.
Ug.263.
Hb.2.
OM
bx
0 200 400m
m
500
400
300
200
100
0
1
2
3
4
5
6
7
8

Fig. 5. — 5. ábra

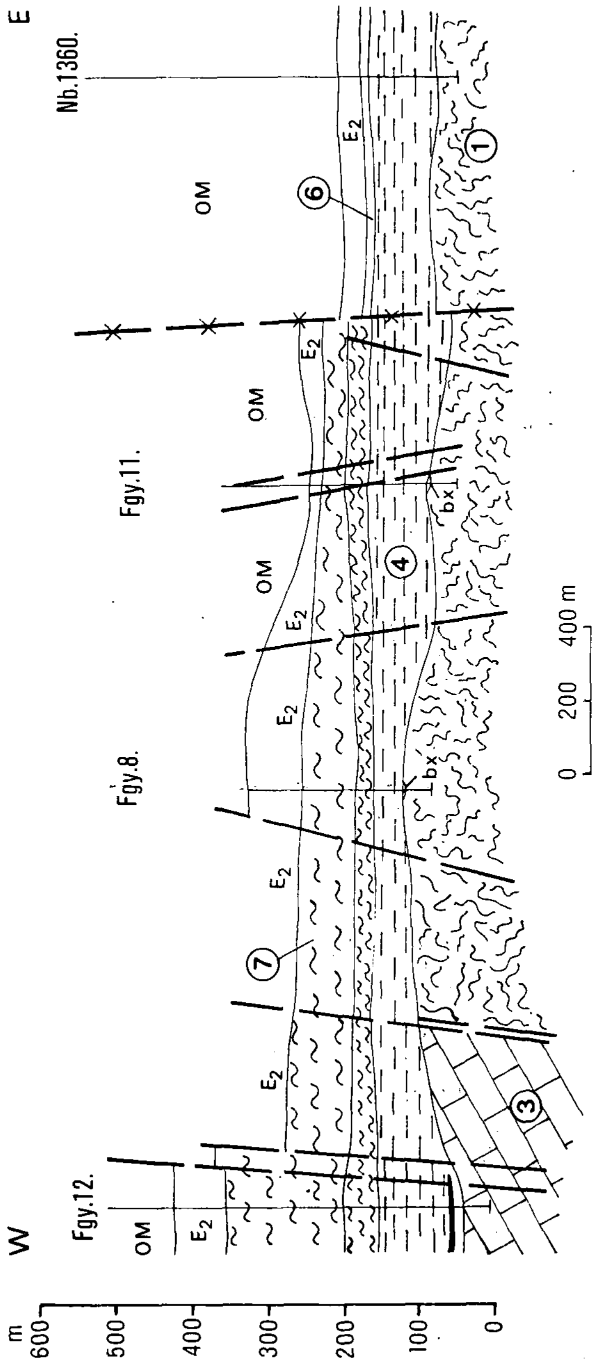

W
E
Nb.1360.
Fgy.11.
Fgy.8.
Fgy.12.
OM
E_2
bx
m
600
500
400
300
200
100
0
0 200 400 m

Fig. 6. — 6. ábra

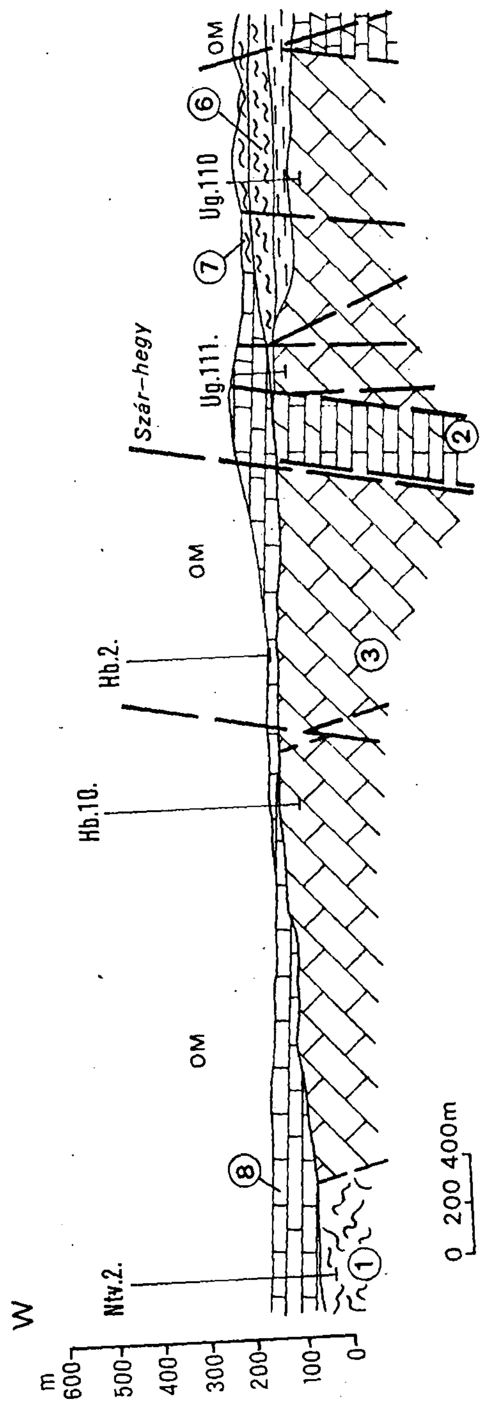

E
W
OM
6
Ug.110
7
Ug.111.
Szár-hegy
2
OM
Hb.2.
3
Hb.10.
OM
8
1
Ntv.2.
m
600
500
400
300
200
100
0
0 200 400m

Fig. 7. — 7. ábra

frequently but in small quantities iron-rich spherical grains also occur. In certain samples traces of plant decomposition can also be observed, often with radially segregated kaolinite crystal grains around them. The presence of some rocks considered to be residue also are indicative of one-time depression in the basement. An example for this is given by a 2.2-m-thick weakly weathered spongiolite-flint debris with grains as large as at the most 6 cm in diameter, resting on the Isztimér Formation, as embedded in dark brown clay. Some conspicuous forms of the former karst scenery of the land built of Dachsteinkalk are indicated in borehole section Bj—79 where the bauxite profile is divided into two parts by Dachsteinkalk (Fig. 8).

Several boreholes cut across bauxitic rock and even bauxite infillings in karstic caverns and fissures mainly in some places where the "transitional beds" member of the Dachsteinkalk Formation constitutes the immediate underlying unit, as in the case of the northern Iharkút area.

The early Senonian surface on which the bauxite accumulation took place must have been flatter and less rugged than the one on which Senonian sedimentary cycle set out have existed, since the bauxite material reached the then

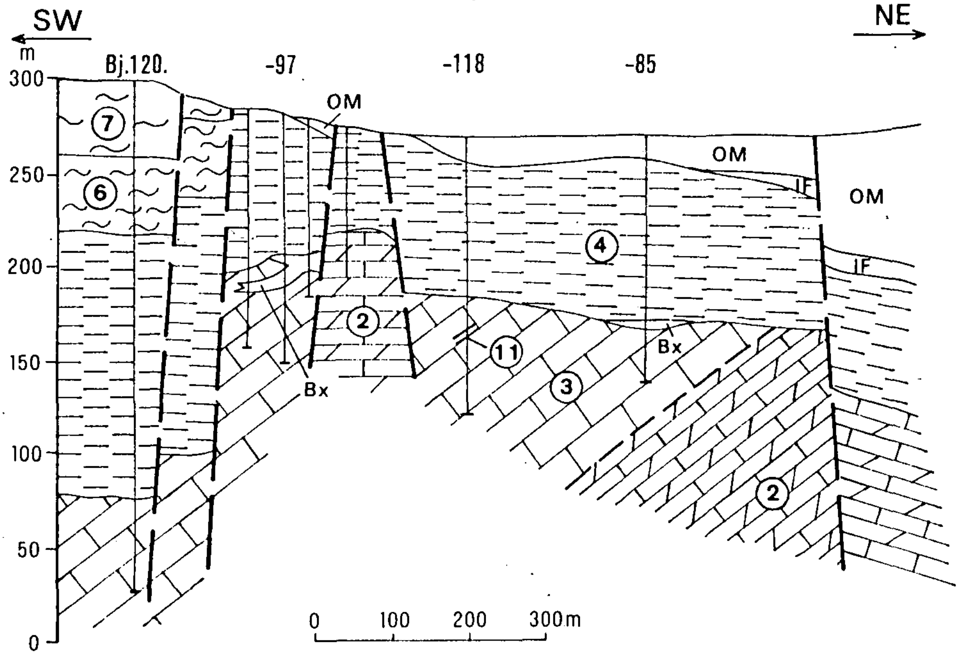


Fig. 8. Features of the pre-Senonian basement around Bakonyjákó (SZANTNER, F. et al. in KNAUER, J. et al., 1984, a detail. (For explanation of symbols see Fig. 4—7)

8. ábra. A Bakonyjákó körüli preszenon alaphegység jellege (SZANTNER F. et al. in KNAUER J. et al., 1984, részlet. (Jelmagyarázat: ld. 4—7. ábra) and now most elevated island-like highs of the Triassic basement. Accordingly the relief i.e. the differences in elevation of the surface became sharper following the bauxite formation.

After the accumulation of the bauxite on the residues in the local depressions of the surface, swamps, coal swamps and lakes were formed but turned to be covered, often and soon, by fluvial-floodplain sediments gradually getting over the elevated ridges and hills, too. The fluvial sedimentation became more general about the end of palynozone "B". In the most elevated part of the basement the zone "B" was 8—10 m thick while in the deepest parts it exceeded 100 m.

The main channel system of the river pattern was developed outside our area of study, however, in an area situated ENE of Szár-hegy a borehole has cut across an isolated formation of coarse detritus. Its stratigraphic position is uncertain, however, it reminds us of that of the section borehole Pt 8 of Porva (CSÁSZÁR, G. 1984). If it is Senonian, it might have belonged to the system of the northern main river branch. The other beds seem to be weakly developed, in part possibly belonging to tributaries. It may have been transported into the basin by a tributary the Albian sporomorph assemblage reworked from a nearby area into the oldest part of Csehbánya Formation, namely the forms found together with the ones characteristic of the Senonian (section Bj—47, interval ranging from 378.5 m to 383.5 m, described by JUHÁSZ, M.):

Conbaculatisporites cretaceus DEÁK
Ischyosporites estherae DEÁK
Klukisporites foveolatus POCOCK
Bikolisporites baconicus JUHÁSZ
Citracicosisporites augustus AGASIE
Costatoperforosporites sp.
Vadaszisporites urkuticus DEÁK
Gleicheniidites senonicus ROSS
Appendicisporites stylosus (Thg.) DEÁK.

The sporomorphs indicating palynological zone "A" and the redeposited Albian forms of the lowermost horizon of the thickest part of the Csehbánya Formation prove that the sedimentary accumulation set out in the even today deeper zones. In the neighbourhood of the fluvial system, like in Magyarpolány and Devecser, the long-lasting lacustrine-swamp depositional conditions, from time to time, extended also to our region. The negative relief forms causing this phenomena might have been limans and/or depressions formed by the retardation of filling up. The carbonate Munieria beds indicated as interfingerings from the Ajka Formation (Fig. 2) refer definitely to lacustrine sedimentation.

After the above-mentioned alluvial basement levelling the area almost as a whole must have subsided and the basement morphology hardly changed for a time. These minor changes in shallow marine environment are indicated by the temporary proliferation of Exogyrae and by the fluctuation of the calcium carbonate/pelite rate.

From time to time the connection with the opener sea also changed, as reflected by quantitative changes of the plankton. As the sea got to be opener, the reducing power of the bottom mud extinguished, and the presence of the plankton became stabilized, whereas its composition changed, and the strongly calcareous sediments became dominant. The transition was gradual or was manifested by bed alternations. The graduality of the process is also proved by the fact that the geophysical parameters change by 8—10 m above the boundary traced upon geological considerations between the Polány Formation and the Jákó Formation.

It is well-known that when the transgression reached the locally highest surface elevations, the sea started to develop patch-reefs at once, which extended later towards the basin and regressed from there several times. The Bakonyjákó basement elevation that became part of the sedimentary basin as early as during the deposition of the Csehbánya Formation, later seems to have got into an elevated position again. Although today it is not covered with younger Senonian units owing to denudation, the extension of the Jákóhegy Breccia Member indicates that a rift body had been formed also on this block. The lowermost layer belonging to the member is mostly situated by about 80 m above the Polány/Jákó Formation boundary, showing that the material transport started at all sides of the block approximately at the same time.

REFERENCES — IRODALOM

BIHARI, D. 1981: Magyarázó a Bakony-hegység 20 000-es földtani térképsorozatához, Ugod 1—52. — Földt. Int. kiadv.

CSÁSZÁR, G.—HAAS, J.—J. EDELÉNYI, E. 1978: Dunántúli-középhegység bauxitföldtani térképe M=1:100 000 — Földt. Int. kiadv.

CSÁSZÁR, G. 1984: Magyarázó a Bakony-hegység 20 000-es földtani térképsorozatához — Borzavár 1—138. — Földt. Int. kiadv.

GÓCZÁN, F. 1964: A bakonyi szenon palynológiai standardja — Földt. Int. Évi Jel. 1961-ről: 253—261.

HAAS, J. 1979: A felsőkréta Ugodi Mészkő Formáció a Bakonyban — Földt. Int. Évk. 61. 1—171.

HAAS, J.—J. EDELÉNYI, E. 1979: A dunántúli-középhegységi felsőkréta üledékciklus ősföldrajzi elemzése — Földt. Int. Évi Jel. 1977-ről: 217—224.

HAAS, J.—J. EDELÉNYI, E. 1980: A Dunántúli-középhegység bauxitföldtani térképe. Felső-kréta bauxitszint. M-1:200 000 — Földt. Int. kiadv.

J. EDELÉNYI, E. 1988: History of evolution of the Upper Cretaceous Basin in the Bakony Mts at the time of formation of the terrestrial Csehbánya Formation — Acta Geol. Hung. v. 31/1—2 19—31.

J. EDELÉNYI, E. 1990: A Dunántúli-középhegység bauxitföldtani térképe. A szenon bauxitszint ősföldrajzi térképei M=1:250 000 — Földt. Int. kiadv.

JUHÁSZ, M. 1980: A bakonyjákói-medence szenon képződményeinek palynológiai vizsgálata — Kézirat, JATE, Geoprospect Ltd.

KNAUER, J. et al. 1977: A Bakonyjákó—Nagytevel—Bakonybél reménybeli bauxitterület előkutatási programja 1—92. Kézirat, Geoprospect

KNAUER, J.—MAROS, GY. 1987: Részletes bauxitföldtani térképezés, fáciesvizsgálat és speciális tektonikai mérések az ugodi Szár-hegy és Durrogós-tető körzetében — Kézirat, Geoprospect Ltd. Földt. Int.

KNAUER, J.—SZŐTS, A.—SZANTNER, F.—NAGY, J.—HORVÁTH, I.—KAKAS, K.—HORVÁTH, J.—H. KONCZ, M.—TAKÁCS, P. 1984: Jelentés a bakonyjákói terület bauxitkutatási munkálatairól (előkutatás és felderítő fázis I. ütem) 1—133. II. 1—34 — Kézirat, Geoprospect Ltd., Földt. Int.

MINDSZENTY, A.—KNAUER, J.—SZANTNER, F. 1984: Az Iharkúti bauxit üledékföldtani jellegei és felhalmozódási körülményei — Földt. Közl. 114. 1. 19—48.

NAGY, T.—KNAUER, J.—BAKÓ, T.—BODRI, GY.—HORVÁTH, I.—H. KONCZ, M.—NAGY, J. 1986: Jelentés a Bakonyjákó—Nagytevel—Bakonybél bauxitkutatási terület előkutatási munkálatairól. I. 1—177. II. 1—47. III. — Kézirat, Geoprospect Ltd. Földt. Int.

SZANTNER, F.—KNAUER, J.—MINDSZENTY, A.—SZABÓ, I.—SZŐTS, A.—TÓTH, K.—HORVÁTH, I.—H. KONCZ, M.—KAKAS, K.—URAY, SZ. 1981: Jelentés az iharkút—németbányai területen végzett felderítő bauxitkutatásról és a készletszámítás eredményeiről I—IV. 1—260. — Kézirat, Geoprospect Ltd.

A PRESZENON TÉRSZÍN KÉPE ÉS A SZENON CIKLUS KIFEJLŐDÉSE BAKONYJÁKÓ—NAGYTEVEL—UGOD TÉRSÉGÉBEN

KNAUER JÓZSEF*—GELLAI MÁRIA**

* Magyar Állami Földtani Intézet
Budapest, Stefánia út 14.
H-1143

** Geoprospect Kft. P.O.B. 31.
H-8221

ETO: 551.248.1 (234.373.1)
551.8:551.763.33

Tárgyszavak: Szenon, őstérszín, faunaegyüttes, sporomorfák, őskörnyezet, rétegtani egységek, Bakony

A területen a cikluskezdő szenon formációk közül a Csehbányai F. domináns. A Szár-hegytől KÉK-re eső sáv esetleg az É-i folyamághoz, a terület többi része mellékágak (mellékfolyók?) rendszeréhez tartozhatott. Az Ajkai F. ennek bázisán, az aljzat kisebb mélyedéseiben alaptelepként, közbetelepülésként főleg munieriás tavi kifejlődésben, végül a Csehbányai F. fölött, az üledékgyűjtő feltöltődése révén létrejött kiegyenlített aljzaton kialakult nagykiterjedésű, epizódikus mocsári képződményként fordul elő. A nagyon rövid életű brakk szakasz (Csingervölgyi Márga) után bekövetkezett tengerelöntés egyenletes vastagságú (40—45 m) hemipelágikus márgát rakott le (Jákói Márga F.), ennélfogva az ősdomborzat-rekonstrukciós szerkesztés vonatkozási szintje e formáció talpa lehet.

A három formáció együttes vastagsága és az Ugodi Mészkő transzgressziós szakaszának becsült vastagsága a preszenon térszín legalább 270—300 m-es szintkülönbségeit jelzi. Ez a térszín felső-triász, DNy-on néhol liász képződményeken, ill. a helyi mélyedéseket kitöltő bauxittelepeken és reziduumokon (pl. tűzkőtörmelék) alakult ki. A térszín egyenetlenségeire utal helyi kőzettörmelék gyakori megjelenése számos bauxittelepben, erőteljesebb karsztformákra pedig iharkúti típusú telepek előfordulása nemcsak az iharkút—németbányai előfordulás szomszédságában, hanem a bakonyjákói magasrögön is. A magasrög a későbbiekben is kiemelkedés volt, melyen rudistás zátony alakult ki, nem közvetlenül az aljzatra, hanem a Jákói F.-ra települve. A magasrög ma már nagyrészt a Csehbányai Formációig lepusztult, az Ugodi Mészkő törmelékéből képződött Jákóhegyi Breccsa azonban körös-körül megtalálható a Polányi Márga F. szelvényeiben.

A NEW OCCURRENCE OF THE SENONIAN NAGYTÁRKÁNY BAUXITE FORMATION AROUND AJKA

by

JÓZSEF KNAUER*—A. E. MÁRTA NÉMETH**—ÁGNES FEKETE*

*Hungarian Geological Survey
Budapest, Stefánia út 14.
H-1143

**Balatonalmádi, Rövid u. 11/828
H-8222

UDC: 551.763.31 (234.373.1)
553.492.1

Keywords: Senonian bauxite, borehole section, sedimentology, geochemistry, S Bakony Mountains, Ajka

Earlier the Senonian Nagytárkány Bauxite Formation was only known in the type areas (in the western part of the Southern Bakony Mts) and in the region of Iharkút (NW Bakony Mts). An exploratory borehole drilled by the Hungarian Geological Survey penetrated a thick Senonian bauxite profile in the region of Ajka (in the middle part of the S Bakony Mts) which is assigned to this Formation, according to its sedimentological and geochemical features as well as its paleomorphological position. The present paper gives a geochemical comparison made between the Ajka and other Senonian bauxite deposits, dealing with the question of Al-Ti correlation, giving a description of the clastic minerals and of the direct overlying and underlying rocks of the bauxite deposit and evidencing also mathematicaly a discontinuous deposition upon sedimentological and geochemical proofs. The latter is one of the most important feature of the concerned genetics.

A borehole (Ak 33) drilled in 1990 by the Hungarian Geological Survey in the vicinity of Ajka within the framework of bauxite prospecting has proved that the Nagytárkány Bauxite Formation known so far in the regions of Nagytárkány and Iharkút is encountered in this region, too (Fig. 1). Although several thin bauxite beds with the same stratigraphic position drilled earlier in the region had not been assigned to the Nagytárkány Formation. The borehole was drilled at a morphologically preferred site of the gravity map (Fig. 2), taken for analogous with the paleomorphological situation of the Nagytárkány and Iharkút bauxite deposits. A geological column of the borehole is shown in Fig. 3.

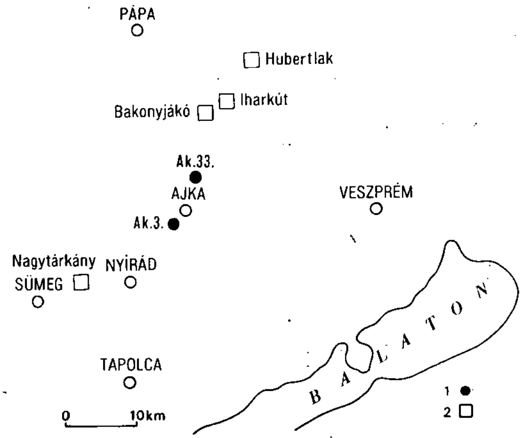


Fig. 1. The areas of occurrence of the Nagytárkány Bauxite Formation
1 – borehole, *2* – group of deposit
1. ábra. A Nagytárkányi Bauxit Formáció előfordulási területei
1. fúrás, *2.* telepcsoport

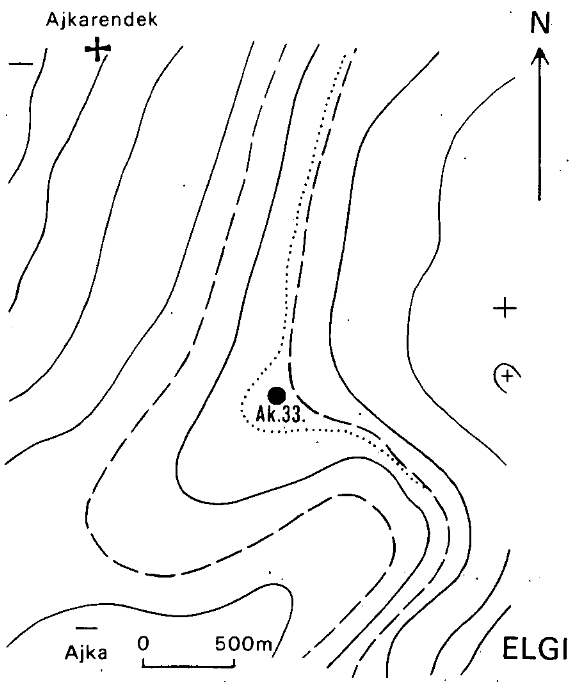


Fig. 2. Gravity anomaly map (ELGI, Budapest) with the site of borehole Ak 33 basic gravity contours by 1 mgal

2. ábra. Gravitációs anomália térkép (ELGI, Budapest) az Ak. 33. sz. fúrás helyével. Az alap-izovonalköz 1 mgal

Rocks underlying the bauxite deposit

The bauxite deposit is immediately underlain by a 10-cm-thick, pale red-brown-yellow variegated, unlaminated clay of uneven fracture (Al_2O_3=9.3%, SiO_2=11.6%) resting on the Hauptdolomit Formation, the 1.1-m-thick upper part of which is fractured and slightly altered. The concerned clay was developed owing to the resilification of bauxite and was also subjected to alterations by oxidation and reduction. Thus, the clay must be separated by hiatus from its overlying oxidizing bauxite deposit. In thin section, its texture is light yellowish-brown and is like a woven stuff. This points to a kaolinitic composition. Where the original shaped components had been, globular spaces were filled with fine-grained kaolinite (subordinately gibbsite). The rock incorporates a number of limonite/haematite pseudomorphs after pyrite cubes with edge length ranging from 20 to 200 μm, moreover a few slightly rounded or rectangular dolomite clasts 400 μm to 1 mm large with ferrous/manganiferous edges are also seen.

General features of the bauxite deposit

The bauxite is almost throughoutly unstratified, showing a not too varied appearance. It is brownish-red, dark brownish-red, and red in the topmost part, including minor, deironized patches here and there, at places with thin deironized interval. A part of this rock is a pelitomorphic, at some places microclastic bauxite mudstone of aggregate structure, whereas the greater part is a bauxite wackestone but bauxite packstone is also observed. Its grains are mostly autochtonous (chemically) diagenetic ooids, roundish substances with no internal structure; spheroidal grains that are strongly ferruginous; at some sites wackestone-like bauxite deposits pointing to a paraautochtonous reworking; as well as well-segregated, heavily ferruginous spheroidal grains filled with kaolinite or crystalline-gibbsite also encountered at Iharkút. The occurrence of desiccation cracks is frequently observed on the strongly ferruginous grains. Colloidal iron hydroxide segregations are observed both in the wackestone and in the mudstone units. These features are identical with the known features of the Nagytárkány Bauxite Formation. According to the trace element composition and the TiO_2 and P_2O_5 contents of the nearest bauxite profile having a similar stratigraphic situation (profile Ak 3, 342.6 to 343.9 m) it can be correlated with the upper part of bauxite profile Ak 33.

When examining the distribution of main elements (Table 1), a striking feature is represented by a definite discontinuity of the bauxite deposition. This can be detected mainly on the basis of the changes in TiO_2 and P_2O_5 contents, the module (Al_2O_3/SiO_2), and the aluminium and iron content. A total of six subdivisions have been identified. However, each of these portions can be subdivided according to additional changes in features. The distribution of trace elements (Table 2) is in correspondence with the aforesaid subdivision. Another

Table 1 —1. táblázat

Sections of the bauxite sequence crossed by borehole No Ak 33 on the basis of the changes of the chemical composition

Az Ak. 33. sz. fúrás bauxitszelvényének szakaszai a vegyi összetétel változásai alapján

Serial No.	Depth interval m From	To	Phase	Al_2O_3 %	SiO_2 %	Fe_2O_3 %	TiO_2 %	Loss of ignition %	CaO %	MgO %	S Total %	P_2O_5 %	C_{org} %	$FeCO_3$ %	MnO_2 %	Module
1	384.7	385.2		49.3	13.8	17.2	2.9	15.2	—	—	—	—	—	—	—	3.57
2	385.2	386.0	F	49.5	13.6	17.6	2.9	14.2	—	—	—	—	—	—	—	3.64
3	386.0	387.2		50.8	11.1	19.3	2.9	14.3	00.14	00.13	00.04	0.25	00.14	00.27	—	4.58
4	387.2	388.1	E_2	57.4	05.0	20.9	2.9	12.5	—	—	—	—	—	—	—	11.48
5	388.1	389.0		57.7	03.7	22.1	2.8	11.7	00.13	00.12	00.09	0.23	00.05	00.09	—	15.59
6	389.0	390.0		60.5	00.7	23.0	2.6	11.6	00.11	00.10	00.04	0.25	00.07	00.06	—	86.43
7	390.0	391.0		58.9	01.0	23.4	3.2	11.4	—	—	—	—	—	—	—	58.90
8	391.0	391.5		59.5	00.9	23.0	3.2	11.5	—	—	—	—	—	—	—	66.11
9	391.5	392.1		58.4	02.6	21.7	4.6	11.4	—	—	—	—	—	—	—	22.46
10	392.1	393.0	E	58.4	02.4	21.7	4.6	11.6	—	—	—	—	—	—	—	24.33
11	393.0	393.8	E_1	59.0	01.7	23.4	3.5	11.7	—	—	—	—	—	—	—	34.71
12	393.8	394.9		57.4	03.0	22.6	3.6	11.5	—	—	—	—	—	—	—	19.13
13	394.9	395.8		56.1	04.8	22.6	3.8	11.4	00.11	00.02	00.08	0.25	00.09	00.05	—	11.69
14	395.8	396.9		55.9	03.6	23.0	3.2	11.4	—	—	00.05	—	—	—	—	15.53
15	396.9	398.0		57.9	01.6	24.6	2.2	11.5	00.13	00.06	00.04	0.29	00.04	00.07	—	36.19
16	398.0	399.0		57.7	02.8	24.2	2.6	11.6	—	—	00.06	—	—	—	—	20.61
17	399.0	400.0		54.4	04.1	24.6	4.2	11.1	—	—	—	—	—	—	—	13.27
18	400.0	401.0		54.3	02.8	26.6	4.1	11.1	00.12	00.08	00.04	0.43	—	—	—	19.39
19	401.0	402.0		55.3	02.8	25.8	3.6	11.1	—	—	—	—	—	—	—	19.75
20	402.0	403.0	D_2	55.6	03.8	24.6	3.5	11.3	—	—	—	—	—	—	—	14.63
21	403.0	404.0		55.8	04.8	23.0	3.5	11.5	—	—	—	—	—	—	—	11.63
22	404.0	404.6		56.1	04.1	23.8	3.5	11.4	—	—	—	—	—	—	—	13.68
23	404.6	405.5	D	56.9	03.6	23.8	3.5	11.5	—	—	—	—	—	—	—	15.81
24	405.5	406.5		53.0	07.1	24.2	3.5	11.3	00.10	00.07	0.006	0.41	—	—	—	7.46
25	406.5	407.5	D_1	53.3	06.6	23.8	3.5	11.5	—	—	—	—	—	—	—	8.08
26	407.5	408.5		55.1	04.0	25.0	3.6	11.1	—	—	—	—	—	—	—	13.78

Serial No.	Depth interval m From	To	Phase	Al_2O_3 %	SiO_2 %	Fe_2O_3 %	TiO_2 %	Loss of ignition %	CaO %	MgO %	S Total %	P_2O_5 %	C_{org} %	$FeCO_3$ %	MnO_2 %	Module
27	408.5	409.5		51.8	04.8	27.1	4.6	10.8	—	—	—	—	—	—	—	10.79
28	409.5	410.5		52.1	04.9	26.7	4.6	10.9	—	—	—	—	—	—	—	10.63
29	410.5	411.5		50.8	05.7	27.1	4.3	10.6	00.13	00.11	00.03	0.37	00.02	—	0.20	8.91
30	411.5	412.5	C_2	49.8	05.0	28.3	4.6	10.4	—	—	—	—	—	—	—	9.96
31	412.5	413.5		50.3	04.8	27.5	4.5	11.0	—	—	—	—	—	—	—	10.48
32	413.5	414.5		51.6	05.0	26.2	4.4	11.7	—	—	—	—	—	—	—	10.32
33	414.5	415.5		51.8	04.5	26.3	4.8	11.5	—	—	—	—	—	—	—	11.51
34	415.5	416.5		51.3	05.0	25.4	4.9	12.0	00.13	00.08	00.06	0.34	00.03	—	0.20	10.26
35	416.5	417.5	C	53.1	03.3	23.8	4.4	14.4	—	—	—	—	—	—	—	16.09
36	417.5	418.3		54.4	03.4	23.0	4.6	13.5	—	—	—	—	—	—	—	16.00
37	418.3	419.3		54.6	03.8	23.8	4.0	13.3	—	—	—	—	—	—	—	14.37
38	419.3	419.5		53.3	02.9	22.6	4.0	14.9	—	—	—	—	—	—	—	18.38
39	419.5	419.8	C_1	52.1	04.8	23.0	4.2	14.6	—	—	—	—	—	—	—	10.85
40	419.8	420.0		53.1	05.0	22.6	4.2	14.4	—	—	—	—	—	—	—	10.62
41	420.0	420.3		51.0	05.3	22.6	4.2	15.7	—	—	—	—	—	—	—	9.62
42	420.3	420.5		51.6	05.3	22.6	4.2	15.8	00.10	00.04	00.08	0.34	00.03	—	0.20	9.74
43	420.5	421.0		54.4	06.2	21.8	4.1	12.3	—	—	—	—	—	—	—	8.77
44	421.0	421.5		51.8	09.3	22.2	3.4	11.7	—	—	—	—	—	—	—	5.57
45	421.5	421.8	B_2	50.5	12.5	21.8	2.8	11.4	00.13	00.08	00.06	0.37	00.09	—	0.16	4.04
46	421.8	422.1		49.5	11.9	22.6	2.8	11.2	—	—	—	—	—	—	—	4.16
47	422.1	422.4	B B_1	55.9	07.4	21.1	2.7	11.6	—	—	—	—	—	—	—	7.55
48	422.4	422.7		55.4	07.6	21.5	2.7	11.5	—	—	—	—	—	—	—	7.29
49	422.7	422.8	A A_2	66.6	07.7	07.4	4.0	13.3	—	—	00.07	—	—	—	—	8.65
50	422.8	423.4	A_1	56.9	04.7	23.0	2.9	11.3	—	—	—	—	—	—	—	12.11
51	423.4	423.8		56.9	04.4	22.6	2.8	11.5	00.20	00.13	00.05	0.36	00.06	—	0.24	12.93

Analysis made by: Hungalu Prospecting Company

Table 2 — 2. táblázat

Trace element distribution in the bauxite section of Ak 33 borehole
A nyomelemek eloszlása az Ak. 33. sz. fúrás bauxitszelvényében

Serial No. Ak-33	Depth interval m From	to	Ga_2O_3 %	BeO %	ZrO_2 %	V_2O_5 %	MnO_2 %	Cr_2O_3 %	NiO %	CuO %	MoO_3 %	PbO %	SnO_2 %	Phase
3.	386.0	387.2	0.0047	0.0011	0.111	0.177	0.062	0.093	0.0067	0.0008	0.0005	0.0125	0.0015	F
6.	389.0	390.0	0.0055	0.0009	0.084	0.219	0.329	0.048	0.0081	0.0006	0.0013	0.0111	0.0015	
8.	391.0	391.5	0.0058	0.0010	0.107	0.217	0.327	0.053	0.0087	0.0008	0.0017	0.0108	0.0020	E_1
13.	394.9	395.8	0.0053	0.0012	0.165	0.176	0.342	0.056	0.0132	0.0014	0.0018	0.0120	0.0020	
15.	396.9	398.0	0.0052	0.0013	0.071	0.209	0.275	0.040	0.0106	0.0009	0.0018	0.0105	0.0017	
18.	400.0	401.0	0.0046	0.0014	0.163	0.211	0.342	0.061	0.0120	0.0016	0.0018	0.0114	0.0018	D_2
24.	405.5	406.5	0.0052	0.0021	0.136	0.211	0.316	0.063	0.0180	0.0045	0.0018	0.0112	0.0018	D_1
29.	410.5	411.5	0.0059	0.0010	0.173	0.202	0.243	0.064	0.0178	0.0019	0.0017	0.0128	0.0018	C_2
34.	415.5	416.5	0.0042	0.0007	0.200	0.180	0.195	0.051	0.0112	0.0012	0.0016	0.0112	0.0017	
42.	420.3	420.5	0.0051	0.0013	0.193	0.151	0.232	0.054	0.0103	0.0016	0.0017	0.0089	0.0018	C_1
45.	421.5	421.8	0.0043	0.0016	0.091	0.177	0.192	0.047	0.0129	0.0017	0.0012	0.0102	0.0017	B_2
47.	422.1	422.4	0.0048	0.0020	0.083	0.200	0.199	0.049	0.0115	0.0020	0.0014	0.0109	0.0020	B_1
49.	422.7	422.8	0.0063	0.0019	0.137	0.121	0.104	0.068	0.0082	0.0015	0.0009	0.0073	0.0022	A_2
51.	423.4	423.8	0.0053	0.0019	0.104	0.208	0.258	0.044	0.0116	0.0021	0.0016	0.0100	0.0022	A_1

[box] Maximum, relative — [slash] Minimum, relative — - - - - - Characteristic limit

Analyses made by: Hungalu Prospecting Company observation is that the P_2O_5, Zr and Cu contents are higher in the lower part (A—D) of the profile, and lower in the upper (E—F) part of the section.

The bauxite with normal or high TiO_2 content has a somewhat more complex distribution. The TiO_2 content exceeding 3% is to be considered high, when Al_2O_3 content surpasses 50%, with the rest of constituents corresponding to the usual percentage. If Al_2O_3 content exceeds 55 or 56%, then TiO2 percentage is taken for high when surpassing 3.5%. Accordingly, the TiO_2 content is normal (but higher than the average) for the intervals ranging from 384.7 to 391.5 m, from 395.8 to 399.0 and from 421.0 to 423.8 m, whereas it is high for the intervals ranging from 391.5 to 395.8 and from 399.0 to 421.0.

Results of the micromineralogical study (Table 3)

The average sample from two intervals of the bauxite deposit as well as the immediate overlying and underlying rocks have been examined.

Detrital minerals of the "underlying clay" (423.8 to 423.9 m)

Opaque minerals. Pyrite forms mostly aggregates of small idiomorphic (hexahedral) grains. That is why it mainly occurs in the grain-size fraction coarser than 0.2 mm. The rest of opaque minerals are only haematite pseudomorphs formed after pyrite. Ilmenite is lustrous black, fresh and pseudo-hexahedral; the dull brown, altered ilmenite (rutile II) is recognisable by its crystal form. Galena is a xenomorphic fragment, and chromite is an Mg-Al bearing chrome-picotite, and also xenomorphic.

Transparent minerals. Quartz: Angular or slightly rounded, mostly water-clear grains, in part faded by liquid or gas inclusions; some specimens contain a number of opaque inclusions being otherwise still water-clear; a few larger quartzite grains are also encountered. Feldspar: The plagioclase grains are slightly decomposed, and greyish-white. Twinning is rather clearly visible. On a few grains cleavage can also be clearly observed. Tourmaline: Smoke-coloured, dark, ditrigonal prism fragments. Zircon: Pink (with various shades) or less frequently colourless or slightly yellowish, most frequently compact, prism-shaped--bipyramidal, rarery elongated, prismatic. Most grains are water-worn. Two grains examined using a microprobe method contained xenotime inclusions. Rutile: Reddish-brown and flesh-red, worn grains of resinous lustre. Two water-clear colourless euhedral minerals forming knee-shaped twin were also identified. Epidote: Light lemon-coloured or greenish-yellow, anhedral, slightly rounded grains with a high refractivity. Disthene: Colorless, water-pure and tabular; its high refractivity is well visible in all the three directions. Staurolite: medium-dark brown, with resinous lustre.

Detrital minerals of the bauxite (415.0 to 421.0; 421.0 to 423.8 m)

The features of minerals are the same as those described above. The jet-black fragments of magnetite cannot be reliably distinguished from haematite

Table 3 — 3. táblázat

A pc% distribution of clastic minerals on the basis of counting 200 to 600 pcs microclasts
A törmelékes ásványok db%-os megoszlása 200—600 db mikroklaszt leszámolása alapján

Depth interval/- measured qty	Direct overlying bed 382.5—383.2 m/250 g				bauxite 415.0—421.0 m/250 g				bauxite 421.0—423.8 m/250 g				"underlying clay" 423.8—423.9 m/160 g			
Sieve fractions (mm)	>0.2	0.2—0.1	0.1—0.06	0.06>	>0.2	0.2—0.1	0.1—0.06	0.06>	>0.2	0.2—0.1	0.1—0.06	0.06>	>0.2	0.2—0.1	0.1—0.06	0.06>
haematite+magnetite	2	3	6	7o	ny	16	10	6	—	24	10	10	—	4	4	1
chromite *	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
ilmenite	—	1	2,00.00	2	—	—	3	1	—	—	4	1	—	ny	ny	ny
rutile II	—	—	1	2	—	—	—	—	—	—	8	6	—	2	2	2
pyrite	—	0,3	—	—	—	—	—	—	—	—	—	—	15	6	7	12
galena *	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
quartz	93	88	79	71	—	68	42	65	—	60	52	54	75	70	23	4
feldspar	—	2	2	1	—	9	13	10	—	10	8	1	5	8	6	2
tourmaline	—	1	3	7	—	5	8	5	—	4	6	4	3	10	16	1
zircon	3	0,6	4	6	—	4	9	7	—	2	3	10	—	—	16	31
rutile	—	0.3	1.5	3	—	ny	5	2	—	—	7	13	1	1	22	40
epidote	2	1	ny	ny	—	—	—	—	—	—	—	—	1	—	1	—
florenzite *	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
kyanite	—	—	—	—	ny	ny	1	3	—	—	—	1	—	—	2	3
staurolite	—	—	1❏	1❏	—	—	—	1	—	—	—	—	—	—	1	1
corundum	—	0.3❏	0.3❏	—	—	—	—	—	—	—	—	—	—	—	—	—
muscovite	—	2	ny	ny	—	—	—	—	—	—	—	—	—	—	—	—
chlorite	—	—	0.5	1	—	—	—	—	—	—	—	—	—	—	—	—
xenotime *	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	ny
monacite *	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	ny
dolomite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	ny	ny❏
Qty of each fraction (g)	0.44	0.17	0.71	2.59	—	0.007	0.007	0.144	—	0.006	0.026	0.05	0.002	0.0003	0.015	0.002
Σ Washing residue (g, %)	3.91 g		1.56%		0.158 g,		0.06%		0.032	0.03%			0.139 g.		0.01%	
										+	Δ				Δ	

On the fraction <0.2 mm microprobe analyses were also performed. The results obtained have been added to the results of light-microscope tests.
A <0,2 mm frakcióból mikroszonda-elemzések is készültek, eredményeikkel kiegészítettük a fénymikroszkópos vizsgálatok eredményeit.

Symbols — Jelek:
- * identified by microprobe only — csak mikroszondával azonosítva,
- ❏ verified by microprobe — mikroszondával igazolva,
- \+ the probe analysis was made using selected opaque grains — kiválogatott opak szemcsékből, ill.
- Δ the probe analysis was made using an integrated sample of all fractions — a frakciók összevont teljes mintájából készült a szondaelemzés.

which is also anhedral, except for the very rare octahedral grains, therefore haematite+magnetite is included in the table showing quantitative distribution. In a comparison with descriptions of extraclasts of other Senonian bauxite deposits, the Ajka bauxite deposit can be regarded to be richer of varied extraclasts.

A description of the immediate cover (382.5 to 383.2 m)

The interval ranging from 382.0 to 384.0 m, the sample has been taken from, is a dolomite-siltstone with a poor silicate clast content which is likely to have been deposited in a local depression inundated by water, according to examinations by M. GELLAI. (That is why this rock as a distant analogue of the Ajka freshwater limestone, has been assigned to the Ajka Formation). Its mineral composition, as compared to that of the bauxite, is somewhat more varied; here corundum (sky-blue, angular, transparent grains), muscovite and chlorite are also observed. The appearance of mineral grains is the same as of those described for the "underlying clay", but a light-brown or dark brown pleochroic tourmaline version is also encountered.

When comparing the spectra of the extraclasts of the "underlying rock", the "bauxite" and the "overlying rock", no significant difference is observed, particularly when the per cent proportion of each mineral is calculated without taking quartz into consideration. In the bauxite the absolute quantity of microclasts is greater than that of the underlying rock but the quality spectrum is poorer. This has led us to the following two conclusions: 1) There is no essential difference between the original material of the underlying decomposed bauxite and its overlying bauxite deposit. Moreover, a small amount of dolomite-silt was accumulated here by a transport from the nearby dolomite terrain. 2) The material of the direct overlying rock which originates mainly from the fine detritus of the nearby dolomites, is likely to have been mixed with detrital minerals washed out from the bauxite deposits similar to the those penetrated by Ak33, or the denudation background, when the Ajka Formation was deposited, was the same as during the deposition of the bauxite deposit.

Subdivision of the bauxite complex (Table 4)

Unit A_1 — Dark brownish-red bauxite mudstone which is lighter-coloured at the top. Though it is found at the bottom of the complex, it is of strikingly good quality, with a mean trace element composition. According to its chemical features and to the facies of the underlying kaolinite-bearing bed, it is likely to have been deposited rather close to the bottom of the one-time "depositional trap", but not directly on it. A fissure in this bed contains wackestone with a bauxite-lithoclastic content of 70% (A).

Unit A_2 — This bed is built of wackestone with an iron content varying from spot to spot. The rock underwent an intensive deironization and, as a result, is relative enriched in Al and Ti, and shows a high value of loss of

Table 4 — 4. táblázat

Sedimentological features of the bauxite section of the AK 33 borehole
Az Ak. 33. sz. fúrás bauxitszelvény szakaszainak szedimentológiai jellegei

Phase		Matrix								Diagenic elements and intraclasts												Extraclasts		
		Textural type									Lumps		Globular grains				Ooliths							
													iron content to from matrix						more shells					
symbol (A=joint infillings)	thickness (m)	M	W_1 m=20—30%	W_2 m=40—60%	W_3 m=70—80%	P	deironization	kaolinization	desiccation crack network	spastoids	gibbsitic	rich/poor in iron	similar	different	large	well segregated	undeveloped	single-shell	core rich in iron	composite intraclasts	degree of sorting	size µm range frequent (g)	bauxite (with origin)	zircon (c), quartz (q), metamorphite (m)	phase
F	2.6			D		S	+	+				$S^<$		S	S^x	S^v			S		0	50—4000	E		F
E_2	0.8	D					+																		E_2
E_1 M	10.9	D										A	A	A	S						0	30—1000		mcq	E_1
W			S				f'n		+		S^x	$S^<$	S	So	S^x						0	50—1500			
D_2	6.5	S	D				+'					D		D							1	50—1500 g:50— 500		c	D_2
D_1	3.0	A'		D			r	r	+			A	$S^<$		D<	D	A		$S^<$		1	100—3000 g:400—300			D_1
C_2	8.0			D	A	S		+					D^x					S	S^x	A	2 }	100—4000			C_2
C_1	4.5				D								D						A D		2 }	g:200—500			C_1
B_2	1.1	D						f																	B_2
B_1	0.6	D																							B_1
A_2	0.1	A		D	A		+n	p		S			A	S		A	S				1 }	50—2000			A2
A'					D						A		S			A^v		S	S		3 }	g:500			A
A_1	1.0	D	S								A		S			A^v			S		0 }	50—2000			A_1

D=dominant, S=subdominant, A=subordinate or accessory, '=above, r=along desiccation cracks, n=along plants, f=in spots, p=in stripes, o=margin poor in iron, x=desiccation crack, <=resilification and pedogenic iron segregation, v=poor in iron — manganese ignition with an SiO_2 content being similar to that of horizon B1. In addition to deironization, some trace elements were mobilized, and the bed features minimum V, Mn, Ni, Mo, Pb — and less definitely — Cu contents, whereas components like Cr and, to a certain extent Ga and Zr come to a higher concentration. The amount of grains largely varies. At some parts of the sample the texture is packstone. An interface between the different textural fields is observable. The degree of kaolinitization of the rock is varying at places the one-time grains are partly or entirely replaced by kaolinite, however, an irregular stripe consisting almost purely of kaolinite fields, with one or two sphaeroidal grains inbetween, can also be observed. A definite minimum on the natural gamma radiation chart (Fig. 3) is likely to be associated with this bed and its direct vicinity.

Unit B_1 — Dark brownish-red bauxite mudstone.

Unit B_2 — Brownish-red bauxite mudrock, including, in a proportion of 30 to 40 %, 30 /μm-to-2 mm-sized kaolinite spots, and subordinately limonitic patches. During diagenesis silica did not leave but was mainly rearranged in this material in which the Al content is lower and the Si content is higher than in the former units.

Unit C_1 — A dark brownish-red wackestone bauxite with an Si content decreasing upwards in the profile. The interstitial spaces are usually filled with kaolinite, whereas kaolinite and/or gibbsite are included inside the strikingly ferruginous, well-segregated grains and between their surfaces. On the gamma-ray section this unit shows intensive changes of radiation. The composition of the transported material is likely to have changed at the boundary between C_1 and B_2.

Unit C_2 — A dark brownish-red bauxite wackestone intercalated by bauxite packstone, a somewhat lower-grade bauxite but of comparatively uniform quality, with a high TiO_2 content. At the base of the bed a minimum of Be and Cu is observed. The gamma radiation value is rather generally high. At the top part the rock is of a loose packstone type (including a few kaolinite groundmass) and is easily falling apart. The more bonded parts are of wackestone type. It can be observed in the well-segregated ooids that in a combined presence of gibbsite and kaolinite each small gibbsite crystal is euhedral, whereas the rest of space is occupied by kaolinite.

The relative deterioration in quality in C_2, as well as the kaolinite-bearing feature of the groundmass and the occurrence of combined intraclasts allow us to assume the existence of a certain discontinuity as far as the depositional process of bed group C is concerned.

Unit D_1 — Despite an increased A_1 content, this portion features a Ti content lower than that of portion C, definite maxima of Cu and Be, an increase in Cr content, and a minimum of Zr. The amount of Si shows a considerable change by increasing upwards in the sequence. The gamma-radiation is greatly reduced. As far as the appearance of bauxite is concerned, there is no significant change as compared to portion C. Here the desilication is somewhat weaker than in group C, and the traces of Si-rearrangement are strong

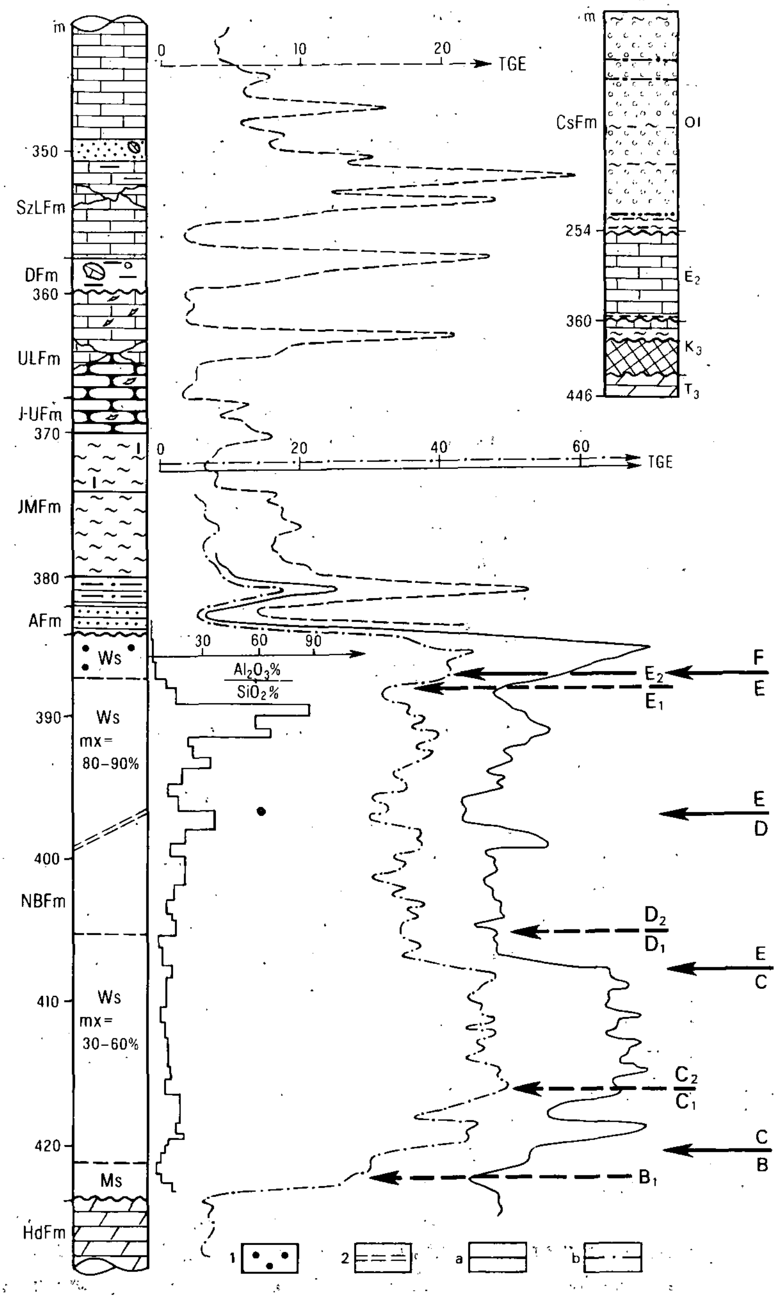

m
350
SzLFm
DFm
360
ULFm
J-UFm
370
JMFm
380
AFm
Ws
390
Ws
mx=
80–90%
400
NBFm
410
Ws
mx=
30–60%
420
Ms
HdFm
0
10
20
TGE
0
20
40
60
TGE
30
60
90
Al_2O_3%
SiO_2%
m
CsFm
Ol
254
E_2
360
K_3
446
T_3
F
E
E_2
E_1
E
D
D_2
D_1
E
C
C_2
C_1
C
B
B_1
1
2
a
b

Fig. 3. The section of borehole Ak 33

HdFm = Hauptdolomit Formation, NBFm = Nagytárkány Bauxite Formation (dominant texture types: Ws = wackestone, Ms = mudstone, mx = matrix, 1 = bauxite pebble, 2 = fine stratification, A, B_1 = units of the bauxite profile, AFm = Ajka Formation, JMFm = Jákó Marl Formation, J-UFm = Jákó-Ugod Formation, ULFm = Ugod Limestone Formation, DFm = Darvastó Formation, SzLFm = Szőc Limestone Formation, CsFm = Csatka Formation, TGE = natural gamma radiation equivalent, "TGE" in Hungarian (a = prior to casing, b = after casing)

3. ábra. Az Ak. 33. sz. fúrás rétegsora

HdFm = Fődolomit Formáció, NBFm = Nagytárkányi Bauxit Formáció (a domináns szövettípus = Ws = wackestone, Ms = mudstone, mx = matrix, 1 = bauxitkavics, 2 = finom rétegzettség), A, B_1 = a bauxitszelvény szakaszai, AFm = Ajkai Formáció, JMFm = Jákói Márga Formáció, J-UFm = Jákói-Ugodi Formáció, ULFm = Ugodi Mészkő Formáció, DFm = Darvastói Formáció, SzLFm = Szőci Mészkő Formáció, CsFm = Csatkai Formáció, TGE = természetes gamma egyenérték (a = csövezés előtt, b = csövezés után)

at the top. Kaolinite infillings are widespread. The entire rock displays a zigzagging pattern of desiccation cracks. At the top a thin bed of bauxite mudstone is found, presumably bringing about a minor but well-observable minimum in gamma radiation and at the same time, indicating the weakened action of one-time diagenesis, a phenomenon which must have been associated with the break in the sedimentation (see also desiccation cracks).

Unit D_2 — The hiatus at the end of unit D_2 is followed by a considerably higher-grade position of a similar chemical composition. However, its texture is differents constituting bauxite wackestone containing only 10 to 20 % shaped components, as well as bauxite mudrock. The highest grade of quality within the unit seems to be associated with the wackestone type. Some lumps with no internal structure are frequently surrounded by a margin that is inversely rich or poor, as compared to their material, in Fe. In the closing part of the unit a small increase in the proportion of Si is observed. The uppermost 10 cm of the rock is almost completely discoloured.

Unit E_1 — As with the basal part of D_1, an increase in Al content and a decrease in Ti content can be observed here. Nevertheless, the amount of Ti varies in a wide range within the unit concerned, and so does the V content. The Cu content is low. The trace elements are of average concentration. In the gamma-ray profile the unit begins with a minimum followed by fluctuations in accordance with changes in grade. An important feature is that despite the considerably higher grade, the gamma-ray value is much less than that of unit C_2. This may be derived from the differences in the composition of the initial materials (see the different Ti contents). The lowermost, 20-cm-thick portion consists of beds 3 to 4 mm and 5 to 10 mm thick, parallel to one another. Portion E_1 ends with a bed showing features of bauxite mudstone, diversified by irregular deironized spots or repeated colloidal ferruginous segregations, the latter pointing to pedogenic processes. Thus, the indications of a subsequent hiatus, as with that encountered at the end of portion D_1, are also observed here.

Unit E_2 — Bauxite mudstone, with a few or without grains. It is distinguished from unit E_1 by its chemical composition reflecting the effects by descending waters. In addition to an enrichment in Si, also a decrease in Fe content and an increase in the amount of the loss of ignition hitherto almost invariable, is also indicative of the above-mentioned effects. A considerable minimum of gamma radiation is observed at the E_2/E_1 boundary.

Unit F — Partly wackestone, partly — thus, at the bottom, too — packstone bauxite which is deironized in spots or almost completely, and has, at some other places, higher limonite and haematite content. At the bottom, textural lithoclasts similar to the material in subdivision E as well as pie-like pieces are encountered. In this the repeatedly percolating water must have played a role. The poor grade of this portion, however is possibly due to the new material carried in by water, but partly to a resilicification taking place before it has turned to be covered. Deironization and an increase of the value of loss of ignition are likewise attributable to this process, being also associated with limonitization, sideritization and a slight increase in organic carbon content. In addition to a maximum of Cr content, which is usual by concomitant in the case like that, V, Mn, Ni and Mo minima point to an intensive mobilization of elements. (The mobilization of Ni can be observed even in the uppermost part of subdivision E). The appearance of a significant gamma radiation maximum shown in the middle of the horizon is difficult to have been interpreted upon our own records.

Mathematical analysis of the distribution of main constituents in the subdivisions

As already shown, each unit and subunit distinguished on the basis of the sharp changes in the chemical composition in the concentration of some individual constituents — prior to knowing any other data, can be interpreted from a bauxite-geological aspect. Nevertheless, using the cluster analyis (worked out by Ó. Kovács, L.), our assumptions have been put to a test like that. The individual arrays of analysis can be grouped into five groups, considering the five main constituents. Sample No. 49, representing an independent group (the reference numbers used here and elsewhere correspond to the codes presented in Tables 1 and 2) is separated from the rest apparently because of its extremely low iron oxide content. In an analysis disregarding Fe content (that is, furnishing data of $Al_2O_3\%+SiO_2\%+TiO_2\%+L.o.I.\%= 100\ \%$ by recalculation) the bed was assigned to group Y where it originally had belonged prior to deironization taking place in the period of break in bauxite deposition. "Short-range" regrouping also took place in a few other cases shown by arrows in the Figure. Owing to these minor changes in position, the Figure concerned gives a better reflection of the difference between portions A_1 and B, and of the D/C boundary. In addition, Fig. 4 clearly shows the position of units A—F and of each subunit, including their independence and relation to the rest of the units. Samples corresponding to portions B_1, B_2, C_2 and F are arranged in well distinguishable groups. Group C_1 is somewhat heterogeneous. The picture of group E is also more

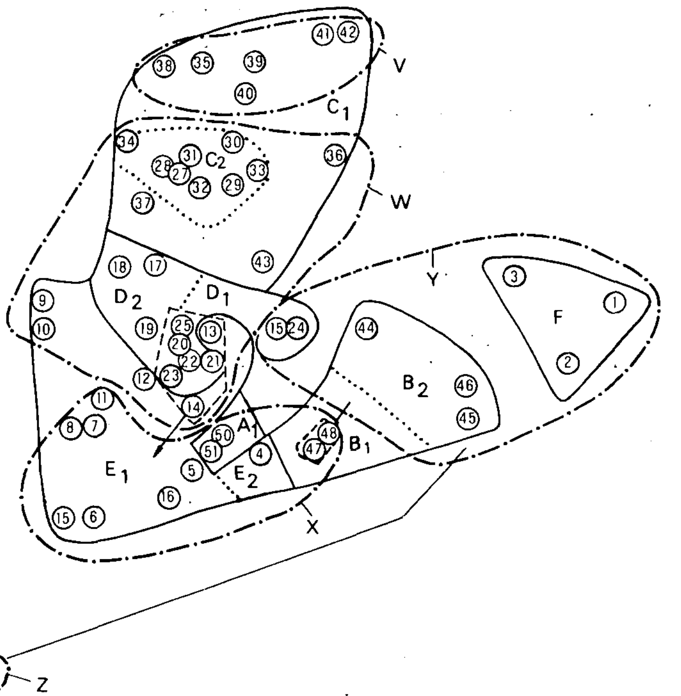


Fig. 4. Relationships between samples according to cluster analysis (groups X-Z), also indicating units (A_1F) marked upon the distribution of elements

4. ábra. A minták rokonsága a klaszter-analízis alapján (X-Z csoport), az elemeloszláson alapuló szakaszok (A_1-F) feltüntetésével

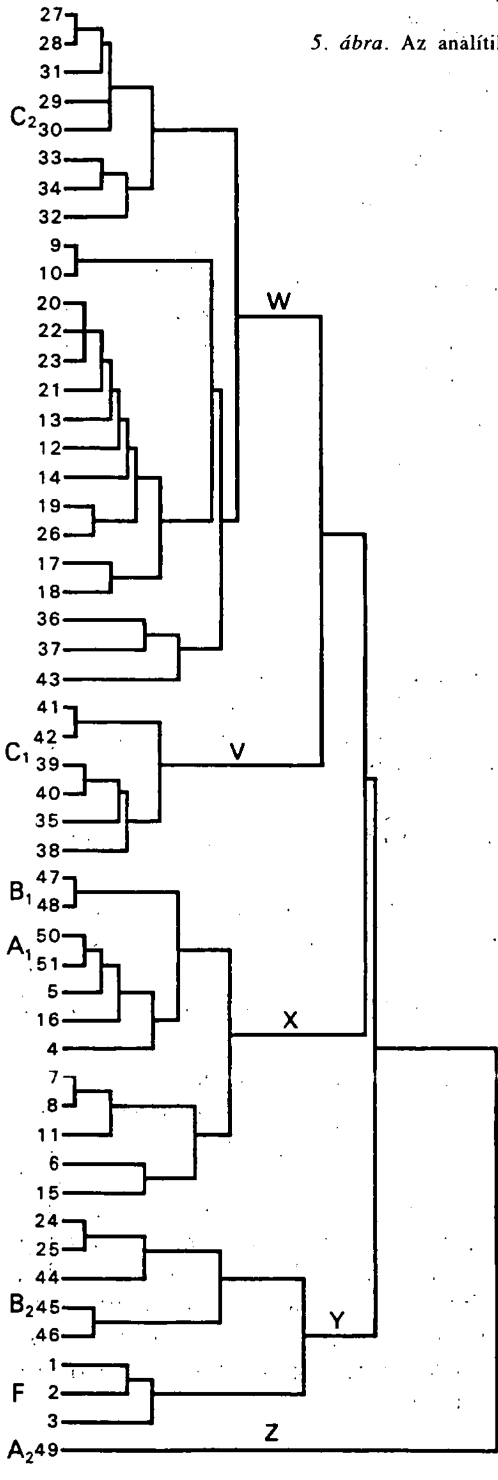
disseminated. Sedimentologically, the latter also represents the most diversified portion of the complex.

Samples deemed to correspond to the same group, even if other distinctions are also feasible, are usually easy to have encircled. Sample 13 corresponding to group D may indicate a similarity concerning facies. As shown by the analytical tree (Fig. 5) portions A_2, B_2, C_1, C_2 and F are positively separated but portion B_1 is a rather separate one, too.

As far as the tree" plotted with the neglection of iron oxide (Fig. 6), unit A_2 (49) disappears, whereas C_2 remains separate. A slight difference is observed for C_1. The positions of A_1 and B_1 are shifted, pointing to an iron mobilization stronger than average. It is also shown that the independence of group F is not only due to deironization. In addition, the relations according to the module have also been studied, however, they do not fit the grouping already formed or the grouping developed using the analysis. As shown earlier, this is expectable since a periodic formation and accumulation of bauxite is to be dealt with here. That is to say, a module or module arrangement can be characteristic of any unit if the initial material is roughly the one and the same, and the diagenetic conditions are similar.

Fig. 5. The "analytical tree", also indicating the group X-Z and the well distinguishable portions

5. ábra. Az analítikus fa az X-Z csoport és a markánsan jelentkező szakaszok feltüntetésével



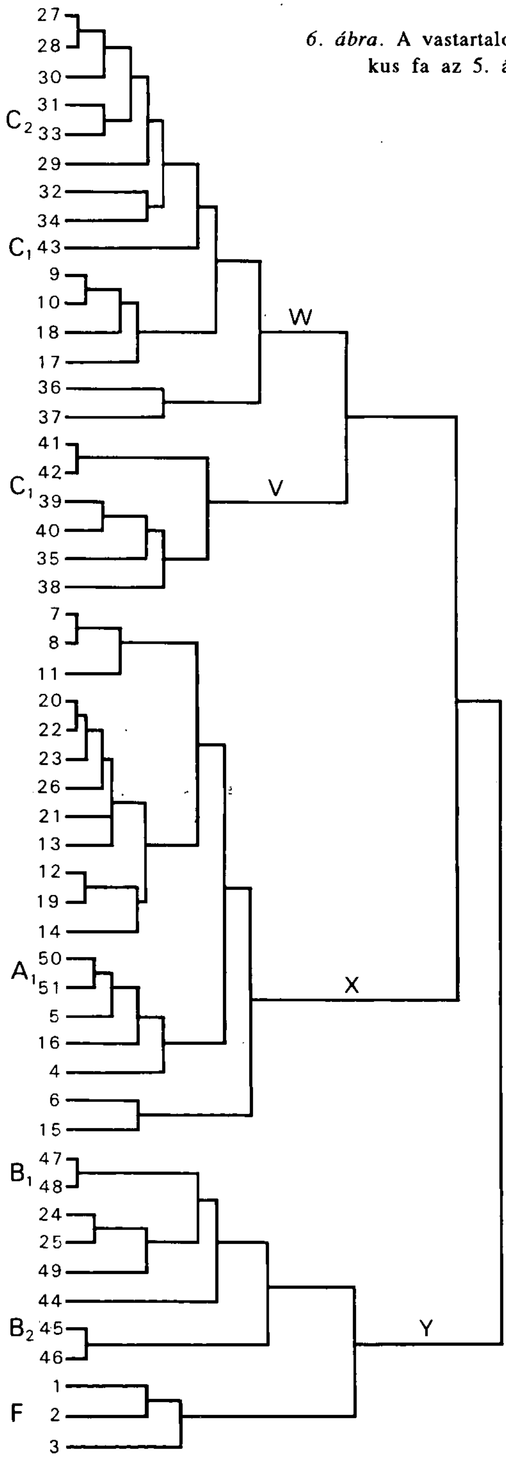


Fig. 6. An "analytical tree", plotted with disregarding Fe content and showing each unit indicated in Fig. 5

6. ábra. A vastartalom figyelmen kívül hagyásával készült analitikus fa az 5. ábrán szerepelt szakaszok feltüntetésével

A comparison of the bauxite complex with the Iharkút bauxite according to their compositional elements.

All data concerning the Iharkút deposit were taken into consideration on the basis of a study by I. HORVÁTH—Z. PÉTER (in: SZANTNER, F. et al. 1986). These data were calculated from data obtained by the analysis of a total of 25 bauxite deposits (Ik-I—V, Nb-I/XII, II—XI, XIII, XV—XIX) and 320 samples.

The average grades of Ak33 in percentage are as follows:

Al_2O_3	54.6	(54.9	TiO_2	3.5	(2.8)	MgO	0.09	(0.04)
SiO_2	4.7	(5.6)	L.o.I	11.9	(11.8)	P_2O_5	0.30	(0.21)
Fe_2O_3	23.1	(23.9)	CaO	0.13	(0.28)	S	0.06	(0.03)

The average grades of deposits Ik-V and Nb-XIII are by far coincident with these values but the grade of a number of deposits also is roughly similar. The Fe, S and Mg contents are rather like, whereas the P content is somewhat lower. A number of average values of deposits at Iharkút completely comply with those of the Ajka bauxite deposit, whereas there are a few beds with considerably higher averages (Ik—III—IV, Nb-VIII, —XVIII). As far as the Ajka profile is concerned, here the CaO content is noticeably lower and the loss of ignition is markedly different, neither of them is corresponding to the average value of any deposit at Iharkút. As for titanium content, it deviates even from the portions of the Ajka profile having a lower titanium content. Here we note that the Al_2O_3/TiO_2 relation referred to as + 1.0000, that is, of a correlation of "absolute validity" in the aforesaid study, may be true for a given type or initial material of bauxite, since in some units of the Ajka profile completely different TiO_2 contents are joined by the same Al_2O_3 content and contradictions are even greater when making a comparison with the Iharkút deposit. This eventually means that the correlation may be valid for the enrichment processes but the initial TiO_2 content of the original material is an essential influencing factor.

Of the trace elements, Ga, Pb and Sn fall entirely in the range of values relating to the Iharkút deposits (see the study cited, p. 340, Table 5), whereas Mo corresponds to the lower part of the range of values. The proportion of Be is, in a few samples, less than the minimum obtained for Iharkút. Zr, V and Ni correspond to the range of values of the Iharkút bauxite of Senonian cover, whereas regarding the deposits with secondary covering, the values of Ajka are lower. In comparison with all bauxite deposits of Iharkút, here the Cu contents are noticeably lower whereas the minimum value of Cr for Ajka is close to the average value relating to Iharkút. The only significant difference is manifested in the low Mn content of the Ajka deposit.

A comparison of the bauxite complex with other Senonian bauxites in Hungary, on the basis of the Cr-Ni and Cr-Be ratios.

By interpreting the Cr–Ni occurrence at Ajka the Iharkut "data field" by interpreting the areas of small Ni and great Cr contents in the region, and also at the Nagytárkány "data field" are present to a smaller extent, however it is fairly far from the Bakonyjákó "data field" (Fig. 7).

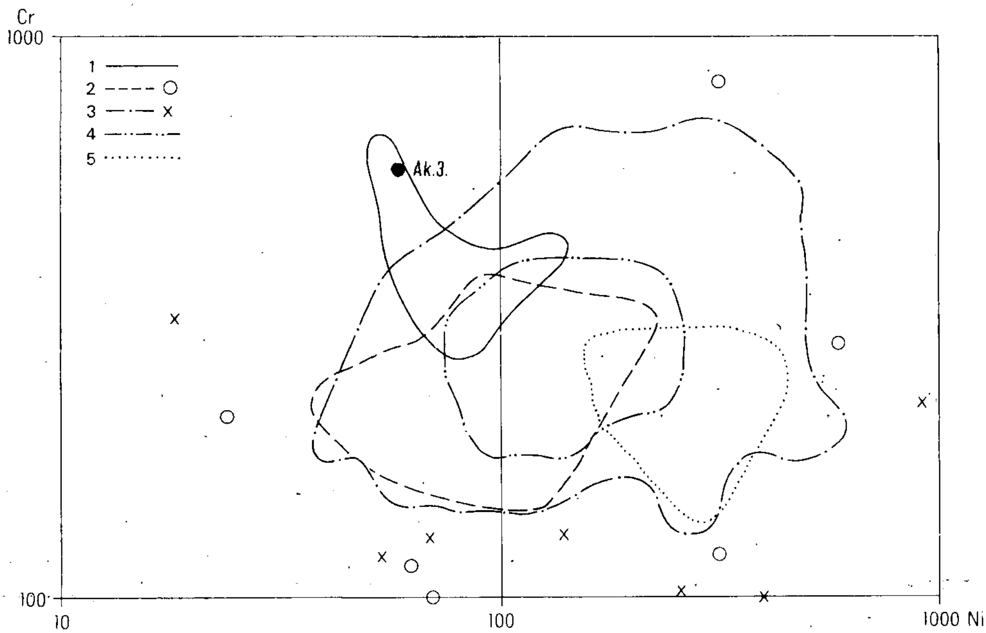


Fig. 7. The Cr–Ni contents in various of the Nagytárkány bauxite

1. Profiles of Ajka, *2.* type area, *3-4.* Iharkút-Németbánya (3. areas with fewer data pairs or distant individual data pairs, *4.* the bulk of data pairs), *5.* Bakonyjákó

7. ábra. A Nagytárkányi Bauxit Formáció kifejlődéseinek Cr–Ni tartalma

1. ajkai szelvények, *2.* típusterület, *3-4.* Iharkút–Németbánya (*3.* kevesebb adatpárt tartalmazó tartomány és távoleső egyedi adatpárok, *4.* az adatpárok zöme), *5.* Bakonyjákó

An interesting that in regard to its kind of makeup and paleomorphological position, the Senonian Bakonyjákó bauxite differs from the Iharkút-Németbánya bauxite deposits. The picture shown by the Cr-Be diagram is similar; here the difference from the Hubertlak (Ugod) bauxite of also unlike mode of building is most striking. Regarding Cr-Ni contents of the samples taken from a part of the Halimba Bauxite Formation covered by Senonian, the correlation is closer than between the Ajka deposits and the bauxite occurrences of Iharkút-Németbánya. (Fig. 9). This is easy to understand since the bauxite material of the allochtonous Senonian deposit of Halimba at least partly originates from the Iharkút-type bauxite (JUHÁSZ, E. 1989). Also regarding the SE-NW course of material transport to Halimba, as stated by E. JUHÁSZ, it can also be added

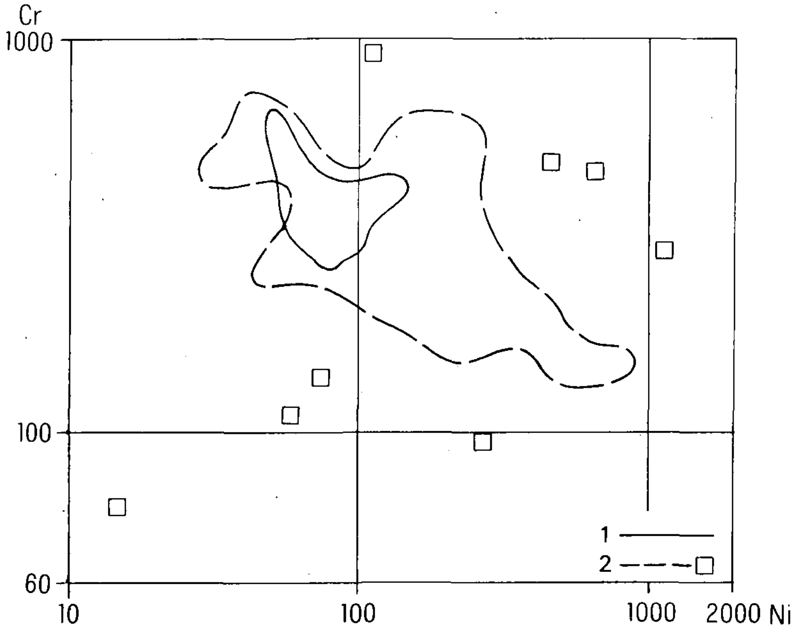


Fig. 8 — 8. ábra

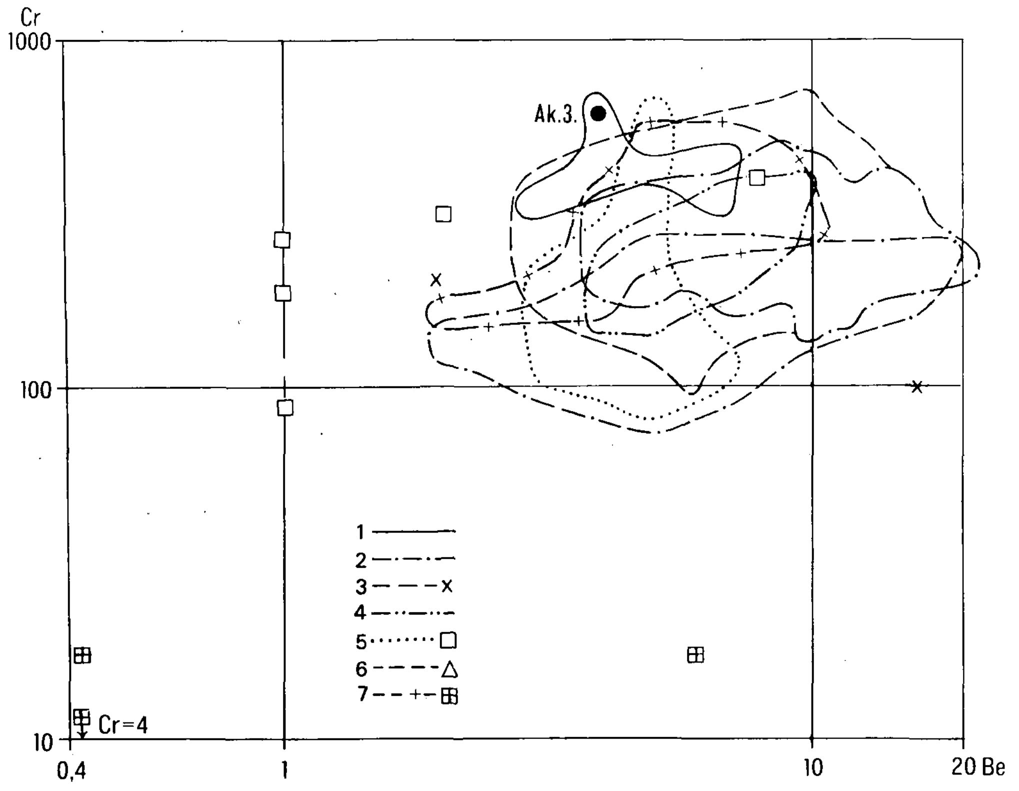


Fig. 9 — 9. ábra

Fig. 8. A comparison of the Ajka bauxite profiles with the Halimba Bauxite Formation according to the Cr–Ni ratio

1. Ajka, *2.* Halimba, the area of data pairs found comparatively close to each other and of the distant individual data pairs

8. ábra. Az ajkai bauxitszelvények és a Halimbai Bauxit Formáció összehasonlítása a Cr–Ni viszony alapján

1. Ajka, *2.* Halimba, az egymáshoz viszonylag közel eső adatpárok területe és a távoleső egyedi adatpárok

Fig. 9. Cr-Be contents of the various facies of the Nagytárkány Bauxite and of the bauxite of the Kozmatag Formation

1. Ajka, *2—3.* the stock of samples from the formation concerned (*2.* the greater part, *3.* realm with a smaller amount of data pairs or distant individual data pairs), *4—5.* type area (*5.* from the part immediately overlain by a secondary (Eocene) cover), *6.* Hubertlak, *7.* Kozmatag Formation (*5—7.* individual data pairs that are distant from the bulk of data)

9. ábra. A Nagytárkányi Bauxit Formáció kifejlődésének és a Kozmatag Formáció bauxitjának Cr-Be tartalma

1. Ajka, *2—3.* a formáció mintaállománya (*2.* zöm, *3.* kevesebb adatpárt tartalmazó tartomány és távoleső egyedi adatpárok), *4—5.* a típusterület (*5.* a másodlagos (eocén) fedő alatti részről), *6.* Hubertlak, *7.* Kozmatag F. (*5—7.* a zömtől távoleső egyedi adatpárok feltüntetésével)

that the areal extent of bauxite deposits type Ak3 and Ak33 had been very large, covering at that time a greater proportion of the present-day Southern Bakony Mountains region, or even extending beyond these limits.

REFERENCES — IRODALOM

FEKETE, Á.—MAROS, GY. 1991: Az ún. nagypontosságú és hagyományos módszerrel egyaránt vizsgált bauxitok nyomelemösszetételi adatainak összehasonlítása — Kézirat, Földt. Int. Adattár

JUHÁSZ, E. 1989: Sedimentological features of the Halimba Karstic Bauxite, Hungary — Trav. ICSOBA v.19 (no. 22) 301—310.

MINDSZENTY, A.—KNAUER, J.—SZANTNER, F. 1984: Az iharkúti bauxit üledékföldtani jellegei és felhalmozódási körülményei — Földt. Közl. 114. (1): 19—48.

E. NÉMETH, M.—K. GELLAI, M.—NÉMETH, A. 1990: Anyagvizsgálati jelentés az Ajka, Ak. 33. sz. bauxit-előkutató fúrás 6,0-457,3 m közötti mintáiról 1—60. — Kézirat, GEOPROSPECT, Földt. Int. Adattár

POLGÁRI, M. 1991: Bauxit nehézásvány-preparátumok elektronmikroszondás vizsgálata különös tekintettel a krómit előfordulására 1—38. — Kézirat, Földt. Int., MTA—GKL Adattár

SZANTNER, F.—KNAUER, J.—MINDSZENTY, A. et al. 1986: Bauxitprognózis 1—467. — VEAB kiadv. Veszprém

A SZENON NAGYTÁRKÁNYI BAUXIT FORMÁCIÓ KIFEJLŐDÉSE AJKA TÉRSÉGÉBEN

KNAUER JÓZSEF*—E. NÉMETH MÁRTA**—FEKETE ÁGNES*

*Magyar Állami Földtani Intézet
Budapest, Stefánia út 14.
H-1143

**Balatonalmádi, Rövid u. 11/828
H-8222

ETO: 551.763.31(234.373.1)
553.492.1

Tárgyszavak: szenon, bauxit, fúrásszelvény, szedimentológia, geokémia, D-i Bakony, Ajka

A paleomorfológiai megfontolások alapján az ELGI által mért gravitációs anomália térkép segítségével telepített Ajka Ak.33. sz. bauxit előkutató fúrás mintegy 40 m vastag szenon bauxitszelvényt harántolt, amely szedimentológiai jellegeiből adódóan a Nagytárkányi Bauxit Formációba tartozik. A fő- és nyomelemek eloszlása, a hirtelen összetétel-változások alapján kiválasztható szakaszai genetikailag értelmezhetők.

A geokémiai jellegek, így elsősorban a TiO_2 és P_2O_5 tartalom, valamint a Cr-Ni és Cr-Be arány alapján a szelvény, a közeli Ak.3. sz. bauxitkutató fúrás „alsószinti" bauxitszelvényével együtt, a formáción belül bizonyos önállóságot mutat, közelebb áll az iharkút-németbányai kifejlődéshez, mint a típusterületéhez, határozottan elkülönül viszont a bakonyjákói és a hubertlaki szenon bauxitoktól. Kérdéses, hogy teleptanilag milyen mértékben felel meg az ajkai bauxit az iharkútinak.

PALEOKARSTS CONTROLLED BY HIGH-FREQUENCY SEA-LEVEL CHANGES, BUDA MOUNTAINS, HUNGARY

by

ANNAMÁRIA NÁDOR—LÁSZLÓ KORPÁS—ERIKA JUHÁSZ

Hungarian Geological Survey
Budapest, Stefánia út 14.
H-1143

UDC: 551.4.07 (234.373.27)
552.54 (234.373.27)

Keywords: Dachstein Limestone Formation, Szépvölgy Limestone Formation, Upper Triassic, Upper Eocene, paleokarst, Caribbean type karstification, evolution of karst, sea-level change, Buda Mts

Syn-diagenetic (Caribbean type) paleokarsts in the Upper Triassic Dachstein Limestone and in the Upper Eocene Szépvölgy Limestone were formed as a result of subaerial exposure on certain parts of the carbonate platform during sea-level low stands of 4-5th order sea-level changes. These discontinuities represent a time gap of some ten thousand million years in the sequence.

Introduction

The karst-studies of the Buda Mts has been so far restricted to the processes of the Late Cretaceous-Late Eocene continental period, and to the phenomena of the Miocene-Pleistocene thermal karst-system. Although these two phases are recorded in the best way in the geological record of the area, the multiple karst evolution of the Buda Mts consists of more detailed processes. Some of these cannot be described and interpreted according to the classical geomorphological nomenclature, but approaches from sequence stratigraphy and carbonate diagenesis can help us to understand these processes.

Carbonate sedimentology and diagenesis has been developed much in the past decade, which led us to the new definition of karst. In addition to the classical determination of CVIJIC (1918), nowadays the meteoric diagenetic processes (near-surface solution, cementation, etc.) are also considered to be karstic in origin.

The Caribbean type karstification (in the terminology of ESTEBAN, 1991) and the related diagenetic processes take place on the subaerially exposed carbonate platform during sea-level low-stands. The processes of solution and precipitation in the semi-lithified sediment of high primary porosity and unstable mineralogy are determined by the relative mineral stability in addition to the dissolved CO_2 content of the water. The water movement and the solution are basically controlled by the inter-granular porosity and the open fracture pattern.

Due to the recognition, that sea-level low-stands are the main periods of paleokarst evolution (ESTEBAN and KLAPPA, 1983), sequence stratigraphy also became an important tool in paleokarst research (ESTEBAN, 1991). During sea-level changes of 4—5th order, carbonate sediments are subaerially exposed only for a short time (some ten thousands, or maximum a hundred thousand years). During 3rd order sea-level changes, the fall may be as many as 100 metres. The longer exposure time (some million years) and the bigger relief is resulted in more significant karst profile, while the biggest karst systems have been formed during exposure time of some ten to hundred million years related to 2nd order sea-level changes (Fig. 1).

Geology of the Buda Mts

The Buda Mts are the NE segment of the Transdanubian Central Range, its structure and geological buildup are very similar within the unit.

The Middle-Upper Triassic sequence is mainly represented by shallow marine dolomites and limestones, which are the oldest known formations on the surface (Budaörs Dolomite, Main Dolomite, Dachstein Limestone).

The Lofer-cycles of the Dachstein Limestone are dissimilar to that one of the other parts in the TCR. In the Buda Mts the supratidal A members are practically missing, and the intertidal B members are also subordinate. The sequence is composed of repeated CB—CB members without disconformity, which represent the external part of the platform margin, where sedimentation is able to keep pace with the quick subsidence (HAAS, 1989).

In the Jurassic and Early Cretaceous pelagic sedimentation, similar to that one of the E parts of the TCR is probable. After the stripping of these sediments the area might have been subaerially exposed only in the Late Cretaceous. (Concerning this problem, the opinion of the authors differ. Contrary to the above mentionned interpretation of A. NÁDOR, L. KORPÁS and E. JUHÁSZ thinks the young Mesozoic to be a sedimentation-free erosional period).

The facies conditions and sedimentation in the Late Eocene and Early Oligocene were determined by the Buda line (BÁLDI et al. 1983), which represented the most important paleogeographical boundary at that time (KORPÁS, 1981, BALÁZS et al., 1981). The Late Eocene sedimentation of the Buda Mts took place on paleo-slopes, determined by synsediment antiforms NW of the Buda line (FODOR et al., 1991). On the basis of detailed microfacies analyses of the Priabonian Szépvölgy Limestone and Bryozoan Marl (KÁZMÉR, 1985), the facies model of the shallow marine sedimentation can be outlined (shoal, mud-mound, coral- red algae reef, external part of the shallow shelf, deeper shelf). SE of the Buda line the Late Eocene sedimentation is represented by the bathyal Buda Marl.

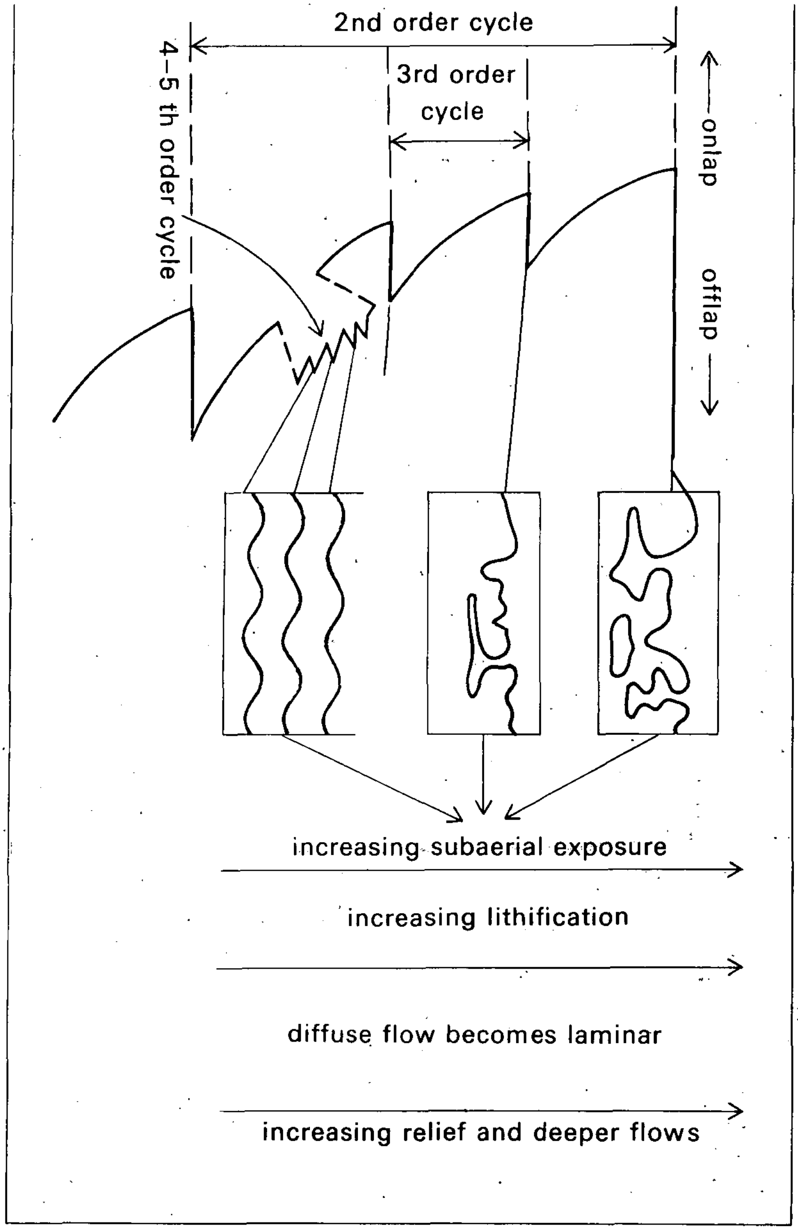


Fig. 1. The relationship between the sea-level changes and the evolution of paleokarst (KERANS, 1989)
1. ábra. A tengeszint változások és a paleokarszt fejlődésének kapcsolata (KERANS, 1989)

In the Early Oligocene the Hárshegy Sandstone and the Tard Clay were deposited, then the Kiscell Clay buried the karst system, which was built up of Triassic and Eocene carbonates.

From the Egerian the area gradually became a dryland. With the uplift of the mountain, the Kiscell Clay, which was covering the carbonate rocks began to erode, and bigger and bigger parts of the karst-system became subaerially exposed again. The Neogene thermal processes overprinted the previous non-thermal karst phases and made their recognition very difficult.

Late Triassic paleokarsts

Late Triassic paleokarsts in the Dachstein Limestone are known from the Fazekas Hill quarry and the Rácskai quarry at Máriaremete. The Lofer cycles are characterized by 1—2 m thick Megalodont-bearing C, and 10—50 cm thick B members with microbial laminites and oncoids.

On the Fazekas Hill a triangular shaped structure (tepee) of 25 cm in length and 6 cm in height can be observed. It is composed of parallel laminae of algal mats of the the B member (Plate I, Photo 1). This records the subaerial exposure of the microbial laminites on the tidal flat, which was then desiccated and cracked up creating a microform, which resembles to a small Indian hut (Fig. 2).

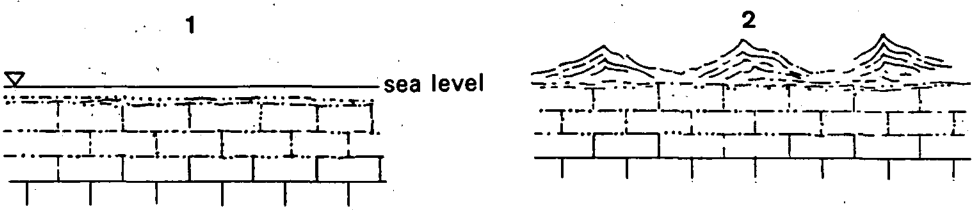


Fig. 2. Sketch of the development of the tepee structure, not to scale

1. shallow marine sedimentation on the tidal flat, 2. subaerially exposed microbial laminites crade up due to dehydration

2. *ábra.* A tepee szerkezet kialakulásának vázlata, elvi ábra, lépték nélkül

1. Sekélytengeri üledékképződés az árapály síkságon, 2. A tengerszint esés következtében szárazra került algagyep felcserepesedik

In both quarries reddish, wavey, clayey laminae of 1—8 mm in thickness occur at the top of the re-dissolved B members, parallel to the bedding (Plate I, Photo 2). These discontinuities also show evidence of early subaerial exposure. Sediments, deposited during the next sea-level rise fossilized then this horizon.

In Rácskai quarry monomict, matrix-supported breccias of 10—50 cm in thickness occur in conform position to the bedding, they are generally found in the horizons of the B members. The SE wall of the quarry exposes a fossil tidal channel of 1.2 m in height and 2 m in length (Plate II, Photo 1). Angular mud clast of 1—3 cm in diameter form the base of the channel, they show a continuous transition to the unaffected base rock beneath (Plate II, Photo 2). This pattern also show evidence of early subaerial exposure during sedimentation, when the upper part of the semi-lithified sediment dried up and brecciated (Fig. 3). The breccia horizons which are found unconformably to the bedding also reflect the original facies pattern (e.g. the wall of a tidal channel) and

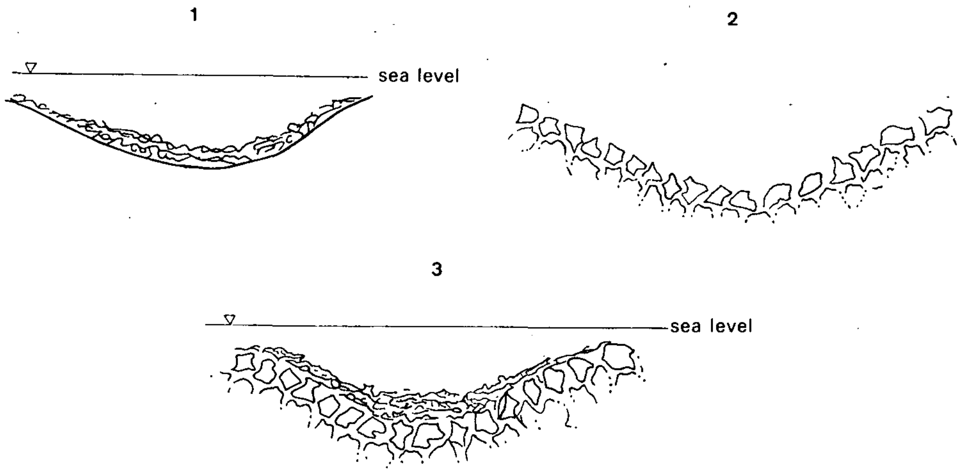


Fig. 3. Sketch of the development of the syndiagenetic breccias; not to scale
1. shallow marine sedimentation, tidal channel; *2.* the upper part of the subaerially exposed carbonate sediment brecciates up due to sea-level fall; *3.* sediments of the next sea-level rise fossilize the breccia-horizon

3. ábra. A szín-diagenetikus breccsák kialakulásának vázlata, elvi ábra, lépték nélkül
1. sekélytengeri üledékképződés, árapály csatorna; *2.* a tengerszint esés következtében szárazra került üledék felszíne felbreccsásodik; *3.* az újbóli tengerszint emelkedés során képződött rétegek fosszilizálják a breccsás szintet

are not the results of local emersion, tilting and angular disconformity within the Triassic sedimentation.

In the Fazekas Hill quarry solutionally enhanced fissures of 1—5 mm in width are nearly perpendicular to the bedding. They are filled with red, fine-grained sediment, similar to those ones, which are found at the top of the truncated B members (Plate III, Photo 1). This fissures do not cross the cycle boundaries. They are interpreted as erly karstic phenomena, which developed during the 4—5 th order sea-level low-stands in the Triassic.

Late Eocene paleokarsts

Fenyőgyöngye quarry exposes the Priabonian Szépvölgy Limestone, where a bedding plane controlled, lens-shaped cavity of 5—8 m in length and 0.8 m in height can be observed. It is filled with fine-grained calcarenite, which is composed of 0.1—1.5 cm thick graded laminae parallel to each other (Plate III, Photo 2). Near to the wall of the cavern cross bedding and micro slumps can be observed in the infilling marterial, which also contains some angular clasts of the host limestone of 3—8 cm in diameter. They are interpreted as collapse breccias, which may have fallen into the infilling material due to the decrease of stability of the cavity. The calcarenitic infilling contains Nummulite fragments (Plate IV, Photo 1) of Late Eocene age. The calcarenite also contain few clastic debris, these are angular quartz grains of some hundred microns in diameter. The small amount of the terrigenous debris refers to marine environment during the infilling, out of the contact of continental terrains. Both the infilling and the host limestone shared the same bright orange luminescent pattern, which refers to identical diagenetic processes affected each (phreatic environment).

The boundary between the host-rock of the cavity and the calcarenitic infilling is sharp, but no significant karstification can be observed (Plate IV, Photo 2). The host limestone contains bird-eye structures and coral fragments, which indicates little water depth and/or reef facies.

Summarizing these sedimentological observations, we suppose, that these cavities were dissolved in locally emerged carbonate build-ups in the mixing zone during 4—5th order sea-level falls, and were filled in the subsequent high-stand period (Fig. 4).

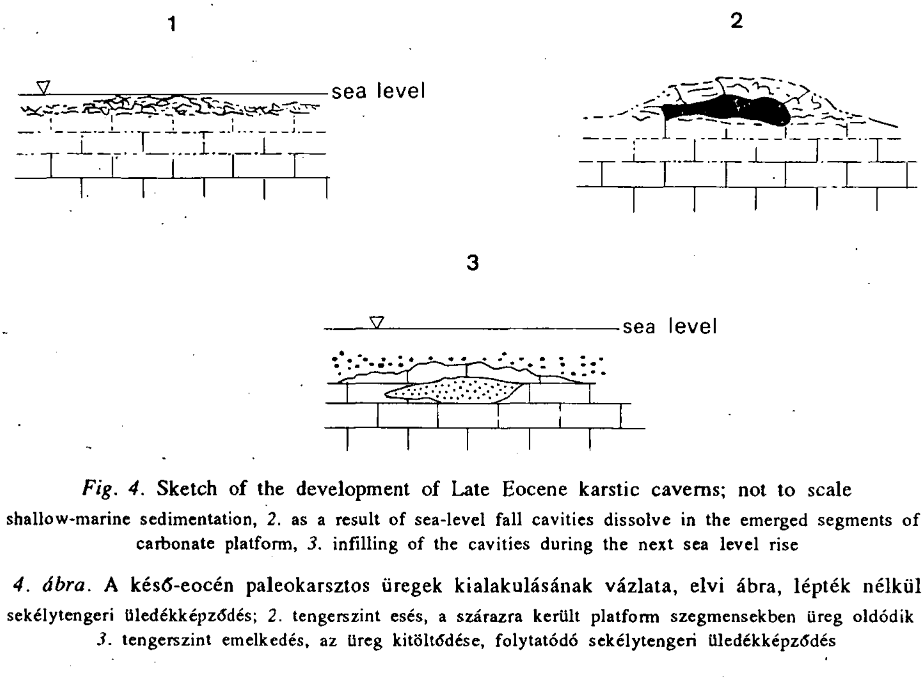


Fig. 4. Sketch of the development of Late Eocene karstic caverns; not to scale

1. shallow-marine sedimentation, *2.* as a result of sea-level fall cavities dissolve in the emerged segments of the carbonate platform, *3.* infilling of the cavities during the next sea level rise

4. ábra. A késő-eocén paleokarsztos üregek kialakulásának vázlata, elvi ábra, lépték nélkül

1. sekélytengeri üledékképződés; *2.* tengerszint esés, a szárazra került platform szegmensekben üreg oldódik ki; *3.* tengerszint emelkedés, az üreg kitöltődése, folytatódó sekélytengeri üledékképződés

Since that time, similar karst phenomena have become known from several other quarries in the Buda Mts (Mátyás Hill, Pál-völgy, Kecske Hill quarries) and caves (Pál-völgyi, Szemlő-hegyi, Ferenc-hegyi, Mátyás-hegyi caves). The lens-shaped cavities were dissolved everywhere paralel to the bedding of the limestone. Their average size ranges between 0.5—3.0 m in length and 10—50 cm in height. The style of the infilling, however, is differing in certain places from that one of the Fenyőgyöngye quarry. In the Mátyás Hill E-ern quarry and in the Kecske Hill quarry a continuous transition can be observed between the lowermost part of the laminated calcarenite and the underlying host rock of the cavity (Szépvölgy Limestone). In thin sections, this gradual transition can be even better recognized and no sharp boundary can be seen between the two sediments. This continuous transition can also be explained by the above outlined model of syndiagenetic karstification. In this case the whole sedimentary transport might have changed during the sedimentation, thus proving the same age of the limestone and the laminated calcarenite.

A model for sea-level controlled karst evolution in the Buda Mts

The karst phenomena in the Dachstein Limestone and Szépvölgy Limestone in the Buda Mts both represent early paleokarsts (Caribbean type) which form an integral part of limestone diagenesis. The subaerial exposure periods, when these paleokarsts developed are connected with 4—5th order sea-level falls.

The tepees and the reddish clayey laminae (A members) in the Dachstein Limestone refer to minor subaerial periods, which characterize the Lofer cyclic sedimentation. Since the exposed un/semi-lithified carbonate sediments rose above the sea-level only by a few centimetres, the karst profile was very thin, and the desiccation affected only the uppermost part of the sediment. Dm to m thick breccia horizons and the solutionally enhanced fissures indicate already thicker karst profile. During 4—5th order sea-level falls the exposed karst profile can be as thick as a few metres. The exposure time is maximum 10 000 years long (ESTEBAN, 1991), and the meteoric diagenetic processes were resulted in more significant karstification.

The dissolution of the Late Eocene cavities can be interpreted similarly. The subaerial exposure of the carbonate build-ups interrupted the shallow marine sedimentation only for short time. The cavities might have dissolved in the mixing zone of the freshwater and seawater. The infilling calcarenite deposited during the next sea-level rise, which chocked these cavities soon after their dissolution.

REFERENCES — IRODALOM

BALÁZS, E.—BÁLDI, T.—DUDICH, E.—GIDAI, L.—KORPÁS, L.—RADÓCZ, Gy.—SZENTGYÖRGYI, K.—ZELENKA, T. 1981: A magyarországi eocén-oligocén határ képződményeinek szerkezeti-faciális vázlata — Földt. Közl. 111.: 145—156.

BÁLDI, T.—HORVÁTH, M.—KÁZMÉR, M.—MONOSTORI, M.—NAGYMAROSY, A.—VARGA, P. 1983: The terminal eocene events — Field guide to late-eocene (priabonian) early oligocene (kiscellian) profiles of Hungary, Viságrád Meeting, 1983, 75.

CVIJIC, J. 1918: Hydrographie souterranie et evolution morphologique du Karst — Rec. Trv. Inst. Geogr. Alp. 6. (4): 376—420.

ESTEBAN, M. 1991: Paleokarst: Practical application — in: WRIGHT, V. P. et al. (eds): Paleokarst and Paleokarstic reservoirs, Postgraduate Research Institute for Sedimentology, Univ. of Reading, short course, 89—119.

ESTEBAN, M.—KLAPPA, C. F. 1983: Subaerial exposure environment — AAPG Mem. 33.: 1—54.

FODOR, L.—NAGYMAROSY, A.—FOGARASI, A.—MAGYARI, Á.—PALOTÁS, K.—GATTER, I. 1991: A Budai szerkezeti öv földtani kutatása — Kézirat, ELTE Általános és Történeti Földtani Tanszék
HAAS, J. 1989: Felső-triász karbonátos táblafejlődés a Dunántúli Középhegységben — Doktori értekezés tézisei, 10.
KÁZMÉR, M. 1985: A budai felső-eocén mészkő mikrofácies modellje — Ősl. Viták 31.: 59—64.
KERANS, C. *1989: Karst-controlled reservoir heterogeity and an example from the Ellenburger* Group (Lower Ordovician) of West Texas — Bureau of Econ. Geol. Rept. of Invest., Univ. of Texas at Austin. 186.: 40.
KORPÁS, L. 1981: A Dunántúli Középhegység oligocén-alsómiocén képződményei — Földt. Int. Évk. 64.: 140.
NÁDOR, A. 1991: A Budai-hegység paleokarszt jelenségei és fejlődéstörténetük — Kézirat, Egyetemi doktori értekezés 171.
WEIN, Gy. 1977: A Budai-hegység tektonikája — Földt. Int. Alk. Kiadvány, Budapest, 76.

TENGERSZINT VÁLTOZÁSOKKAL KAPCSOLATOS KORAI PALEOKARSZTOK A BUDAI-HEGYSÉGBEN

NÁDOR ANNAMÁRIA—KORPÁS LÁSZLÓ—JUHÁSZ ERIKA

Magyar Állami Földtani Intézet
Budapest, Stefánia út 14.
H-1143

ETO: 551.4.07 (234.373.27)
552.54 (234.373.27)

Tárgyszavak: Dachsteini Mészkő Formáció, Szépvölgyi Mészkő Formáció, felső-triász, felső-eocén, paleokarszt, Karib típusú karsztosodás, karsztfejlődés, tengerszint-változás, Budai-hegység

A Budai-hegység területén a szerzők a felső-triász Dachsteini Mészkőben és a felső-eocén Szépvölgyi Mészkőben elsőként igazolták a Karib-típusú, szinszediment paleokarsztok jelenlétét.

A túlnyomórészt B és C tagokból álló Lofer-ciklusos Dachsteini Mészkőben a korai karsztok tepee szerkezetek (Fazekas-hegyi kőfejtő), a rétegsoron belüli árapály csatornákhoz kapcsolódó szin-szediment breccsák (Rácskai-kőfejtő), valamint a ciklushatárokon elhaló oldott repedésrendszerek kitöltéseinek formájában mutatkoznak.

A felső-eocén Szépvölgyi Mészkőben a korai paleokarsztokat a rétegzéssel párhuzamos üregeket kitöltő, laminált, gradált, Nummuliteszeket tartalmazó, bioklasztos mészhomok képviseli (Fenyőgyöngyei, Mátyás-hegyi, Pál-völgyi és Kecske-hegyi kőfejtők, valamint a Pál-völgyi, Szemlő-hegyi, Ferenc-hegyi és Mátyás-hegyi barlangok).

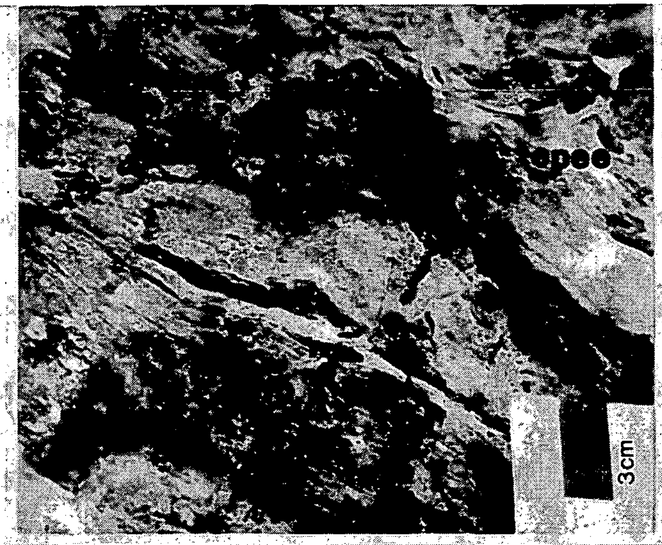
Mind a Dachsteini Mészkőben, mind a Szépvölgyi Mészkőben kimutatott korai karsztjelenségek az üledékképződéssel közel egyidejű, 4—5 rendű tengerszint esésekhez kapcsolódnak, s kialakulásuk időtartama maximum néhány tízezer évre tehető.

PLATES — TÁBLÁK

Plate I — I. tábla

1. Tepee structure, Fazekas Hill quarry

2. Clayey lamina on the truncated surface of the B member, Fazekas Hill quarry

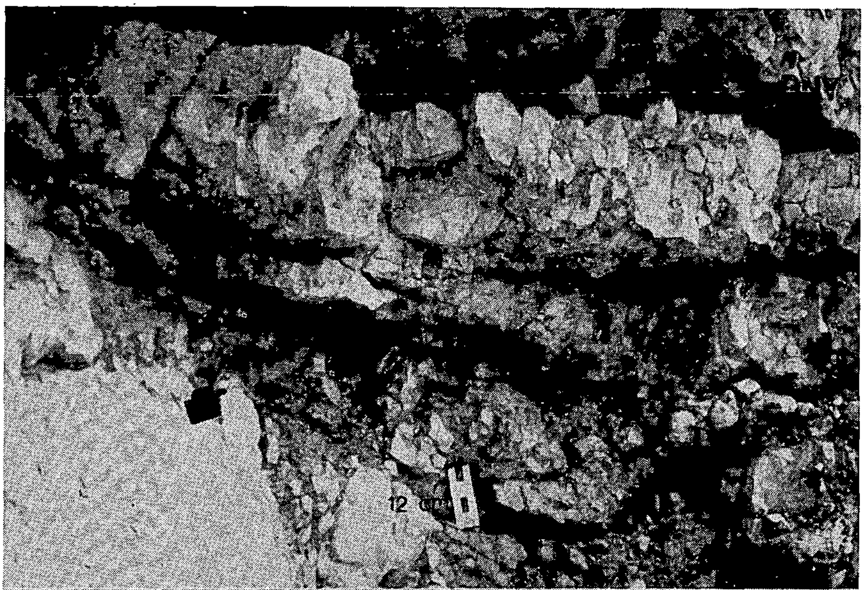


1

2

Plate II — II. tábla

1. Tidal channel in the Dachstein Limestone, Rácskay quarry
2. Syndiagenetic breccia at the base of the tidal channel, Rácskai quarry



1

2

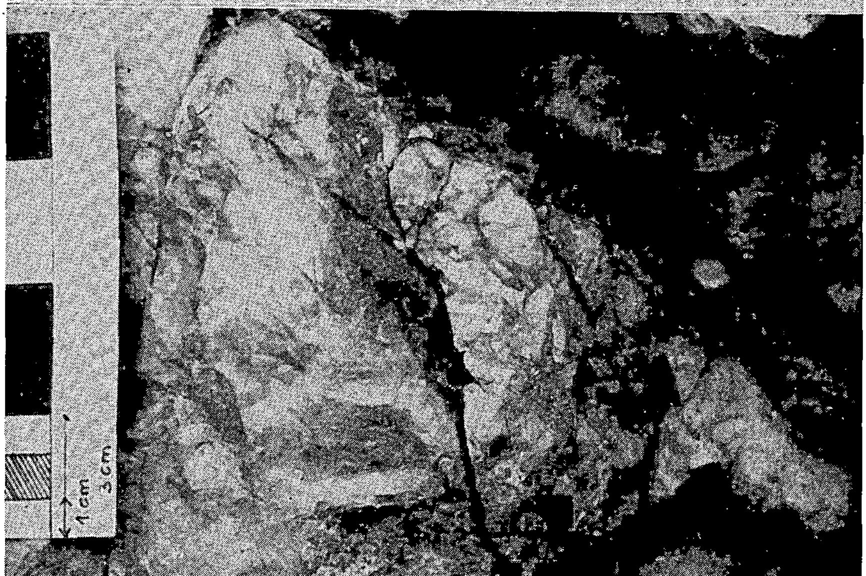


Plate III — III. tábla

1. Solutionally enhanced fissure perpendicular to the bedding in Dachstein Limestone Fazekas Hill quarry

2. Laminated calcarenite filles the dissolved cavity in Szépvölgyi Limestone, Fenyőgyöngye quarry

1

2

Plate IV — IV. tábla

1. Nummulites in the calcarenitic infilling material, Fenyőgyöngye quarry
2. Contact between the calcarenite and the host-rock (Szépvölgy Limestone), Fenyőgyöngye quarry

1

2

THE NEOGENE BASIN OF VÁRPALOTA-SOUTH (BAKONY MOUNTAINS)

by

JÓZSEF KÓKAY

Hungarian Geological Survey
Budapest, Stefánia út 14.
H-1143

UDC: 553.06(439.117):623

Keywords: lithostratigraphy, biostratigraphy, Mollusca, K/Ar dating, dacite tuff, coalification, variegated clay, Miocene, Pannonian, Sarmatian, Karpatian, Ottnangian, Várpalota Basin, horizontal displacement, inclination axis, tectonics

Gravity measurements and geological evidences verify the existence of a southward continuation of the Várpalota Browncoal Field. During the years 1986—1989 five deep boreholes were drilled and seismic measurements along two profiles were realized in the region of the villages Ősi, Berhida, Küngös and Csajág. Three research boreholes have intersected Upper Badenian browncoal seam outlining significant coal reserves.

Further important geological results are as follows:

— The geological makeup of the region and the tendencies of facies development have become known and the paleogeographical relationship with the already known northern basin has turned to be clarified.

— The reconnaissance of the tectonic setting of the concerned. By obtaining awareness of the geological structure of the region basin enabled us to draw wide conclusions regarding the structural the tectonics and geokinetics of the whole Neogene basin at Várpalota setting and geo-kinematic conditions of the Várpalota Basin as a whole. The anti-clockwise rotation of the Balatonfő mass resulted in an expansive opening in the westery part of the region and thereby the area of the southern basin subsided. At the same time the northern basin zone belonging geomechanically to the mass of the Balatonfő region "subducted" along the compressive and rightward-directed transcurrent-type Telegdi—Roth lineament thus producing the well-known Várpalota Neogene sedimentary basin (Sárrét, Bántapuszta).

Introduction

In recent years, upon the author's proposal the Institute carried out geological investigations (executing five core drillings with two seismic reflection profiles) in order to verify if the Várpalota browncoal region is continued, in accordance with the previous hypotheses, in a southward direction (Fig. 1).

Consequently, an important increase of the coal resources on which a final report was also written (KÓKAY 1991a), was achieved. Of the boreholes Ber-

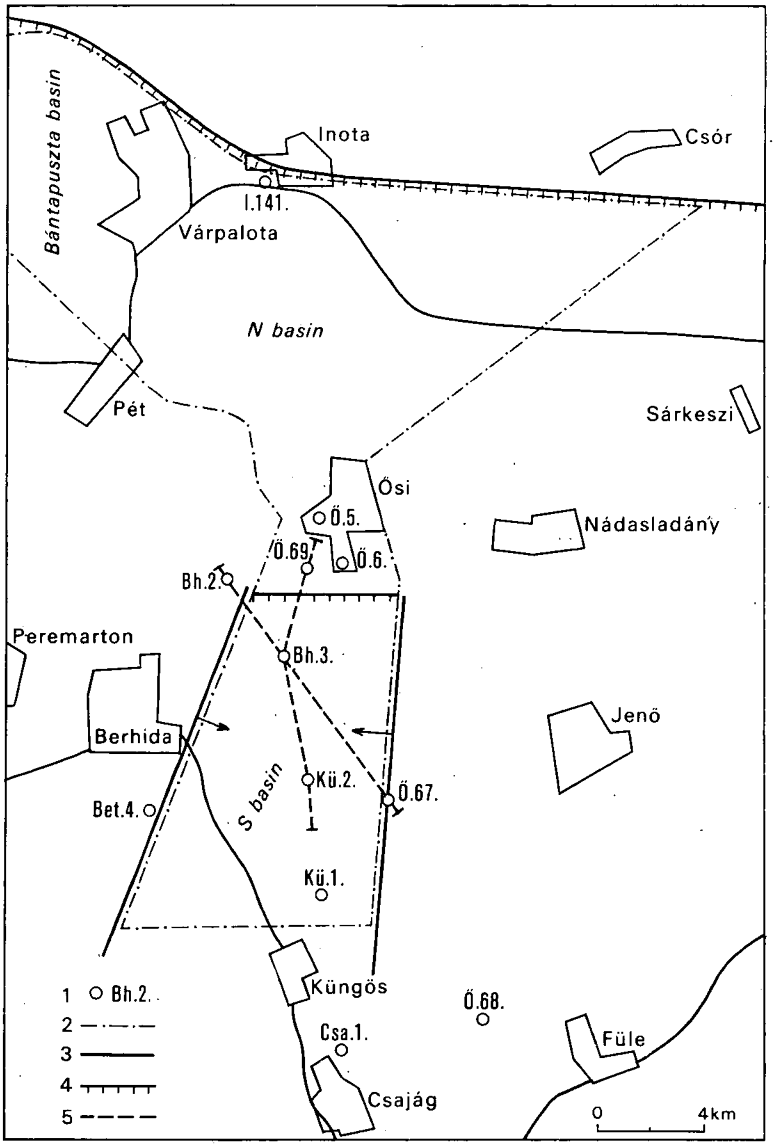


Fig. 1. A generalizing sketch of the Neogene basin of Várpalota

1. locality of boreholes, *2.* boundary of the basin, *3.* tectonic boundary line, *4.* line of sub-duction, *5.* geological profile

1. ábra. A várpalotai neogén medence áttekintő vázlata

1. a fúrások helye, *2.* medence határa, *3.* lehatároló törésvonalak, *4.* alátolódási vonal, *5.* földtani szelvény hida Bh 3 was declared key section and the results of the examinations complemented by paleomagnetic investigations were published (KÓKAY et al. 1991).

The area of exploration includes the Ősi—Berhida—Küngös—Csajág region.

The known Várpalota browncoal basin in the north joins this southern basin sector through a narrow neck by the village Ősi.

The concept for exploration was elaborated on the basis that the southernmost borehole Ő 69 at Ősi was still productive for coal, and whereas towards the south a series of gravity minima was observed indicating presumably a continuation of the basin. From the five boreholes deepened three proved productive for coal (Bh 3, Kü 1 and Kü 2), while Bh 2 and Csa1 indicated marginal position.

Besides the five boreholes deepened within the project, in the course of evaluation the data of the formerly prepared Ő 67, Ő 69 and Bet 4 and other more distant boreholes were used, too. For determining the features of the N-S trending basin and the fracture line delimiting it in the east measurement of two seismic reflection sections were measured by the Roland Eötvös Geophysical Institute (ELGI) (NYITRAI, T. 1987). (The names of the institutions and individuals contributing to the work of the execution, materials testing and evaluation are given in details in the already mentioned final report).

The geological results of the explorations are as follows:

Basement

Contrary to the known Várpalota Basin here it became possible to prove the presence of the waterfree Paleozoic basement. Borehole Bh 2 penetrated the upper part of the Upper Permian (Balatonfelvidék Red Sandstone) sequence while Bh 3 was completed in the lower part of the sequence. Boreholes Kü 2 and Csa 1 reached the Silurian sericitic-chloritic Lovas Shale series under the Miocene formations.

Miocene

Borehole Kü 2 showed that the graben in the deepest part of the southern basin was formed during the Ottnangian through a disjunctive effect of the anti-clockwise rotation of the Balatonfő block (Fig. 2 and 4).

In this graben a 35-m-thick terrestrial variegated clay, older than Karpatian in origin, has accumulated with minor amounts of shale debris at the base. The Karpatian brackish-water sequence with plant fossils was deposited directly on the basement as attested to by borehole section Bh 3 because the concerned drilling was set on the terrace situated W of the oldest graben of deep position. At the same time, in the northern basin, in the forespace of the Telegdi—Roth Line, nearly 100-m-thick marine deposit was settled down. Accordingly, the Ottnangian marine sedimentary sequence of the northern basin (KÓKAY 1971,

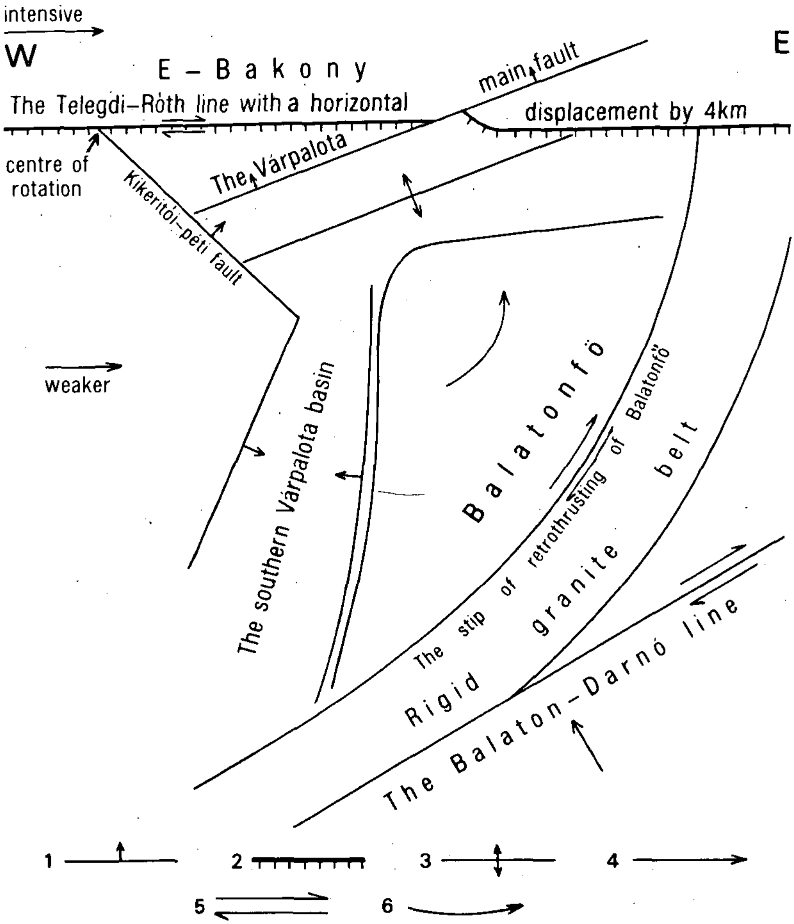


Fig. 2. **Geomechanical sketch of the rise of the Neogene basin of Várpalota**
1. disjunctive fault, *2.* compressive fault, *3.* inclination axis, *4.* vestor of the active force, *5.* relative displacement, *6.* rotation

2. ábra. **A várpalotai neogén medence keletkezésének geomechanikai vázlata**
1. diszjunktív törés, *2.* kompresszív törés, *3.* inklinációs tengely, *4.* aktív erő íránya, *5.* relatív eltolódás *6.* rotáció

1991b) and the under the Karpatian terrestrial sequence of the southern basin from heteromesic facies with each other (KÓKAY et al. 1991, Fig. 3).

The Ottnangian sea did not intrude into the southern basin because of the barrier-type inclination axis developed on account of geomechanical reasons (Fig.2), so that it was invaded by the sea as late as in Karpatian time only.

The bed sequence deposited by the Karpatian sea starts with sandstone of brackish-water origin containing plant fossils, silt and carbonaceous clay with variegated clay, thick, tuffaceous and bentonitic beds, thinning out towards the

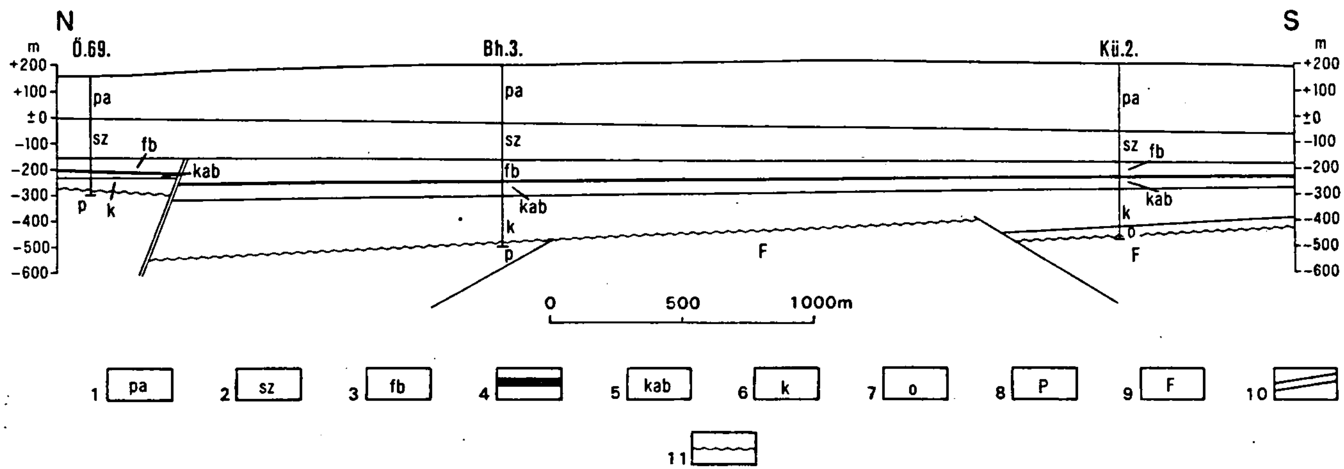


Fig. 3. Geological profile across the southern Várpalota basin

1. Pannonian s. l., *2.* Sarmatian, *3.* Upper Badenian, *4.* Coal seam, *5.* Middle-Lower Badenian, *6.* Karpatian, *7.* Ottnangian, *8.* Permian, *9.* phyllite, shale, *10.* dexhal fault, *11.* unconformity

3. ábra. Földtani szelvény a várpalotai déli medencében

1. pannóniai s. l., *2.* szarmata, *3.* felsőbádeni, *4.* széntelep, *5.* középső-alsó-bádeni, *6.* kárpáti, *7.* ottnangi, *8.* perm, *9.* fillit, agyagpala, *10.* szerkezeti vonal jobbos eltolódással, *11.* diszkordáns település

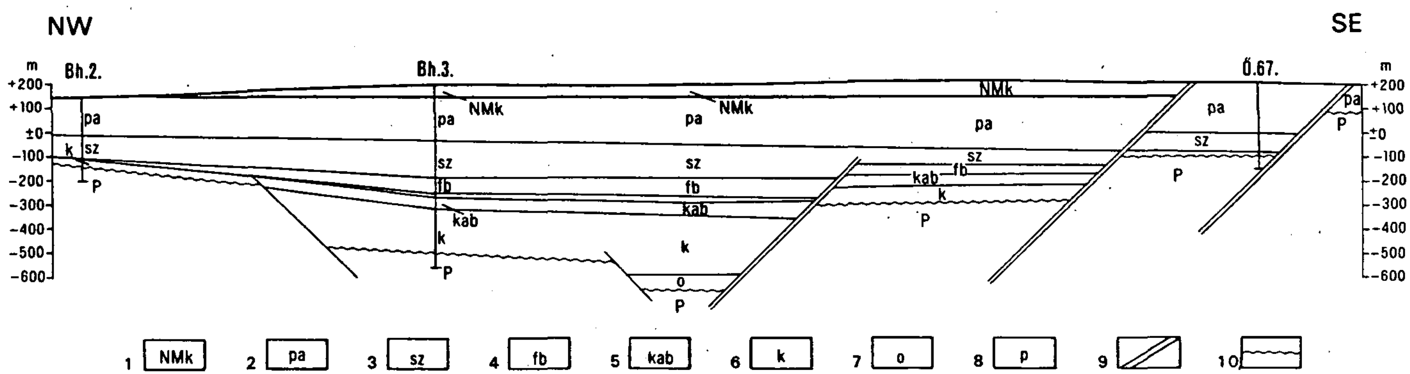


Fig. 4. Geological profile set S of the village Ősi

1. Nagyvázsony Limestone Formation, *2.* Pannonian s. l., *3.* Sarmatian, *4.* Upper Badenian with a coal deposit at the base, *5.* Middle Badenian, Lower Badenian, *6.* Karpatian, *7.* Ottnangian, *8.* Paleozoic, *9.* horizontal tectonic displacement, *10.* unconformity

4. ábra. Földtani szelvény Ősi községtől délre

1. Nagyvázsonyi Mészkő Formáció, *2.* pannóniai s. l., *3.* szarmata, *4.* felsőbádeni a bázison szénteleppel, *5.* középső-bádeni, alsó-bádeni, *6.* kárpáti, *7.* ottnangi, *8.* paleozoikum, *9.* törésvonal horizontális eltolódással, *10.* diszkordáns település south. The thickness of the sequence is 626.6—671.8 m and 593—617 in borehole sections Bh 3 and Kü 2, respectively. In Kü 1 the series corresponding to the brackish-water sequence is terrestrial. The marine series begins with a 20-30-m-thick schlier-type claymarl with sand and gravel intercalations upwards. The thickness of the whole Karpatian is 173.5 m in Bh3, 134.6 m in Kü 2, nearly 100 m in Kül (of which 51.5 m is marine). According to the drillings Bh 2 and Bet 4, the basement is immediately overlain there by a thin Upper Karpatian bed.

In the upper third part of the Karpatian some-m-thick dacite tuff is deposited, sometimes in two beds. Its K/Ar age is 17.6 ± 0.7 m.y.in the Bh3, 16.6 ± 0.6 m.y. in the Kü 1, and 15.9 ± 1.8 m.y. in the Kü 2 drilled sections. The marine Karpathian sequence is overlain by a 2—10-m-thick terrestrial complex composed predominantly of variegated clay assignable, according to the present author, to the lower part of the Lower Badenian substage (KÓKAY 1987). This is transgressively overlain by with typical "Szabó quarry" molluscan shells of the early Badenian sea, attaining a combined thickness of 22 m thick in borehole Bh 3, 14.6 m in Kü 2, and 9.5 m in Kü 1. On the marine Lower Badenian it rests a unit of terrestrial silt, clay and sand, considered by the author as classifiable into the Middle Badenian substage (KÓKAY 1987). Its thickness is 19 m and 11.2 m in borehole sections Bh 3 and Kü 2, respectively. The Upper Badenian sedimentary sequence overlies the terrestrial Middle Badenian as a result of the tectonic subsidence of the whole Várpalota Basin, with the basal Várpalota browncoal seam. According to I. ELEK, who studied this seam coal-petrologically in the drilled section Bh 3 the formation coal seam in the southern basin strated with a deep swamp facies with lots of drift-wood instead of forest swamp facies as it is true for the N basin (KÓKAY 1967 a). The uppermost part was formed in a shallow swamp environment. Afterwards a long-lasting deepening started and thus the coal formation came to an end. In its lower part the deposit includes clayey intercalations alternating with xilitic and huminitic sections. Its thickness from N to S (Bh 3, Kü 2, Kü 1) is decreasing but obviously it is the same toward the E and W margins. In the southern basin the ash content of the coal is higher and the humidity is lower than in the northern basin while the calorific value is similar. The greater ash contents can be explained by the fact that here the paleoenvironment was largely constituted by Paleozoic rocks producing much pelite due to weathering (mainly claymarl), instead of Triassic carbonate basement rocks.

On the coal seam it rests a span-thick band with molluscan shells. While in the northern basin *Congeria boeckhi* is predominant, here the forms *Bithynia vadászi-Theodoxus crenulatus várpalotaensis* are frequent.In boreholes Bh 3 and Kü 2, 3-m-thick alginite, alginitic clay marl followed on the mollusc-bearing bank (Solti 1983) with some white-coloured and laminated lime precipitaties indicating the significant delepening of the sedimentary basin. On the alginitic layer dacitic tuffite was deposited by one or two to three beds, showing a thickness of 6.7 m in section Bh 3. It is missing in borehole Kü 1. Its K/Ar age in borehole section Bh 3 is 15.0 ± 0.6 m. y., the average age in the basin is 14.2 m. y. This age dated corresponds to the beginning of the Late Badenian.

The alginitic claymarl becoms silty upwards, then, in the upper third part of the basin sequence finely-grained sandbeds with parallel cleavage planes appear, which are unknown in the northern basin. The Upper Badenian series is by some-m-thick freshwater clay which is mostly huminitic and bentonitic. The total thickness of the Upper Badenian together with the coal deposit is 83 m in borehole B 3, 65.2 m in Kü 2, and 32.6 m in Kü 1. In boreholes Bet4 and Ósi67, as hardly distinguishable from the under/overlying terrestrial strata limy-argillaceous rocks a few metres thick are present, displaying a marginal facies and fossils of *Congeria boeckhi.*

On the Upper Badenian sequence the terrestrial variegated-clayey, subordinately sandy and gravelly layers of the Sarmatian Gyulafirátót Formation are deposited (KÓKAY 1954). The thickness of the formation, from N to S is gradually decreasing. In borehole Bh 3, the Sarmatian rests upon the Upper Badenian with coarse gravel, testifying thereby to the significantly increased relief energy caused by intensive earth crust motions in several zones of the basin (KÓKAY 1956, 1968, 1976, 1985). At the same time, in borehole Kü 2, deepened at a site of the centre line of the basin this stratigraphic boundary is not sharp.

The older units of the Sarmatian marine series deposited on the terrestrial sequence represent the Kozárd Substage. Towards S it is described by thickening and increasingly argillaceous sediments with thin (max. 5 cm) pearl-white gypsum laminae. Upon its macrofauna it can be well-distinguished from the younger Sarmatian. The youngest formations of the Sarmatian sequence belong to the Tinnye Substage, generally with higher lime contents. Northwardly, marine beds are interfingering with the variegated-clayey-gravelly sediments of the Gyulafirátót Formation.

At the Sarmatian-Pannonian boundary, at places, there are variegated-clayey and marly substances showing evidences of desiccation and Oxidization, however, the pertaining sedimentation can be taken as unbroken at large, according to the paleomagnetic studies of M. LANTOS (KÓKAY et al. 1991).

Of the 1-2-m-thick Sarmatian—Pannonian boundary formations very characteristic are the small, densely ribbed Cardium form, the small *Modiolus incrassatus*, the *Melenopsis impressa* and the mass occurrence of the Foraminafera *Rotalia beccarii*. Practically, on a conventional basis the boundary is traced by a 1-5-cm-thick dacitic tuff layer at about the middle line of the formation. K/Ar age of the dacitic tuff is 12.0± 0.6 m. y. in borehole section Bet 4.

The Pannonian sequence is described here, first of all, on the basis of Á. JÁMBOR's (1980) comprehensive study. The Sarmatian sediments are followed by Lower Pannonian ancient variegated clay with bands of carbonaceous clay and line mud, sometimes with fossils. They are mainly coastline sediments that had been subjected to desiccation, rarely with gypsum rosettes of evaporitic origin. Towards NW the differentiation of the ancient variegated clay from the Gyulafirátót Formation is problematic.

On the Ancient Variegated Clay gray Lower Pannonian marine series is deposited with differently developed horizontal and vertical formations representing the Csór Aleurite, Zámor Gravel and Csákvár Claymarl lithostratigraphic units. Typical fossils are *Congeria czjzeki*, and sole markings after Pectinaria and Arenicola. The lower part of the Upper Pannonian sequence is the sandy-silty-claymarly series of the Tihany Formation, from down upwards with *Congeria ungulacaprae*, *Congeria balatonica* and all the Tihany molluscan assemblage characteristic of the formation.

The Pannonian sequence is closed by the Nagyvázsony Limestone Formation reffering to the desalinification of the inland sea. Subordinately, it includes freshwater limestone, calcareous marl and calcareous ooze alternating with sand, silt yellow-coloured by oxidation and sandy marl, somewhere with freshwater and terrestrial molluscan shells.

The Quaternary is represented by loess and, on the NW margin, along the Séd brook, with Holocene gravelly alluvial deposits.

Tectonics

The Neogene sedimentary basin of Várpalota were formed by tectonic movements (Fig. 2) starting in the Ottnangian in harmony with the intensive orogenic movements started in the Alpine—Carpathian region. The whole Central Range moved periodically in E-NE directions producing also zones of retrothrusting (KÓKAY 1990). As for the movement direction, the primary retrothrusting zone is that of Balatonfüzfő which archly joins the Balaton—Darnó Line. The deep-situated plastic semi-plastic region of the Alps of counter-wing constitution expanded in a lateral direction yielding to the pressure exerted by the African Mass on the block of Bakony, as it is general geomechanical law in case of the mountain-building development of this type referred to (KÓKAY 1986). The c. W-E trending direction of the active force includes an angle with the transcurrent Balaton—Darnó lineament.Therefore the arched dislocation surface of Balatonfő also had played the role of a dextral slinding surface. Thus the Balatonfő mass rotating along an arched fault surface (together with the N Várpalota basin) subducted, compressively, beneath the Bakony along the northern margin i.e. the Telegdi—Roth Structure Line.

Consequently, a "foredeep-type" depression was formed (KÓKAY 1976) filled with Neogene sequence some hundred metres thick (northern Várpalota Basin).

At the same time, the Balatonfő mass is open on its W side because expansion produced a sedimentary catchment trench bordered by listric fracture planes (Fig. 4). This is the Várpalota S basin. For the full understanding of this phenomenon we are to presume that a force acting from S on the Balaton—Darnó Line must have played on important part. The Telegdi—Roth Line, however, is not only of compressive type but also a dextral-horizontal fracture because the mass situated N of it moved quicker. Along fracture plane, as early as from beginning of the Ottnangian a ca. 4-km-long righthand transcurrent dislocation took place (KÓKAY 1985, K. Telegdi—Roth 1934). The subduction of the Balatonfő platform and its dextral motion upon compression started in the Ottnangian. Due to the subsidence of the basin platform of the sedimentary basin formed so an inclination axis ("rotation axis", KÓKAY 1976), a pseudo-anticline came into existence. Later, as a result of the anti-clockwise rotation of the Balatonfő mass the inclination axis turned away. At the beginning of the Ottnangian it necessarily had to be parallel with the then newly opened Telegdi—Roth Line. At present it includes an angle of 25° with the Telegdi—Roth Line. The zone along the line of inclination axis may have acted as a ridge or barrier preventing the progress of the transgression of the Ottnangian sea, thus the trench formed along the centre line of the S basin was filled up by terrestrial sediments (borehole Kü 2). The sea advanced over the strip of the inclination axis for the first time in the Karpatian forming a fjord-type gulf stretching into at first depositing sediments with plant remains and, in some strata, fossils of brackish-water origin.

The Neogene sedimentary basin of Várpalota and the related browncoal deposits consist of, as indicated above, two basically well distinguishable structural units: the well-known northern and the newly discovered southern basins. The northern basin is divided into two parts by the Upper Pannonian disjunctive-type Várpalota main structural line of a throw of 300—400 m that is still active, namely the NW sector of basin (Bántapuszta) and the SE sector (Sárrét).

The Várpalota Basin, in the background of the Balatonfő region, was active as generating intensive crust movements. Both the main phases and the subphases of the Neogene tectonic activity were joined with strong displacements. These events, were varied and combinal in time and space (Table 1).

The Neogene units show an undisturbed mode of occurrence in the S basin. The basement of the southern basin dips towards N and the bed sequences are thickening. It is well proved by the N-S geological profile. The tectonic lines closing the southern basin from E and W are of disjunctive type. The norther, structurel line may represent a compressive dislocation (reverse fault or down thrust, or flexure also with some horizontal shift, as a continuation of the E-W, probably compressive Papkeszi line. The vertical size of the boundary tectonic elements are shown in the attached geological (Fig.3 and 4).

The Ottnangian, Karpatian and Badenian seas reached the Várpalota Basin from the east. In the Middle Badenian no connection was established with the open sea and only terrestrial sediments were deposited in the deep structural strips of the sedimentary basin (KÓKAY 1987).

In the Sarmatian, however, due to the rotation of the Balatonfő block the eastern connection was closed and, instead, the southern basin was opened to such an extent that the sea rushed in from the south. As the result of the extremely intensive orogenic activity compressive types can also be indicated (KÓKAY 1968). Most conspicuous is, however, is the emergence of the main structure line of Várpalota, north of which, as the relic of the Pannonian inland sea, a freshwater sequence (Nagyvázsony Formation) developed (KÓKAY 1956). This fault line gives the tectonic backside of the assymetric wedge structure

(KÓKAY 1968, 1976, 1985). Eastern tectonic line that delimitates the southern basin in the east was also renewed and a freshwater sequence belonging to the Nagyvázsony Formation was deposited also here.

Táble 1 — 1. táblázat

Neogene tectonic movements in the Várpalota Basin region
Kimutatható neogén tektonikai mozgási szakaszok a Várpalotai-medence körzetében

Age	Verified places
1. Ottnangian:	Sinking of the central zone of the southern basin
2. Ottnangian-Upper Badenian:	N boundary line of the southern basin
3. Ottnangian-Sarmatian:	Kikerítő transversal fault
4. Ottnangian-Holocene:	Telegdi—Roth Line, inclination axis, Balatonfő structure line
5. Karpatian-Lower Badenian:	W boundary line of the southern basin
6. Karpatian-Sarmatian:	Pét transversal structure line
7. Karpatian-Upper Pannonian:	Structure line No.I of the E part of the southern basin
8. Lower Badenian:	The Bántapuszta erosional valleys with the older Miocene elevation
9. Upper Badenian:	The boundary line of the Uj-Ferenc mining district along the Pét fault
10. Upper Badenian-Upper Pannonian:	Structure line No.II of the E part of the southern basin
11. Sarmatian:	Sub-sliding in the S part of the Bántapuszta basin, the horst between the Uj-Ferenc and Öreg-Cser mines; flexure in borehole I-128/A
12. Pannonian-Holocene:	The main structure line of Várpalota; the Uj-Ferenc transversal fault; sediments of the Nagyvázsony Formation in the N and S grabens

REFERENCES — IRODALOM

DUDKO, A. 1988: Tectonics of the Balatonfő—Velence area (Hungary). — Földt. Int.. Évk. 62.

JÁMBOR, Á. 1980: A Dunántúli Középhegység pannóniai képződményei. — Földt. Int. Évk. 62.

KÓKAY, J. 1954: Le Sarmatien de Várpalota. — Földt. Közl. 84: 29—40.

KÓKAY, J. 1956: Tektonische Bewegungsverhälnisse in der Umgebung von Várpalota. — Földt. Közl. 86: 17—27.

KÓKAY, J. 1968: Tectonic theories in the light of Bakony Mountains evidence. — Földt. Közl. 98: 381—392.

KÓKAY, J. 1973: Bántapusztaer Schichtengruppe — in: PAPP, A.—RÖGL, F.—SENE, J.: M_2 Ottnangien (Chronostratigraphie und Neostratotypen, III. Bratislava, Slowak. Akad. Wiss.)

KÓKAY, J. 1976: Geomechanical investigation of the southeastern margin of the Bakony Mountains and the age of the Litér fault line. — Acta Geol. Acad. Sci. Hung. 20: 245—257.

KÓKAY, J. 1985: Tectonic and geomechanical studies in the Bántapuszta Basin (Várpalota, Bakony Mountains). — Földt. Int. Évi Jel. 1983-ról: 43—50.

KÓKAY, J. 1987: Stratigraphic subdivision and paleographic reconstruction of the Badenian at Várpalota. — Földt. Int. Évi Jel. 1985-ről: 235—241.

KÓKAY, J. 1990: Middle Badenian Rocks in Budapest. — Földt. Int. Évi Jel. 1988-ról: 101—108.

KÓKAY, J. 1991a: Összefoglaló földtani jelentés a Várpalota Dél barnakőszén terület előkutatásáról. — Földt. Int. Ad. (kézirat).

KÓKAY, J. 1991b: Stratigraphische Revision der unterund mittelmiozänen Bildungen des Beckens von Várpalota (Bakony—Gebirge). — Jubileumsschrift 20 Jahre Geol. Zusammenarbeit Österreich — Ungarn. Teil 1. Geol. Bundesanstalt, Wien: 101—108.

KÓKAY, J.—HÁMOR, T.—LANTOS, M.—MÜLLER, P. 1991: The paleomagnetic and geological study of borehole section Berhida 3. — Földt. Int. Évi jel. 1989-ről: 45—63.

NYITRAI, T. 1987: Jelentés az Ősi—Küngös környéki szeizmikus reflexiós mérésekről. (MÁELGI, kézirat).

SOLTI, G. 1983: A várpalotai olajpala. — Földt. Int. Évi Jel. 1981-ről: 249—265.

TELEGDI ROTH, K. 1934: Adatok az Északi Bakonyból a Magyar Középső Tömeg fiatal-mezozoos fejlődéstörténetéhez. — Math. és Term. Tud. Ért. 52: 205—252.

A VÁRPALOTAI DÉLI NEOGÉN MEDENCE (BAKONY-HEGYSÉG)

KÓKAY JÓZSEF

Magyar Állami Földtani Intézet
Budapest, Stefánia út 14.
H-1143

ETO: 553.06(439.117):623

Tárgyszavak: litosztratigráfiai, biosztratigráfiai, Mollusca, K/Ar vizsgálatok, dácittufa, szénképződés, tarkaagyag, miocén, pannóniai, szarmata, bádeni, kárpáti, ottnangi, Várpalotai medence, horizontális eltolódás, inklinációs tengely, tektonika.

A Földtani Intézet utóbbi években történt földtani kutatási munkálatainak eredményeként (mélyfúrási és szeizmikus reflexiós mérések) feltártuk az addig ismeretlen várpalotai neogén barnakőszén medence déli folytatását. A kutatás nem csak jelentős szénvagyon növkedést eredményezett, hanem az egész várpalotai neogén medence genetikájára, szerkezeti felépítésére és ősföldrajzi kapcsolataira vonatkozóan új ismereteket jelent, illetve egyes korábbi feltételezéseket igazol. A kutatási eredmények egyértelműen bizonyítják a Kárpát-medencében a miocén folyamán végbement nagyon jelentős földkéregmozgásokat. A déli medence a Balatonfő terület Ny-i oldalán az óramutató járásával ellentétes irányú rotációjának hatására keletkezett expanzió eredményeként szakadt be.

GEOLOGICAL EVOLUTION HISTORY OF THE LATE PANNONIAN EGYHÁZASKESZŐ CRATER, W HUNGARY

by

GYÖRGY CSIRIK

Hungarian Geological Survey
Budapest, Stefánia út 14.
H-1143

UDC: 551.782.2 (551.263.037)

Keywords: Pliocene, basaltic volcanism, basaltic tuffite, alginite, bentonite, geological history, North-West Hungary, Egyházaskesző

The description of geological history of the Egyházaskesző crater is based on the well logs of 32 boreholes and on a detailed study of core material taken from 2 holes drilled during the intensive investigation done after its discovery in 1986 (SOLTI, 1988) (Fig. 1).

The formation of the Egyházaskesző crater as a part of the Magyargencs—Malomsok basaltic volcanic region is related to the rejuvenative volcanism of Late Pannonian (Pliocene) time in the Carpathian Basin (BENCE et al. 1979) (Fig. 2).

The following main phases can be distinguished in the geological history of the Egyházaskesző crater (Fig. 3): Phase I. Formation of volcanic structure (Fig. 2 and 3); Phase II. Deposition of basaltic tuffite (Fig. 3 and 4); Phase III. Deposition of oil shale (Fig. 3); Phase IV. Deposition of basaltic bentonite containing bone fragments and plant remnants (Fig. 3); Phase V. Deposition of basaltic bentonite (Fig. 3); Phase VI. Changes in the Quaternary (Fig. 3).

Introduction

The description of geological history of the Egyházaskesző crater is based on the well-logs of 32 boreholes and on a detailed study of core materials from 2 holes drilled during the intensive investigation done after its discovery in 1988 (SOLTI 1988).

From the references on volcanic successions the work of CAS & WRIGHT (1989), and from those on the clay sedimentology the paper of CHAMLEY (1989) were used in the interpretation.

Phase I. Formation of the volcanic structure

There is not any natural or artifical exposure available in the volcanic structures called maars in Hungary (Pula, Gérce, Egyházaskesző, Várkesző, Sitke, Szany, Outer and Inner Lakes in the Tihany Penninsula of Lake Balaton)

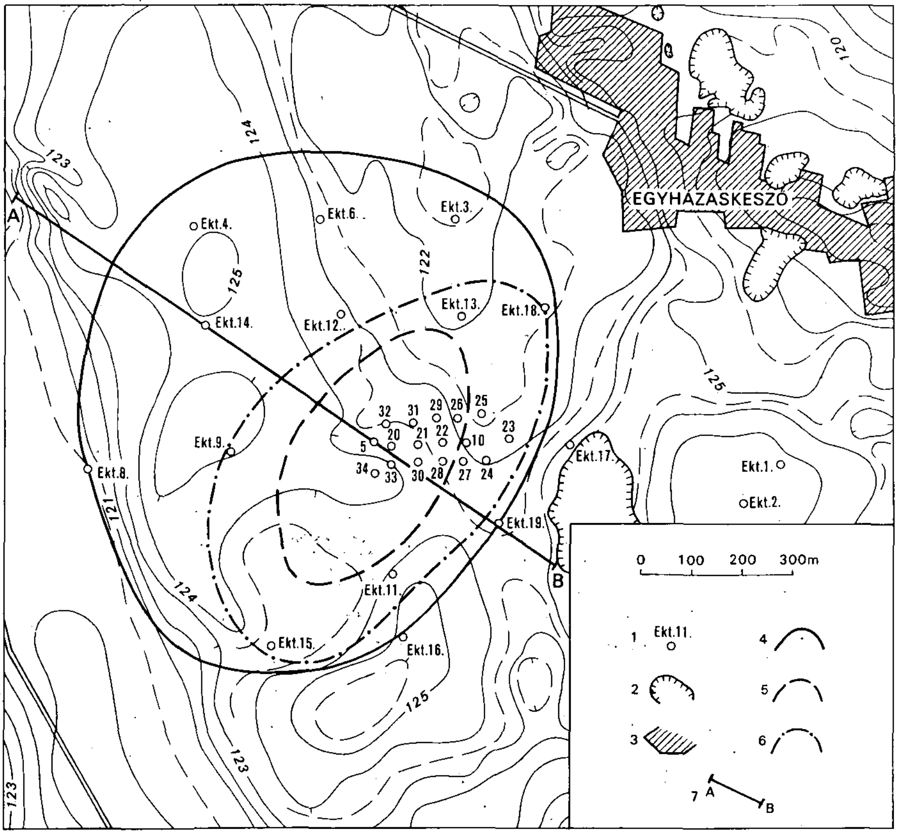


Fig. 1. Map of the Egyházaskesző crater. (after G. SOLTI)

1. bentonite-prospecting borehole, *2.* basaltic tuff quarry, *3.* urban area, *4.* boundary of crater, *5.* boundary of alginite (Phase III), *6.* boundary of basaltic bentonite (Phase V), *7.* geological cross-section

1. ábra Az egyházaskeszői kráter térképe (SOLTI G. után)

1. bentonitkutató fúrás, *2.* bazalttufa bánya, *3.* település, *4.* kráter jelenlegi határa, *5.* alginit elterjedési határa (III. fázis), *6.* bazaltbentonit elterjedési határa (V. fázis), *7.* földtani szelvény nyomvonala

to determine which morphological element of the basaltic phreatic or phreatomagmatic activity they belong to.

The maar-like craters are usually monogenetic and are formed by phreatomagmatic or phreatic eruptions (CAS & WRIGHT, 1989).

The Magyargencs—Malomsok basaltic volcanic region is related to the rejuvenative basaltic volcanism of the Late Pannonian (Pliocene) in the Carpathian Basin (BENCE et al. 1979).

Tectonically it can be connected with the Rába megatectonic line separating the Alpine-type units from the Transdanubian-type units. A fault was determined along the Marcal valley (JUGOVICS 1972). The Magyargencs—Malomsok basaltic volcanic region is situated at the intersection of these two tectonic lines.

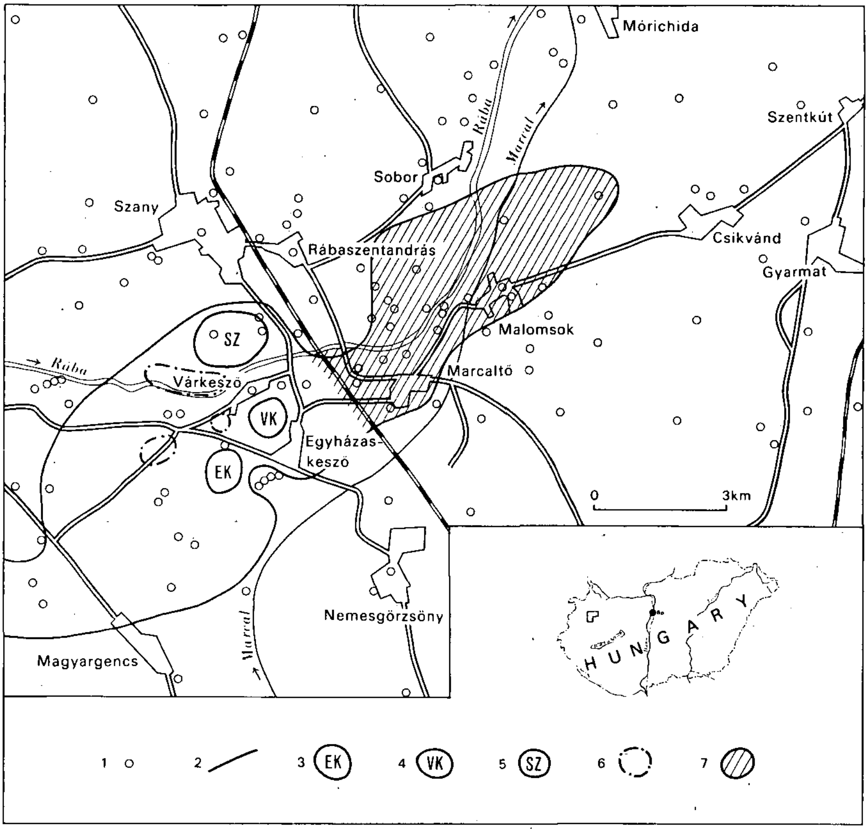


Fig. 2. The Magyargencs—Marcaltő basaltic volcanic region

1. different kinds of boreholes, *2.* the boundary of the Magyargencs—Malomsok basaltic volcanic area *3.* Egyházaskesző crater, *4.* Várkesző crater, *5.* Szany crater, *6.* otther presumed craters, *7.* Malomsok—Várkesző basalt plateau

2. ábra. A Magyargencs—Marcaltői bazaltvulkáni terület

1. különböző kutatófúrások, *2.* A Magyargencs—Malomsok bazaltvulkáni terület határa, *3.* egyházaskeszői kráter, *4.* várkeszői kráter, *5.* szanyi kráter, *6.* feltételezett kráterek, *7.* Malomsok—Várkesző bazaltplató

Due to the interaction between the basaltic magma and the water stored in the sand beds of the Upper Pannonian sedimentary complex, pyroclasts were produced. These pyroclasts form maar-like volcanic structures.

Phase II. Deposition of basaltic tuffite in the Egyházaskesző crater lake

After the eruptions had finished, the Egyházaskesző crater got to be filled up by water encroaching through the permeable basaltic tuffs. The connection was permanent during this phase.

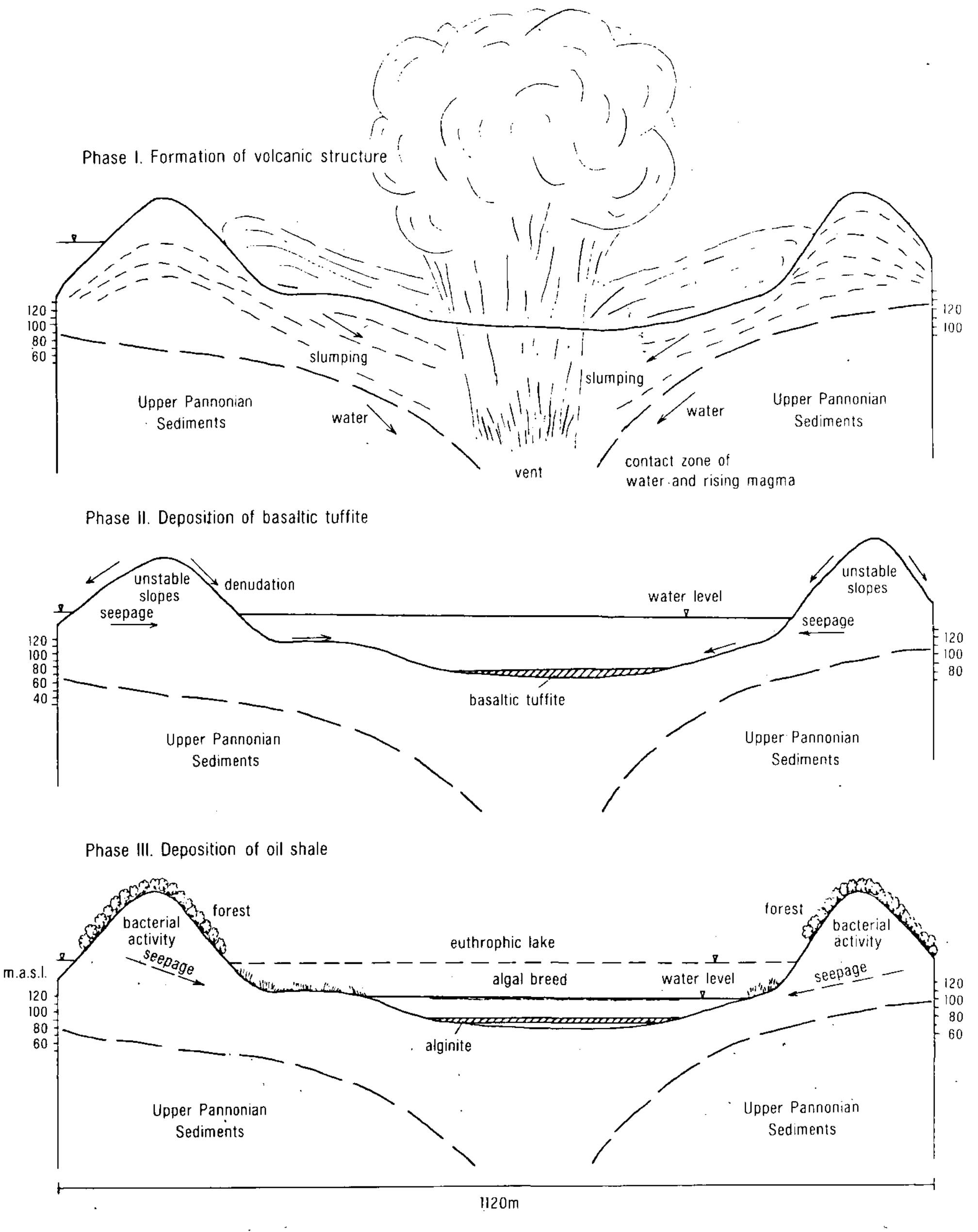
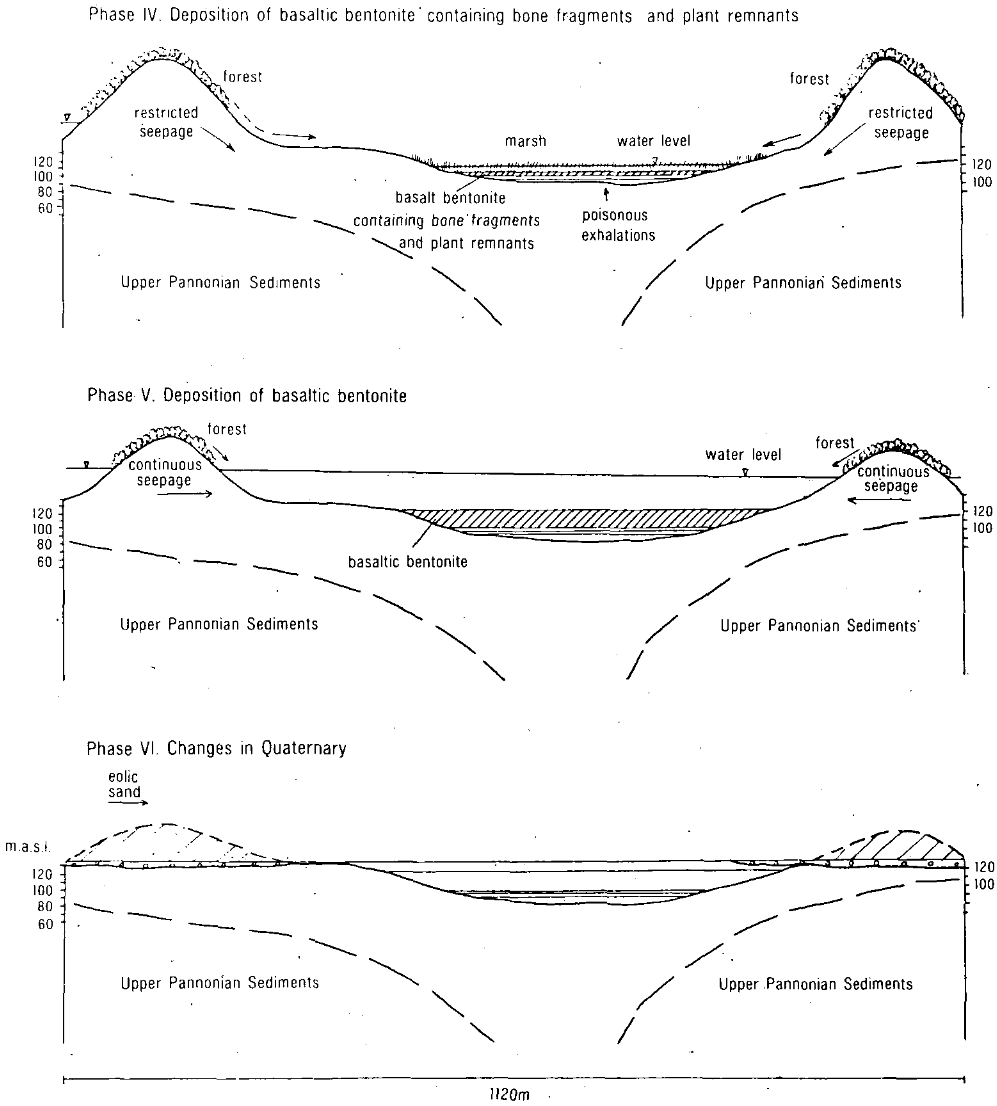


Fig. 3. The main phases in the geological

3. ábra. Az egyházaskeszői kráter fejlődés



evolution of the Egyházaskesző crater
történetének fő fázisai

Immediately after the formation of the Egyházaskesző crater the physical alteration begun, and the smectite formation was subordinate. Basaltic tuffite was deposited by the weathering of the basaltic tuff in the steep outer and inner slopes and by the transport into the crater lake and Pannonian sea. The sediments were transported by the mass flows on the unstable surficial and subaqueous slopes.

Due to the climatic conditions and/or large ash falls, and/or high transportation energy caused by the steep crater walls, and/or the lack of the vegetation the basaltic tuff could not have altered into clay so that basaltic tuffite was deposited. Coarser materials could have reached the lake owing to the lack of vegetation on the shore and to the steep crater walls. The settlement of plants might have been facilitated by the higher degree of maturity of the sediments in the later phases.

Without detailed petrological studies the differentation between the basaltic tuff deposited in crater lake and basaltic tuff forming the wall rock of the crater can hardly be made in certain cases.

Phase III. Deposition of oil shale

The sediments with higher content of smectite have restricted the seepage from the Pannonian sea so that the transpiration caused by sunlight and internal thermal energy of the crater exceeded the supply by rainfall and seepage. Therefore the lake must have become volcanic alkaline salt lake in which real evaporites could not have been precipitated. The oil shale covers smaller area than the basaltic bentonite above it (Fig. 1). The oil shale has been formed by the algal mat deposited as widely as the area it had occupied in a quiet euthrophic lake.

The presence of the alkaline salt lake is evidenced by the presence of zeolite (2 to 5 %) in the oil shale. The zeolite is authigenic in formation in the alkaline volcanic salt lakes (CHAMLEY, 1989). The possibility of an early diagenetic formation of the zeolites during the desiccation of the crater lake after the deposition of the oil shale cannot be excluded.

The ostracods in the oil shale in borehole Egyházaskesző Ekt 5 were studied by A. KORECZ (1987). A few ostracods in relatively good state of preservation were found as representing five species: *Candona* (Candona) cf. *neglecta* G. O. SARS JUV., *Candona* (Pseudocandona) *albicans* BRADY, *Ilyocypris brady* SARS, *Ilyocypris gibba* RAMDOHR, and *Potamocypris maculata* ALM. These species prefered shallow, occassionaly drying environment with water depth 0 to 10 m and salt content of 0 to 2 percent and in rich vegetation (KORECZ 1987).

Phase IV. Deposition of bentonite containing bone fragments and plant remnants

The presence of the bentonite containing bone fragments and plant remnants may indicate marshy or very shallow depositional environment. This environment may have served as a drinking and eating site for animals. Sometimes some gaseous exhalations may have killed the animals and the predators have caused the fragmented nature of the bones in this low energy environment.

Smectite has been formed from the volcanic subamorphous material. This smectite was unstable in this environment with low values of pH and was converted into an illite-smectite mixed layer structure and later into illite by the incorporation of potassium, and then into kaolinite-smectite mixed layer structure and, later, into kaolinite by the incorporation of magnesium. The marshy environment has changed the pH values from a higher (alkaline) to a lower (acidic) one.

Phase V. Deposition of basaltic bentonite

The deposition of basaltic bentonite in the Egyházaskesző crater was controlled by the following factors.

The parent rock of the basaltic bentonite was the basaltic tuff on the inner slope. The glass and the minerals in the volcanic rocks were unstable on the surface. The water migration rate and the temperature in the porous basaltic tuffite were high. Since the crater walls were steep, the wheathering product, the smectite was removed therefore no thick cover restricting the continuation of the process could have formed.

The utmostly important factor attributable to the increasing of clay mineral content is the settlement of the plants.

According to CHAMLEY (1989), the course of the formation of clay minerals in water catchment area or sedimentary basin by authigenic way has not been known yet. Recently, authigenic smectite genesis in an environment with high content of silica and high pH can be observed in Lake Tchad.

In this phase the smectite content increases with fluctuations and at the same time the illite content decreases upwardly. The kaolinite is restricted to the oil shale indicating the acidic character of water chemistry.

An alkaline salt lake was formed during the oil shale phase changing into marshy environment in the phase of the rise of basalt bentonite containing bone fragments and plant remnants.

The number of the factors influencing sedimentation has decreased as evidenced by the uniform mineralogical setting. The watermarked stratification indicating the seasonal change of the depositional conditions cannot be seen.

Phenomena of dessication cannot be found. The homogeneity of the mineralogical composition and the chemistry may refer to the formation of basaltic

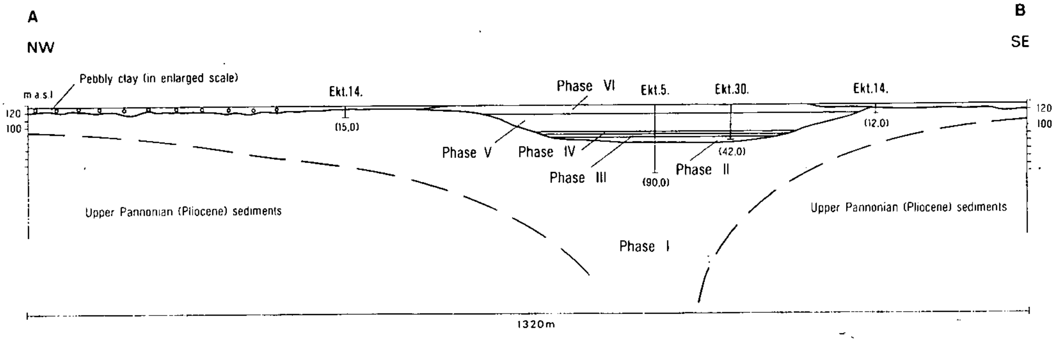


Fig. 4. Geological section setup across Egyházaskesző crater area

Phase I basaltic tuff, *Phase II* basaltic tuffite, *Phase III* alginite (oil shale), *Phase IV* bentonite containing bone fragments and plant remnants, *Phase V* basaltic bentonite, *Phase VI* miscellaneous sediments

4. ábra. Az egyházaskeszői kráter földtani szelvénye

I. fázis bazalttufa, *II. fázis* bazalttufit, *III. fázis* alginit (olajpala), *IV. fázis* csonttöredékes és növénymaradványos bentonit, *V. fázis* bazaltbentonit, *VI. fázis* vegyes üledékek

bentonite from the weathering of the existing volcanic structure and to the lack of the ash falls.

Phase VI. Changes in the Quaternary

Intercalations of basaltic tuffite in the upper part of the complex may refer to the renewal of the volcanic activity in the region.

The quartz content can be related to the silicoclasts of Late Pliocene age. (In the oil shale phase the fine quartz sand transported by the volcanic material from the country rocks was moved into the sedimentary basin by weathering.) For the formation of the uppermost part of the bentonite phase, the effect of the Ice Age is to be taken into the consideration. During this phase the vicinity of the maar-like craters was filled up by the sediments of the Raab fan, and the outer slopes of the craters were much wider and less steep. The beach sands were likely to be transported into the sedimentary basin by wind. It can be mentioned that the Mn content can be related to the variation of quartz content. The increase of the quartz content with undulations probably reflects the effects of the Ice Ages.

The basaltic tuffite in the upper part contains vesiculous basalt fragments in diameter of 3 to 4 cm. These may refer to a nearby ejection.

The crater lake may have been desiccated in the Ice Ages. Several metres of the lake sediments in the uppermost part have been affected by ice movements (cryoturbation) and contain eolic sand layers and ventifacts. The bentonitic surface adhered the pebbles which were polished by the winds blowing from a distinct direction, and then solifluction moved the pebbles into another position. The role of the erosion of the crater lake sediments due to the drying up by ice and blowing away by strong winds cannot be excluded. The events during the Quaternary have not been well understood yet and they still need further studies in the future.

Acknowledgement

I would like to thank dr A. JÁMBOR for his critical reading of the manuscript and his invaluable comments. The work was carried out under the auspices of the Hungarian Geological Survey.

REFERENCES — IRODALOM

BENCE, G.—JÁMBOR, Á.—PARTÉNYI, Z. 1979: A Várkesző és Malomsok környéki alginit (olajpala) és bentonitkutatások eredményei. (Results of alginite (oil Shale) and bentonite prospecting in the vicinity of Várkesző and Malomsok.) — Annual Report of Hungarian Geological Institute of 1977.: 257—267.

CAS, R.A.F.—WRIGHT, J.V. 1989: Volcanic successions. Modern and ancient. — Allen & Unwin. London, Boston, Sydney, Wellington. 410.

CHAMLEY, H. 1989: Clay Sedimentology. — Springer—Verlag. 626.

JUGOVICS, L. 1972: A Kisalföld bazalt és bazalttufa előfordulásai. (Die Basalt und Basalttuffvorkommen der Kleinen Ungarischen Tiefebene.) — Annual Report of Hungarian Geological Institute of 1970.: 79—101.

KORECZ, A. 1987: Jelentés az Egyházaskesző-5 sz. fúrás 38.9—42.3 m közötti szakaszának Ostracoda faunájáról. (Report on Ostracods in interval of 38.9 to 42.3 m in borehole Egyházaskesző-5.) — Hungarian Geological Institute. Manuscript.

SOLTI, G. 1988: Az egyházaskeszői tufakráterben települő bentonit és alginittelep. (Bentonite and oil shale deposit in Egyházaskesző tuff crater.) — Annual Report of Hungarian Geological Institute of 1986.: 379—397.

AZ EGYHÁZASKESZŐ II. SZÁMÚ KRÁTER FÖLDTÖRTÉNETE, FELSŐ-PLIOCÉN, NYUGAT-MAGYARORSZÁG

CSIRIK GYÖRGY

Magyar Állami Földtani Intézet
Budapest, Stefánia út 14.
H-1143

ETO: 551.782.2 (551.263.037)

Tárgyszavak: pliocén, bazaltvulkanizmus, bazalttufit, alginit, bentonit, földtörténet, Kisalföld, Egyházaskesző

Az egyházaskeszői kráter 1986-ban történt felfedezését követő (SOLTI G., 1988) intenzív nyersanyagkutatás során mélyült 32 fúrás rétegsora és 2 fúrás maganyagának széleskörü és részletes anyagvizsgálata lehetővé és indokolttá tette a földtörténeti szintézismunka elvégzését (1. ábra).

Az értékelésnél a vulkáni sorozatokra vonatkozó irodalomból CAS és WRIGHT (1989) és az agyagos kőzetek üledékföldtani irodalomból CHAMLEY (1989) munkáját használtam fel.

Az egyházaskeszői kráter — a magyargencs—malomsoki bazaltvulkáni terület részeként — a Kárpát-medence felső-pannóniai (pliocén) rejuvenációs jellegü bazalt-vulkanizmusához kapcsolódik (BENCE et al., 1979). Tektonikailag a Rába- és a Marcal-vonal kereszteződéséhez köthető (2. ábra).

A kráter a felnyomuló bazaltmagma és a felső-pannóniai üledéksorozatban levő homokrétegek vizének kölcsönhatása eredményeként képződött (I. fázis) (3. ábra).

Az egyházaskeszői kráter vízzel töltődött fel, megkezdődött a kráterfalak fizikai mállása és bazalttufit rakódott le (II. fázis).

Az alginit lerakódása idején a krátertó ideiglenesen zárt, alkalikus, eutróf sóstóvá alakult. A tanulmányozott irodalom szerint az autigén zeolitok képződése lúgos, alkalikus viszonyokat, a kaolinit és illit képződése mocsári, savas kémhatású vízben való lerakódást bizonyít (III. fázis).

A szenes és a csonttöredékes bentonit lerakódása idején a krátertó néhány méter vízmélységű mocsárrá változott, amely az állatok víz- és táplálékszerző helyéül szolgált. A csonttöredékek gázkitörések okozta tömeges elhalást követően a ragadozók tevékenységére utalnak (IV. fázis).

A bentonit a bazalttufa mállástermékeként került a krátertóba. A bazaltbentonit homogenitása az üledékképződési tényezők számának csökkenésére utal (V. fázis).

A feltöltődés befejeződése idején a külső tényezők hatása ismét megnőtt, amelyet a növekvő kvarc- és mésztartalom és bazalttufit-betelepülések bizonyítanak. A legfiatalabb képződményekben a pleisztocén jégkorszakok hatásai is felfedezhetők: krioturbációs poligonok, eolikus homoktelérek, éles kavicsok (VI. fázis). A jégkorszakok során ismeretlen vastagságú üledék pusztult le a fagyás okozta kiszáradás és a defláció miatt. Ennek során tarolódott le a kráter bazalttufa sánca is. A legfelső réteget alkotó fekete bentonit mocsári képződmény. Az események pontos sorrendjének tisztázására további vizsgálatok szükségesek.

UPPER PLIOCENE AND QUATERNARY DEPOSITS IN THE SOUTHERN FORELAND OF THE MÁTRA AND BÜKK MOUNTAINS

by

SÁNDOR JASKÓ

Hungarian Geological Survey
Budapest, Stefánia út 14.
H-1143

UDC: 552.5 (234.373.3./4)
551.781+551.79 (234.373.3./4)

Keywords: Mátra Mts, Bükk Mts, lignite, Quaternary, stratigraphy, stratigraphic units, lithofacies, molluscs, paleogeography

Upon the correlation of data of the lignite exploratory borehole sections drilled in the S foreland of the Mátra and Bükk Mts a precise stratigraphic classification of the Quaternary sequence has been carried out . In dividing the sequence into members the differences in lithofacial characteristics and the molluscan fauna have been proved instrumental.

It has been verified the presence of both tectonic and erosional unconformity developed between the Lower and Upper Pleistocene.

Geological investigations done in the southern foreland of the Mátra and Bükk Mts were first of all devoted to the discovery of lignite deposits.

Relatively little attention was paid to the beds younger than the lignite. For this reason the present study deals with the structure and stratigraphy of the uppermost Pliocene and Quaternary sedimentary sequence offering thereby a contribution to the determination of the thickness and expectable rate of removal of the burden of lignite deposits in an area potentially suitable for open-air mining.

Stratigraphy

The bed sequence of the northern margin of the Great Hungarian Plain is shown in Table I.

The constitution, age and fauna of the Mátra — Bükk Foreland Lignite Formation are discussed in several studies. It is generally agreed that lignite deposits ranging in the S foreland of the Mátra and Bükk Mts all belong to the horizon of oscillating sedimentation of the Upper Pannonian.

The lower part of the Vareigated Clay Formation of the Great Hungarian Plain and the upper part of the lignite-bearing unit are heteropical facies of each other. Where the lignite formation thickens, the variegated clay is fairly thin. Elsewhere, however, the variegated clay is thicker than the lignite deposits. The two units cannot be sharply distinguished. The main difference between them is given by the fact that in the Variegated Clay Formation of the Great Hungarian Plain already there are not significantly thick lignite deposits and the fossil remains become rather scarce.

Table 1 — 1. tábla

Upper Pliocene and Quaternary stratigraphic units in the northern margin of the Great Hungarian Plain

Age	Rock units		
Holocene and Upper Pleistocene	Denudation	Sajóvölgy Gravel Member (fluvial)	
	Intra-Pleistocene unconformity		
Lower Pleistocene and Uppermost Pliocene	Visonta Reworked Volcanics Member (terrestrial)	Tiszapalkonya Gravelly Member (fluvial)	Erdőtelek Clay and Sand Member (freshwater, lacustrine and floodplain sediments)
	Unconformity		
Pliocene	Variegated Clay Formation of the Great Hungarian Plain (terrestrial)		
	Mátra-Bükkalja Lignite Formation (an oscillation of brackish-water, freshwater, lacustrine and swamp sediments)		

Unconformity. Changes in sedimentation. The lignite-bearing formation and the variegated clay each can be detected as displaying largely the same facies in the zone lying at the S foot foreland of the Mátra and Bükk Mts. Beyond this zone, however, a more varied makeup is experienced. Because of a more rugged surface, the one-time deposition also got to be more diversified.

In accordance with the local paleogeographical conditions three different rock-types developed: 1. eruptive rock debris accumulated at the feet of steep hillsides; 2. before the major river-mouths quartzite gravels transported from greater distances were emplaced on the plain; 3. in the gradually subsiding basins an alternating succession of clays and sands of freshwater, lacustrine and flood-plain facies were deposited. The extension in space of the Lower Pleistocene and Uppermost Pliocene members are shown in Fig. 1.

The members are laterally interfingered that is why their boundaries can be drawn only approximately.

The Visonta Reworked Volcanics Member. In the southern foreground of the Mátra and Bükk Mts, materials eroded off the mountain slopes were accumulated and redeposited repeatedly. This formation is generally called "alluvial cone" by geomorphologists.

This name, however, does not reflect precisely the spatial from of the mass of sediment. As a matter of fact, this is not a fan type accumulation formed at the point of a valley where there is a decrease in gradient and showing a thinning out towards the plain. On the contrary, along the feet of the Mátra and Bükk Mts a continuous blanket came into existence with a thickness increasing, instead of decreasing, towards the south i.e. towards the basin. (Fig. 2 and 4)

The best exposure of the sequence consisting of andesite pebbles, redeposited rhyolite tuff and tuffaceous clay is offered by the Visonta Open Pit. Here, from several horizons, from the subsurface depths of 34 m and 9m (uppermost) Pliocene and Early Pleistocene fossil vertebrates were found like *Zygolophodon pavlovi*, *Archidiskodon* sp., *Archidiskodon meridionalis meridonalis*, *Mammuthus* (Parelephas) *trogontherii*, *Bison* sp., (Equus) *Allohippus süssenbornensis* (VÖRÖS, 1982 in: KRETZOI M. et al. 1982).

T h e T i s z a p a l k o n y a G r a v e l M e m b e r. The concerned member consists of the following rocks: quartz gravel and gravelly

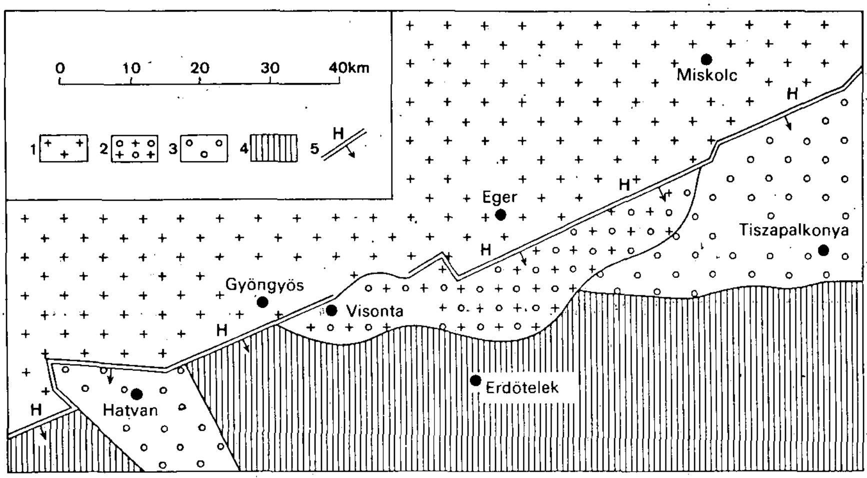


Fig. 1. Areal extent of the Uppermost Pliocene and Lower Pleistocene Members

1. Rocks older than the members referred to, on the surface, *2.* Visonta Reworked Volcanics Member, *3.* Tiszapalkonya Gravelly Sand Member, *4.* Erdőtelek Clay and Sand Member, *5.* boundary fault

1. ábra. A legfelső-pliocén és alsó-pleisztocén korú tagozatok elterjedése

1. A tagozatoknál idősebb kőzetek a felszínen, *2.* Visontai Eruptív Málladék Tagozat, *3.* Tiszapalkonyai Kavicsos Homok Tagozat, *4.* Erdőtelki Agyag és Homok Tagozat, *5.* határvető

sand transported there from more remote areas, alternating with intercalated sandy silt layers. In the region it is present in two areas: in the foreground of the Sajó—Hernád river mouth and at the Zagyva mouth near the town Hatvan. For the description of the layer sequence of the member the depth interval ranging from 28 m to 128 m of the Tiszapalkonya key borehole is exemplified (for its location, see Fig. 1).

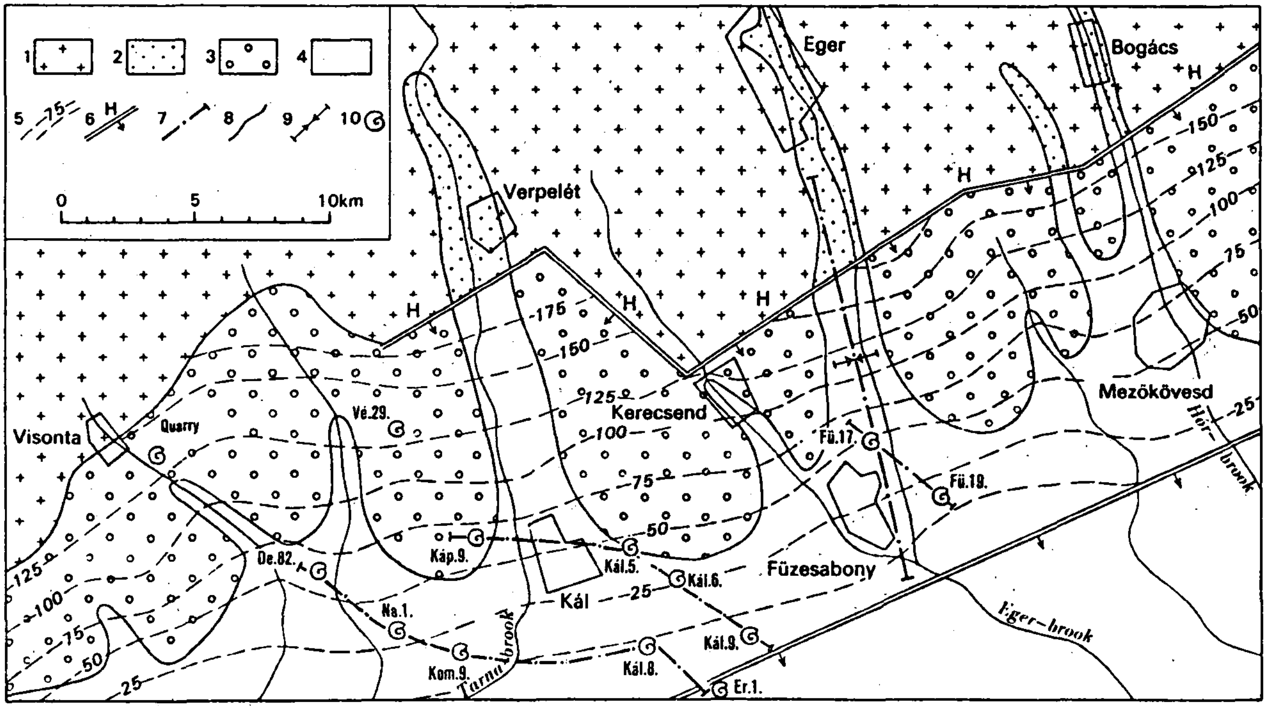


Fig. 2. Sketch map of the foreland of the Mátra and Bükk Mts between Visonta and Mezőkövesd

1. Areas without Quaternary deposition, *2.* Sajóvölgy Gravelly Member deposited directly on Miocene rocks, *3.* Visonta Reworked Volcanics Member, *4.* Sajóvölgy Gravelly Member overlying the Visonta and Erdőtelek Members, *5.* contour lines on base of the Visonta and Erdőtelek Members, *6.* fault; H: boundary fault, *7.* profile direction, *8.* brook bed at present, *9.* intersection of the base level surfaces of the Sajóvölgy and Visonta Members, *10.* localities of the more important finds of fossils

2. ábra. Térképvázlat a Mátra és Bükk tövéről Visonta és Mezőkövesd között

1. Negyedidőszaki lerakódások nélküli terület, *2.* Sajóvölgyi Kavicsos Tagozat közvetlenül a miocén kőzetekre települve, *3.* Visontai Eruptív Málladék Tagozat, *4.* Sajóvölgyi Kavicsos Tagozat a Visontai és az Erdőtelki Tagozat fedőjében, *5.* Visontai és az Erdőtelki Tagozat bázisának szintvonalai, *6.* vetődés, *H:* határvető, *7.* szelvényirány, *8.* jelenlegi patakmeder, *9.* Sajóvölgyi és Visontai Tagozat talpának egymással metszése, *10.* fontosabb kövületlelőhelyek

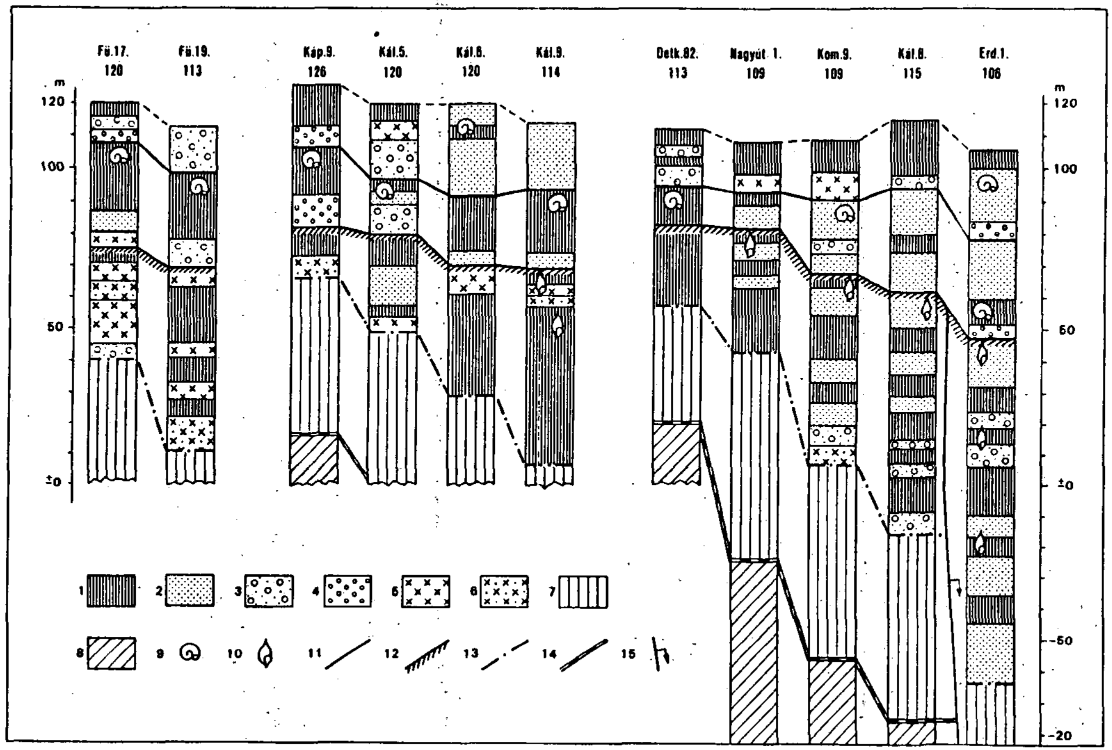


Fig. 3. Columnar sections of Quaternary molluscan beds drilled

1. clay, *2.* sand, *3.* gravelly sand, *4.* gravel, *5.* redeposited rhyolite tuff, *6.* sand with rhyolite tuff debris; *7.* Variegated Clay Formation of the Great Hungarian Plain, *8.* Mátra—Bükkalja Lignite Formation, *9.* Late Pleistocene molluscan fauna, *10.* Early Pleistocene molluscan fauna, *11.* base of the upper horizon of the Sajóvölgy Member, *12.* base of the Lower horizon of the Sajóvölgy Member, *13.* base of the Erdőtelek Member, *14.* base of the Variegated Clay Formation of the Great Hungarian Plain, *15.* fault between two boreholes

3. ábra. A negyedidőszaki molluszka faunás kutatófúrások rétegoszlopai

1. agyag, *2.* homok, *3.* kavicsos homok, *4.* kavics, *5.* áthalmozott riolittufa, *6.* riolittufa törmelékes homok, *7.* Nagyalföldi Tarkaagyag Formáció, *8.* Mátra—Bükkaljai Lignites Formáció, *9.* Felső-pleisztocén molluszka fauna, *10.* Alsó-pleisztocén molluszka fauna, *11.* Sajóvölgyi Tagozat felső szintjének bázisa, *12.* A Sajóvölgyi Tagozat alsó szintjének bázisa, *13.* Erdőtelki Tagozat bázisa, *14.* Nagyalföldi Tarkaagyag Formáció bázisa, *15.* vetődés a két fúrás között

T h e E r d ő t e l e k C l a y a n d S a n d M e m b e r . In the S part of the studied area this, sometimes more than 100-m-thick sedimentary sequence consisting mainly of clay, silt and sand, less frequently of redeposited rhyolite tuff and rhyolite-tuffaceous sand, is widespread. The 60—169 m depth interval of borehole Erdőtelek 1 can be considered the basic type of the member of the Mollusca-rich sequence which was analysed in laboratory in great details (FRANYÓ 1977: 107). When studying the Erdőtelek Sand and Clay Member, E. KROLOPP determined molluscs from the materials of the following boreholes: Erdőtelek 1, Kál 8, Kál 9, Kompolt 9 and Nagyút 1. The age of the Mollusca fauna consisting of aquatic and terrestrial species is Early Pleistocene. The detailed enumeration of the fauna of more than 40 species can be found in the documentation stored in the National Geological Archives. Here only the species of greatest stratigraphic importance are mentioned: *Neumayria crassitesta*, the Early Pleistocene form of *Planorbis planorbis*, *Soosia diodonta* and *Cepaea vindobonensis*.

Figure 3 shows the sequences of the boreholes in wich Quaternary molluscs were found.

Of these Erdőtelek-1 is a key borehole while the others were deepened for lignite exploration. On the basis of the faunal finds and the rock variations the boundary lines of the different members and units were traced and the cover of the lignite-bearing formation divided into four stratigraphic horizons.

So the layer sequences shown in the Figure can be correlated accordingly. It can be stated that at the end of the Late Pliocene-Early Pleistocene sedimentation tectonic movements followed and the areas elevated in the N were eroded.

T h e S a j ó v ö l g y G r a v e l M e m b e r . Here the Upper Pleistocene and Holocene gravels and sandy gravels covering the present-day valley bed of the rivers Zagyva, Tarna, Bodrog and Hernád, meandering in the mountains can be mentioned. After having left the mountain region and entering the plain, the alluvial deposits were spreaded attaining a thickness of more than 50 m at places, where the Sajóvölgy Gravel Member can be divided into two horizons. Eruptive rock detritus and redeposited rhyolite tuff can only be found scarcely in the material. Clay and sand layers can equally be found in both horizons. From these finer-grained deposits rich Mollusc fauna was collected and then determined by E. KROLOPP, from the following boreholes: Erdőtelek 1, Detk 32, Füzesabony 17, Füzesabony 19, Kál 5, Kál 6, Kál 9, Kápolna 9, Kompolt 9, Vécs 29. Both aquatic and terrestrial species can be found in the fauna. The following species indicate a Late Pleistocene age: *Columella edentula, Columella columella, Vallonia tenuilabria, Trichia hispida.* The Late Pleistocene age can be dated upon the absence of Early Pleistocene faunal elements, too.

I n t r a - P l e i s t o c e n e u n c o n f o r m i t y . The intra-Pleistocene unconformity marking the base of the Sajóvölgy Gravel Member can be best disclosed in the area between Visonta and Mezőkövesd (Fig. 2). Here the areal extent of the detritus accumulated at the foot of mountains is delimited by a tectonic line stretching in zigzags towards N. From its other

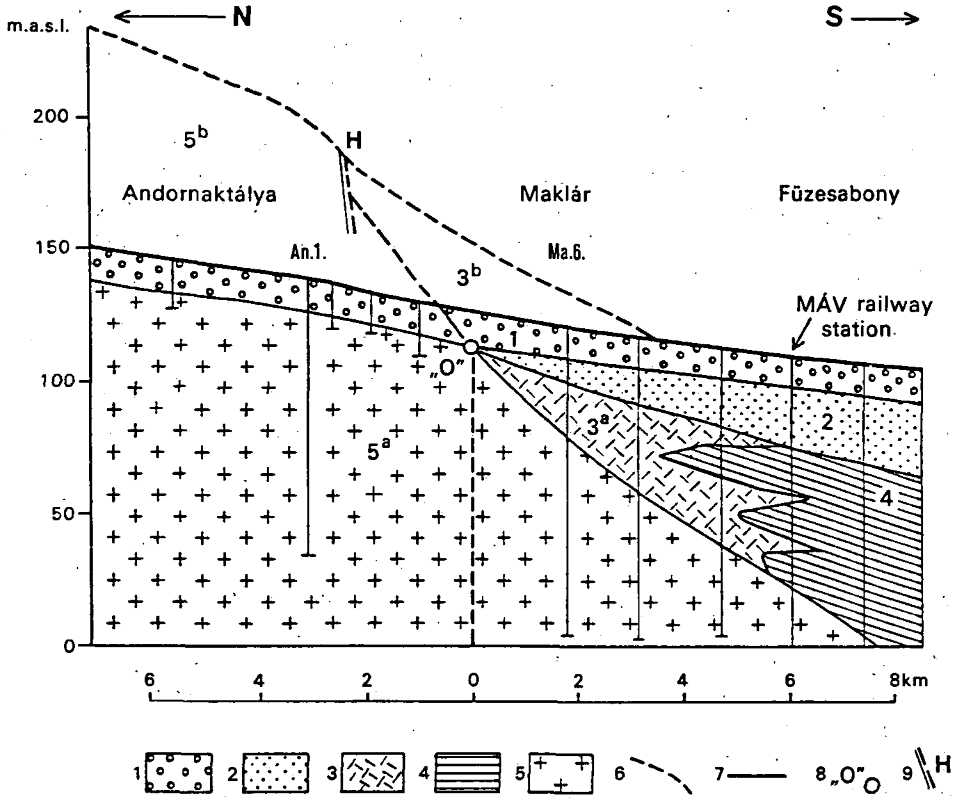


Fig. 4. Geological section of the Eger brook line between Eger and Füzesabony

1. Upper part of the Sajóvölgy Member, *2.* Lower part of the Sajóvölgy Member, *3a.* Visonta Member lying under the base level of valley, *3b.* Visonta Member deposited on hillsides, *4.* Erdőtelek Member, *5a.* Earlier Pliocene and Miocene rocks under the base level of valley, *5b.* Earlier Pliocene and Miocene rocks on hillsides, *6.* sketchy outlines of the hillsides flanking the valley, *7.* present-day surface of the base of valley, *8.* intersection of the base level surfaces of the Sajóvölgy and Visonta members, *9.* boundary fault

4. ábra. Földtani szelvény az Eger patak Eger és Füzesabony közötti szakaszáról

1. Sajóvölgyi tagozat felső része, *2.* Sajóvölgyi Tagozat alsó része, *3a.* Visontai Tagozat a völgytalp alatt, *3b.* Visontai Tagozat a domboldalakon települve, *4.* Erdőtelki Tagozat, *5a.* idősebb pliocén és miocén kőzetek a völgytalp alatt, *5b.* idősebb pliocén és miocén kőzetek a domboldalakon, *6.* a völgyet kisérő domboldalak vázlatos körvonalai, *7.* A jelenlegi völgytalp felszíne, *8.* Sajóvölgyi és Visontai Tagozat talpának egymással metszése, *9.* határvető

side the debris cover was eroded. An other structure line striking WSW—ENE can be traced S of the villages of Mezőkövesd, Füzesabony and Kál. Along this latter fault the base level of the complex is recorded as downthrown by 50 m. The Sajóvölgy Gravelly Member, however, was not affected by the above-mentioned two dislocations. The different mode of occurrence of the piedmont detritus and the younger brook deposits are shown in Fig. 4.

In this section figure not only the beds underlying the base level of the valley but also, marked by broken line, the rocks of the hills flanking the valley on its both sides are also indicated. When comparing the two parts of the figure it turns out that the debris cover on the valley sides is elevated over the present base level of the valley. Since, however, the base of the debris blanket is steeper than the base surface of the brook deposit, the two planes intersect each other. In the figure the point of intersection "0" shows the point wherefrom the debris blanket dives beneath the brook detritus in a southward direction. Fig. 4 shows the valley of Eger brook from Andornaktálya to Füzesabony. The conditions are quite similar in the case of the Tarna brook between Verpelét and Kál and of the Hór brook between Bogács and Mezőkövesd.

Besides these valleys of bigger brooks there are also several smaller ones in the region. These, however, have not been cut down to the base of the piedmont debris blanket and do not transport gravel from more remote areas. The bottom of these minor channels is covered by redeposited loess and brown forest soil accumulated above blanket of the slope-forming detritus. (The uppermost 8 m of the classic Visonta exposure described by KRETZOI and PÉCSI also belongs here).

Finally it could also be mentioned that the action of the intra-Pleistocene denudation can be evidenced not only in the foreland of the Mátra and Bükk Mts but also in more distant areas. Its impact can be especially well observable in the N parts of the basins where on the older (Middle and Lower Pleistocene) deposits younger (Würmian and Holocene) fluvial beds rest with angular and erosional unconformity. Between the Würmian and Mindelian tectonic dislocations were followed by areal erosion e.g. in the Vienna Basin (THENIUS 1974), the northern part of the Little Hungarian Plain (POSPISIL 1978), the southern part of the Little Hungarian Plain (JASKÓ 1990), in the valleys of rivers Zagyva and Sajó, (JASKÓ 1991), and in the East Slovakian Plain (BANACKY 1968, VASKOVSKY 1977). Even in the central part of the Great Hungarian Plain, however, the Quaternary sedimentation was not continuous. In the thick sedimentary sequences dated upon faunal evidences, there are significant stratigraphic gaps and boundaries marked by erosional and angular unconformities (KROLOPP 1970, KRETZOI—KROLOPP 1972).

REFERENCES — IRODALOM

BANACKY, V. 1968: Geological history of the northern part of the east Slovakian lowland in the Quaternary. — Geologické Práce. Zprávy 44—45. 241—262.

FRANYÓ, F. 1977: Az Erdőteleki Et 1.sz. kutatófúrás földtani és vízföldtani eredményei. — Földt. Int. Évi Jel. 1975-ről.: 99—112.

JASKÓ, S. 1990: A Dunavölgy neotektonikájának építésföldtani és környezetvédelmi vonatkozásai. — Földt. Kutatás 32. (4): 45—59.

JASKÓ, S. 1991: A Cserhát—Mátra—Bükkalji lignitterület tektonikai határvonalai. — BKL Bányászat 124.: 378—383.

KRETZOI, M. et al. 1982: Pliocene-Pleistocene piedmont correlative sediments in Hungary. — Quaternary Studies in Hungary. 43—73.

KRETZOI, M.—KROLOPP, E. 1972: Az Alföld harmadkor végi és negyedkori ártéri rétegsora az őslénytani adatok alapján. — Földr. Értesítő 21. (2—3): füzet. 133—158.

KROLOPP, E. 1970: Őslénytani adatok a nagyalföldi pleisztocén és felső-pliocén rétegek sztratigráfiájához. — Őslénytani Viták. 14.: 1—43.

PÉCSI, M. et al. 1985: The absolute chronology of the Plio-Pleistocene alluvial sequence overlying the pediment of the Mátra Mountains. — in: Problems of the Neogene and Quaternary in the Carpathian Basin. 109—114.

POSPISIL, P. et al. 1978: Neotektonické stavba Zitného ostrova a prilahlélo uzemia Podunajskej niziny. — Mineralia Slovaca. Rocnik 10. Cislo 5.

THENIUS, E. 1974: Niederösterreich. — Verhandlungen der Geol. Bundesanstalt. Bundesländerserie. 1—280.

VASKOVSKY, I. 1977: Kvartér Slovenska. — Geol. Ustav Dionyza Stura. Bratislava. 1—246.

FELSŐ-PLIOCÉN ÉS NEGYEDIDŐSZAKI ÜLEDÉKEK A MÁTRA ÉS A BÜKK DÉLI TÖVÉBEN

JASKÓ SÁNDOR

Magyar Állami Földtani Intézet
Budapest, Stefánia út 14.
H-1143

ETO: 552.5 (234.373.3./4)
551.781+551.79 (234.373.3./4)

Tárgyszavak: Mátra, Bükk, lignit, negyedidőszak, sztratigráfia, formációk, litofácies, Molluszka, ősföldrajz

A Mátra és a Bükk-hegység tövében számos lignitkutató fúrás mélyült. Ezek közül néhányból gazdag negyedidőszaki molluszka-fauna került elő. A KROLOPP ENDRE által meghatározott faunát szolgáltató fúrások fekvése a 2. sz. ábrán látható, rétegoszlopaikat pedig a 3. sz. rajz tünteti fel. A visontai lignitkülfejtés gödörfalából előkerült ősgerinces csontok a fedőrétegek legfelső-pliocén és alsó-pleisztocén korát tanúsítják. A felszíni feltárások és a fúrások adatainak összesítéséből a csatolt táblázaton lévő rétegsor állapítható meg.

A lignittelepes formáció felső része és a tarkaagyag formáció alsó része heteropikus fáciesei egymásnak. Közöttük nincs éles határ, fokozatosan mennek át egymásba. A különbségük az, hogy a tarkaagyagban már nincsenek számottevő lignittelepek, ritkák az ősmaradványok és az agyagrétegek vörös, lila, szürke és sárga foltosak lesznek. A tarkaagyag formáció és a lignites formáció az egész területen elterjedt és mindenütt egyforma, változatlan kifejlődésű.

A pliocén kor végén megváltoztak az ősföldrajzi viszonyok. Tagoltabbá vált a felszín domborzata és ennek következtében változatosabbá lettek az üledékképződés körülményei is. Így ugyanazon időben három egymástól eltérő kőzetfajta keletkezett:

1. A meredek hegyoldalak tövében eruptív kőzetek durva törmeléke halmozódott fel, amelyet Visontai Eruptív Málladék Tagozatnak nevezünk.

2. A nagyobb folyóvölgyek torkolata előtt távolról odahordott kavicstömeg terült szét a síkságon. Ez a folyami eredetű lerakódás a Tiszapalkonyai Kavicsos Tagozat.

3. A fokozatosan besüllyedő medencékben édesvízi, tavi és ártéri agyag és homokrétegek váltakoznak egymással. Ez az Erdőtelki Agyag és Homok Tagozat. A három heteropikus kőzetfácies oldalirányban (laterálisan) fokozatos átmenettel kapcsolódik egymáshoz.

A felső-pliocén—alsó-pleisztocén üledékképződés befejeztével tektonikus mozgásokra és kiemelkedő területrészek letarolódására került sor. Ezt követően rakódott le a felső-pleisztocén és holocén korú folyami lerakódás, amelyet Sajóvölgyi Kavics Tagozatnak nevezünk.

A 4. sz. ábrán látható a Visontai Eruptív Málladék Tagozat és az Erdőtelki Agyag és Homok Tagozat oldalirányú összekapcsolódása. A Sajóvölgyi Kavics Tagozat diszkordánsan fedi be őket.

A szelvényrajzon (4. sz. ábra) nemcsak a völgytalp alatti rétegek láthatók, hanem (szaggatott vonallal ábrázolva) jelezve vannak a völgyet két oldalról kísérő domboldalak képződményei is. A hegylábi mállad éktakaró és a jelenkori patakhordalék lerakódását hosszú időköz választotta el egymástól. Ez idő alatt ment végbe a völgyek bevágódása a jelenlegi szintjükbe.

Az intrapleisztocén denudáció nemcsak a Mátra és a Bükk tövében mutatható ki. Ezelőtt már több szerző leírta a Bécsi-medence, a Kisalföld és a Kelet-szlovákiai-síkság területéről is.

1. táblázat

Az Alföld északi peremének felső-pliocén és negyeidőszaki képződményei

Földtani kor	Kőzetformációk		
Holocén és felső-pleisztocén	Lepusztulás	Sajóvölgyi Kavics Tagozat (folyami)	
	Intrapleisztocén diszkordancia		
Alsó-pleisztocén és legfelső-pliocén	Visontai Eruptív Mállad ék Tagozat (szárazföldi)	Tiszapalkonyai Kavicsos Tagozat (folyami)	Erdőtelki Agyag és Homok Tagozat (édesvízi, tavi és ártéri)
	Diszkordancia		
Pliocén	Nagyalföldi Tarkaagyag Formáció (szárazföldi)		
	Mátra-bükkaljai Lignites Formáció (oszcillációs: csökkentsósvízi, édesvízi, tavi, mocsári)		

SCAPHOPODS FROM THE PERMIAN OF THE BÜKK MOUNTAINS

by

CSABA DETRE

Hungarian Geological Survey
Budapest, Stefánia út 14.
H-1143

UDC: 56.551.736 (234.373.4)

Keywords: Bükk Mountains, Permian, Scaphopoda, taxonomy, paleoecologie

In the present study Permian scaphopods are first described from the Bükk Mts. From them conclusions can be drawn for the space of life and the conditions of burial, too. The more exact age dating of the fauna within the Permian is uncertain, however, the accompanying rich Gastropoda fauna is indicative of the Middle Permian and the deepest-situated horizons of the Upper Permian.

Introduction

In the course of the revision of the Permian collection of the Mátra Museum at Gyöngyös we have found a large amount of Permian scaphopods collected is the Bükk Mts by F. LEGÁNYI. A great part of the scaphopod collection amounting to several thousand shells is fragmentary but some well-preserved specimens can be also found.

Although no comparative data are at disposal, it is greatly probable that the quantity of the collected specimens means a paleontological speciality. From the Permian of the Bükk Mts no scaphopods have been known up to now. In Hungary, a few scaphopod were collected from the Mesozoic as rarities (oral information), while in the Cenozoic, especially in the Miocene, several species are known (J. KÓKAY 1966, L. STRAUSZ 1964).

The evolution of the classis Scaphopoda known since the Cambrian is not dynamic. During the past the half billion years they were not abundant or ridely spread, that is to say, they were rather insignificant members of the living world regarding both quantity and the number of taxa. The literature, at any rate, suggests that in the new Paleozoic they must have had a flourishing period because most description refers to remains from this period, and the largest Scaphopoda species are also known from this age (W. K. EMERSON 1962). According to C. C. BRANSON's data, 17 species are known from the Permian. All the species are endemic and are described from the very same locality.

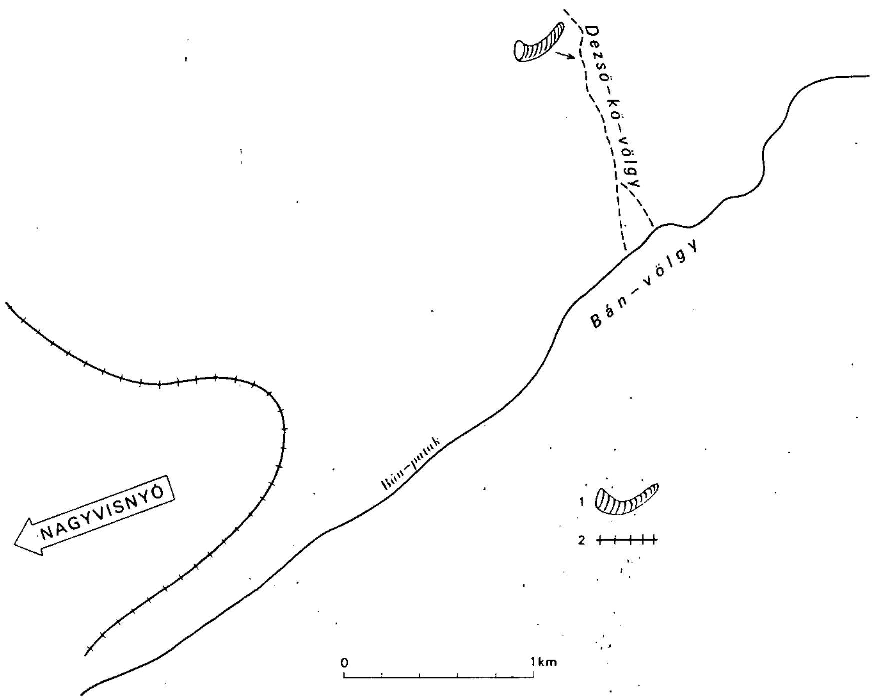


Fig. 1. Geographical position of the Permian Scaphopoda-finding locality in Dezső-kő völgy
1. locality, *2.* railway

1. ábra. A Dezső-kő völgyi perm Scaphopoda lelőhely földrajzi helyzete
1. lelőhely, *2.* vasút

Since from evolution-dynamical aspects it is a rather "conservative" species, this endemisme also points to the greatly unknown character of the taxonomic criteria.

In can be observed that individual representatives of the rare fossil assemblages are represented always by endemic species in the paleontological taxonomy (Asterozoa, Ophiuroidea, etc.).

However, a great part of them is rather conservative, i.e. they are members of species of evolution-dynamically latent groups. The description of a species as endemic can surely be explained by the fact that the describes is ignorant of the other localities of occurrence of a given species which maybe is not to be found in the collection known by the concerned specialist whose knowledge is, anyhow, "endemic".

The locality in the field of the material collected by LEGÁNYI is given as simply as "Dezső-kő völgy". In the course of the necessary revision we have exactly localized the site: it is in a narrow, ravine-like hollow in the N part of the Dezső-kő völgy where in the otherwise S-W tending valley, there is an E-W part ca. 15 m long bordered by two sharp bends. Here several beds bearing frequent ill-preserved scaphopods were found (Fig. 1 and 2).

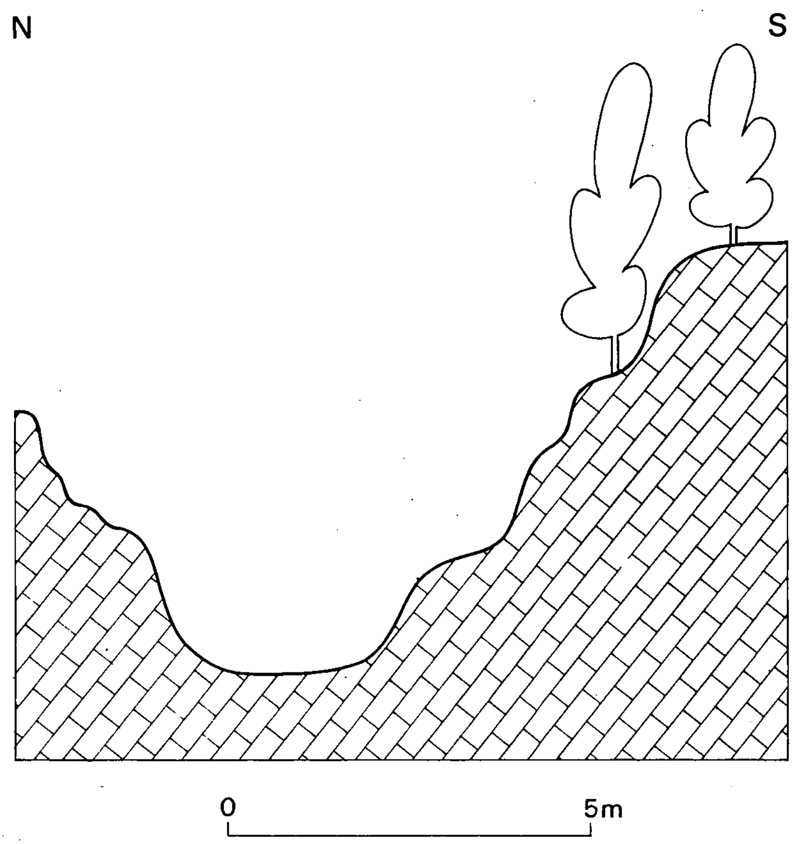


Fig. 2. Section of the Dezső-kő völgy
2. ábra. A Dezső-kő völgyi lelőhely szelvénye

Here also some gastropods were found. Probably the richest gastropod-locality of the Bükk Mts can also be found here. LEGÁNYI, as the first collector gathered the gastropods and scaphopods of the best state of preservation that got free from the rock in the best preservation natural way (DETRE: Permian Gastropods of the Bükk Mts — in print).

The gastropods occurring together with the scaphopods refer to the earlier Late Permian age of the locality. Presumably the local Gastropoda-Scaphopoda facies is the deepest member of the Upper Permian limestone sequence of the Bükk Mts (DETRE, above-cited work).

Taxonomy

The taxonomy of the classis Scaphopoda, because of the rather similar morphology is very simple: The next, smaller taxonomic units of the class are the families. The most detailed taxonomy of the scaphopods at all was given by EMERSON (1962). This taxonomy was also used as basis for the description of the specimens from the Bükk Mts. The morphological nomenclature was also taken over from the same author.

Classis: Scaphopoda BRONN, 1862

Familia: Dentaliidae GRAY, 1934

Genus: Plagioglypta PILSBRY et SHARP, 1897

Plagioglypta robusta n. sp.
Plate I.

Derivatio nominis: The robust shape of the specimens belonging to the species.

Locus typicus: Bükk Mts, NE of Nagyvisnyó in the upper section of Dezső-kő völgy. ("Dező-cliff valley")

Stratum typicum: Probably the lower member of the Upper Permian "Bellerophone limestone".

Description: The shell is of straight conical shape, its cross-section is circular, the vertical angle is 10—20°. The lenght of the well-preserved specimens is 15—20 mm, with a diameter of 3—7 mm (Fig. 3, 4, 5).

No longitudinal ornaments can be found, on the well-preserved specimens concentric ornaments can be observed.

The large specimens (above 10 cm) are all fragmentary and their posterior (anal) part is missing.

Species proxima: *Plagioglypta herculea* (KONINCK, 1863) (See HAYASAKA's) 1925 (classification of the Plagioglypta genus). From this the new species differs first of all with the greater values of the vertical angle; it is mor robust.

The *P. herculea* was found in the Productus beds of Punjab (India) and in the Permo-Carboniferous in Bokhara.

Genus: Prodentalium YOUNG, 1942

? *Prodentalium* sp.
Plate III

Some larger, 4—5-cm-long specimens can be classed here with more or less uncertainty.

Otherwise the genus is known ranging from the Devonian till the end of the Permian from America and Eurasia.

Familia: Siphonodentaliidae SARS, 1859

Genus: Siphonodentalium SARS, 1859

Siphonodentalium sp.
Plate II

Smooth specimens of slightly arched skeleton can be classed here. The cross-section of the skeleton is circular. On a few specimens slight, concentric

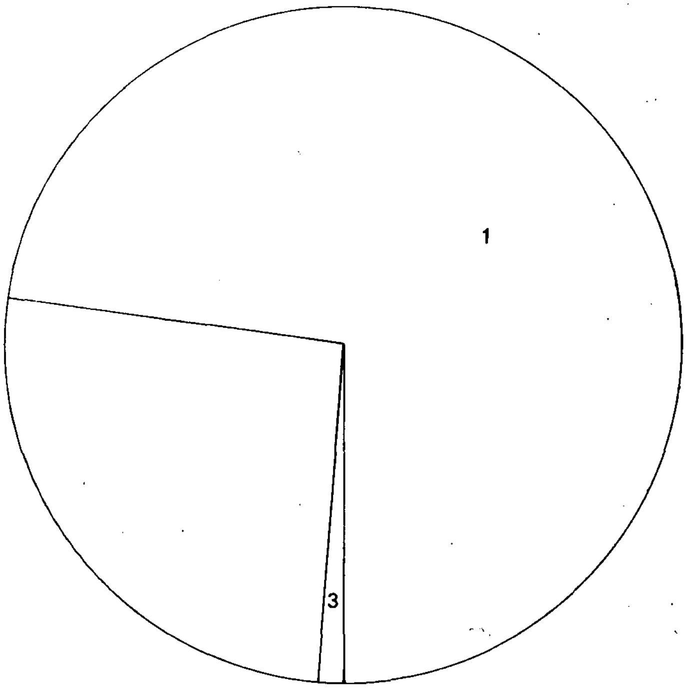


Fig. 3. Distribution of the number of specimens of the Permian Scaphopoda taxa of Dezső-kő völgy
1. Plagioglypta robusta n. sp. 844 specimens, *2. Siphonodentalium* sp. 301 specimens, *3. ?Prodentalium* sp. 15 specimens

3. ábra. A Dezső-kő völgyi perm Scaphopoda-taxonok egyedszámbeli megoszlása a meghatározható példányok alapján
1. Plagioglypta robusta n. sp. 844 db, *2. Siphonodentalium* sp. 301 db, *3. ? Prodentalium* sp. 15 db

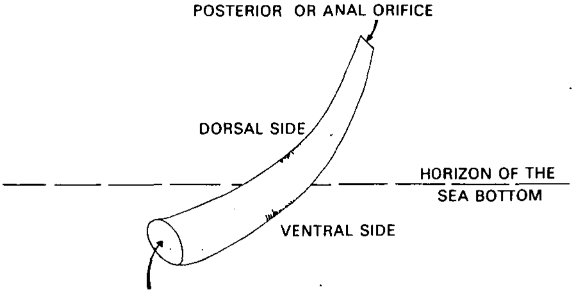


Fig. 4. "In vivo" position of Scaphopodae
4. ábra. A Scaphopodák in vivo elhelyzkedése

ornaments can be observed. The earliest, so far known representative of the genus comes from the Eocene. Its occurrence in the Upper Permian of the Bükk Mts significantly increased the lifetime range of the genus.

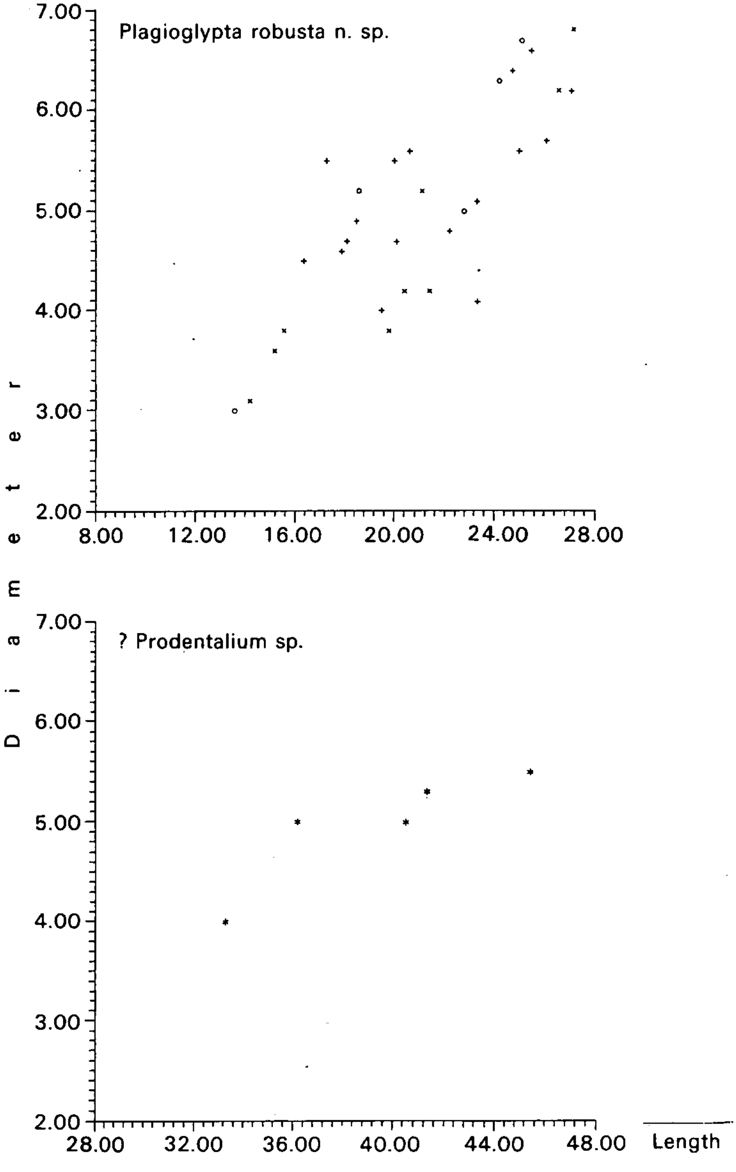


Fig. 5. Morphometric parameters of the *Plagioglypta robusta* n. sp. and the *? Prodentalium* sp. (in mm)

5. ábra. A *Plagioglypta robusta* n. sp. és a *? Prodentalium* sp. morfometriai paraméterei mm-ben

Paleoecology

Scaphopods are one of the most persistent organisms of the living world. The unchanged morphology implies an ecological invariability.

Scaphopods are ubiquist, mud-gluuting living creatures of the vagile benthos. They live penetrating in loose, fine sandy or muddy beds with infrequent moves. They feed mainly on foraminifers. Their abundant occurrence refers to slightly stirred water and the above-described sea bottom, from which the typical species of the hardground environment, e.g. brachipods, are missing. Primary criteria of their spreading are the above-mentioned sea-bottom circumstances.

REFERENCES — IRODALOM

BRANSON, C. C. 1948: Bibliographic Index of Permian Invertebrates. — Geol. Soc. Amer. Memoir 26. 1049 Baltimore.

DETRE, CS. 1993: A Bükk-hegység perm Gastropodái. — Földt. Int. Évk. (sajtó alatt).

EMERSON, W. K. 1951: Nomenclatural notes on the Scaphopoda. The subgenus Dentale Da Costa. — Nautilus, 65.: 17—20.

EMERSON, W. K. 1962: A classification of the scaphopoda mollusks. — Journal of Paleontology, 36 number 3., May 1962. 461—482. 76—80.

HAYASAKA, I. 1925: On some Paleozoic molluscs of Japan I. Lamellibranchiata and Scaphopoda. — Tohoku Imperial University, Science Reports, series 2. (9): 1—30.

HENDERSON, J.B. 1920: A monograph of the East American scaphopod mollusks. — Smithsonian Inst. U. S. Nat. Mus. Bull. 111., 117.

KÓKAY J. 1966: A Herend—Márkói Barnakőszénterület földtani és őslénytani vizsgálata. — Geol. Hung. ser. pal., fasc. 36., 1—49.

LYDBROOK, N. H. 1960: Scaphopoda.—In: MOORE, R. C. (dir. and ed.) Treotise on Invertebrate Paleontology, Part I., Mollusca 1., I 37—41.

PILSBRY, H. A.—SHARP, B. 1897—1898: Scaphopoda. — in TRYON, G.W. Manual of Corehology, 17.: 280.

SARS, G. O. 1859: Bidrag til en skildring a den arctiske Mollusk-fauna ved Norges nordlige Kyst. — Forhandlingen Videnskats Selskabed for 1858. Christiania, 34—87.

STRAUSZ L. 1964: Várpalotai felső-mediterrán csigák. — Geol. Hung. ser. Pal. 25.: 1—150.

YOUNG, J. A. 1942: Pennsylvanian Scaphopoda and Cephalopoda from New Mexico. — Journal of Paleontology, 16.: 120—125.

BÜKKI PERM SCAPHOPODÁK

DETRE CSABA

Magyar Állami Földtani Intézet
Budapest, Stefánia út 14.
H-1143

ETO: 56.551.736 (234.373.4)

Tárgyszavak: Bükk-hegység, perm, Scaphopoda, rendszertan, paleoökológia

A bükk-hegységi permből mindezidáig ismeretlenek voltak a Scaphopodák. A gyöngyösi Mátra Múzeum gyűjteményében LEGÁNYI FERENC gyűjtéséből sikerült nagy mennyiségű bükki perm Scaphopoda-maradványt találnunk. A szükségszerű reambuláció során sikerült a lelőhelyet pontosan megtalálni. A Dezsőkő völgy északi részében lévő szurdokszerű bevágásban. Itt több olyan mészkőpadot találtunk, amelyben gyakoriak voltak rossz megtartású Scaphopodák (szelvény: lásd 1. ábra). Itt sikerült Gastropodákat is találni. Igen nagy valószínűséggel állíthatjuk, hogy ugyanitt található a Bükk-hegység leggazdagabb Gastropoda-lelőhelye is. (DETRE CS. 1993, sajtó alatt).

A Scaphopoda-gyűjtemény több ezer vázból áll, amelyek nagy része hiányos, azonban több tökéletes, igen jó megtartású példányt is tartalmaz. A bükki perm anyag egy új fajba, s két nomenclatura aperta-taxonba sorolható. Tömeges előfordulásuk, itt is mint mindenütt, a finomhomokos—iszapos tengeraljzatra utal, amelyből hiányoznak „hardground" jellegzetes alakjai, mint például a Brachiopodák. Ez a gastropodás—scaphopodás biofácies a bükk-hegységi permben markánsan elkülönülő biofácies-típus.

A Scaphopoda-fauna a permen belül nem jelöl finomabb biokronológiai szintet, a Gastropoda-fauna a felső-perm alsó tagozatára utal.

Plate I — I. tábla

Plagioglyta robusta n. sp.

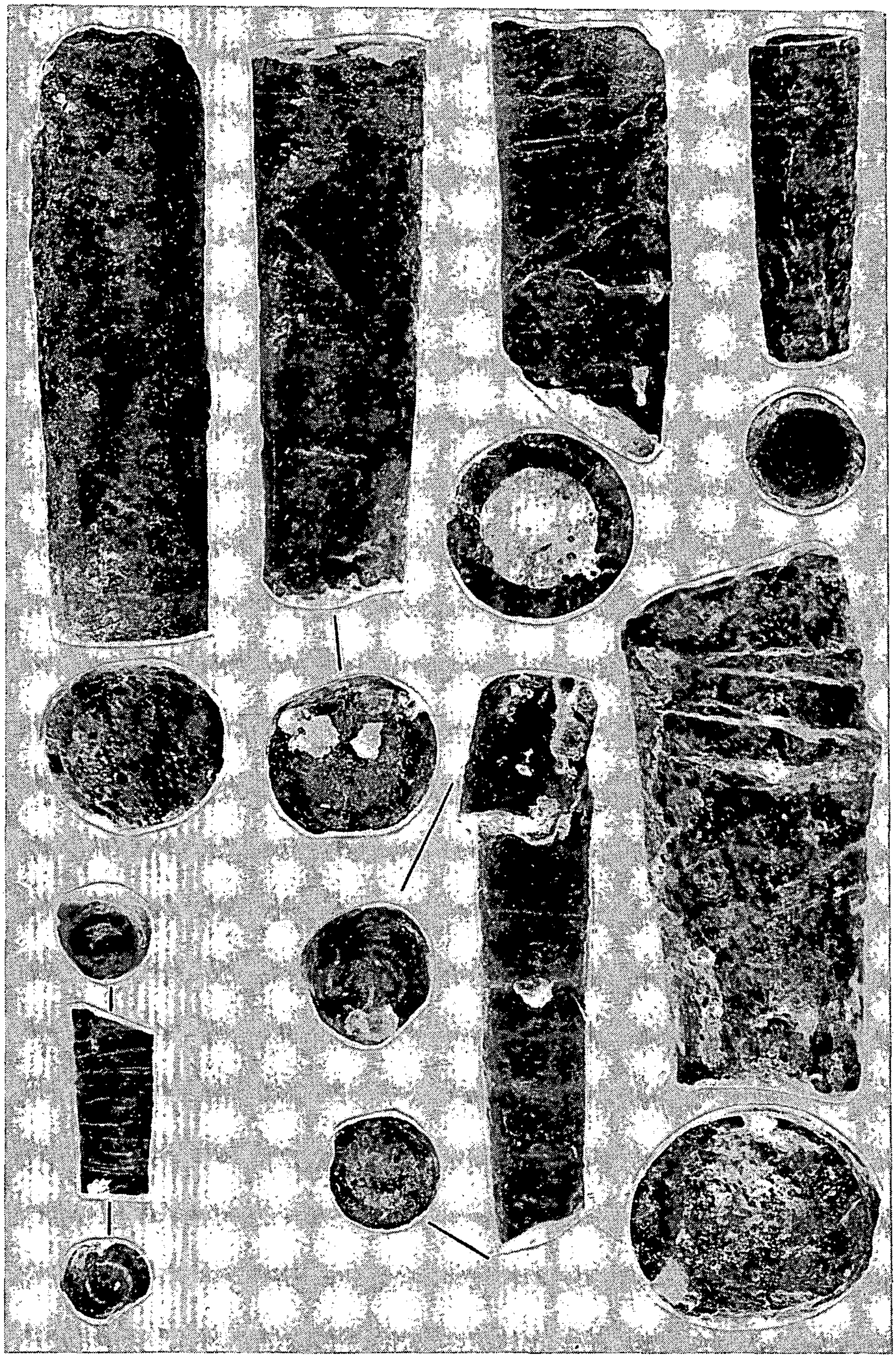


Plate II — II. tábla

1—3 Siphonodentalium sp.

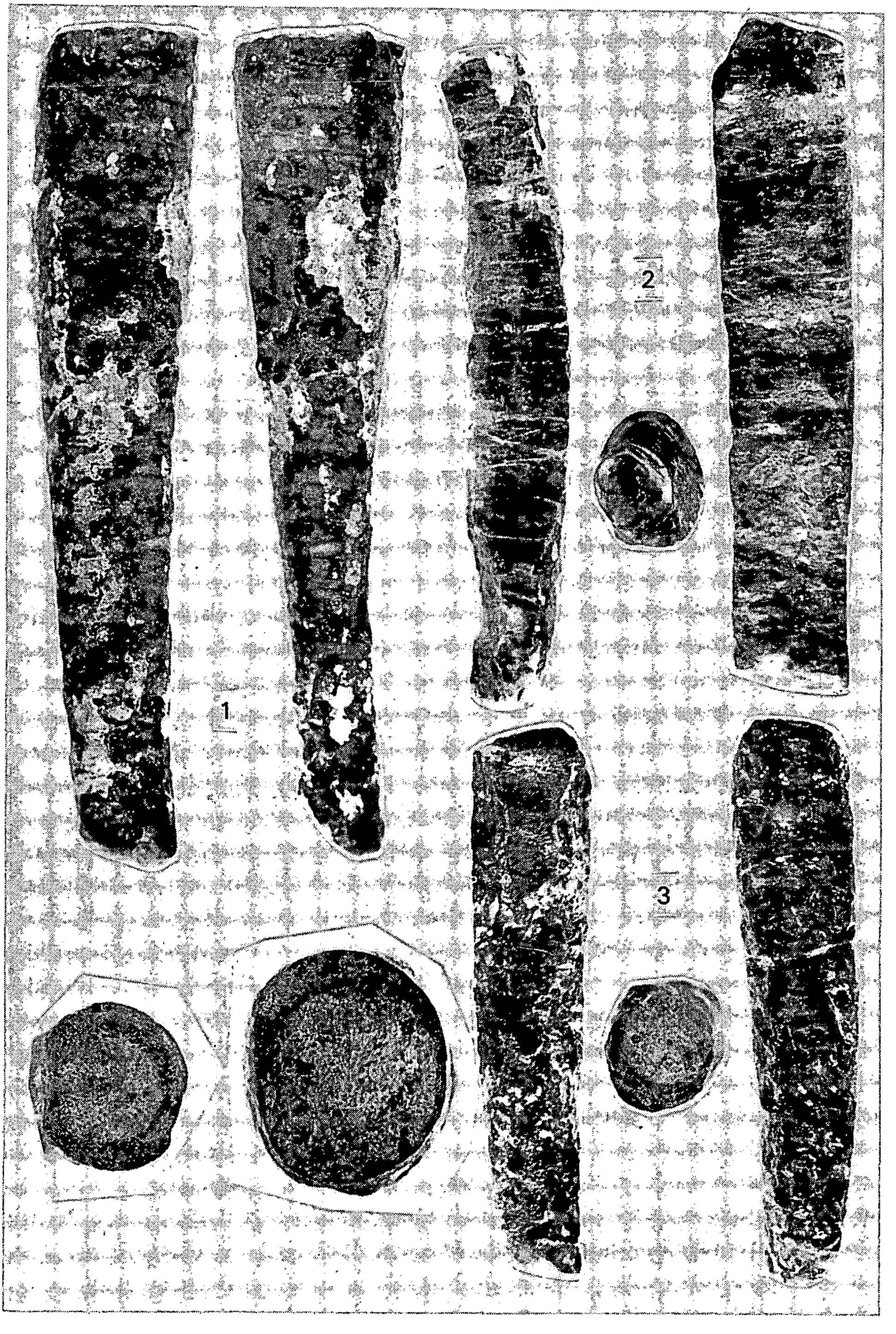
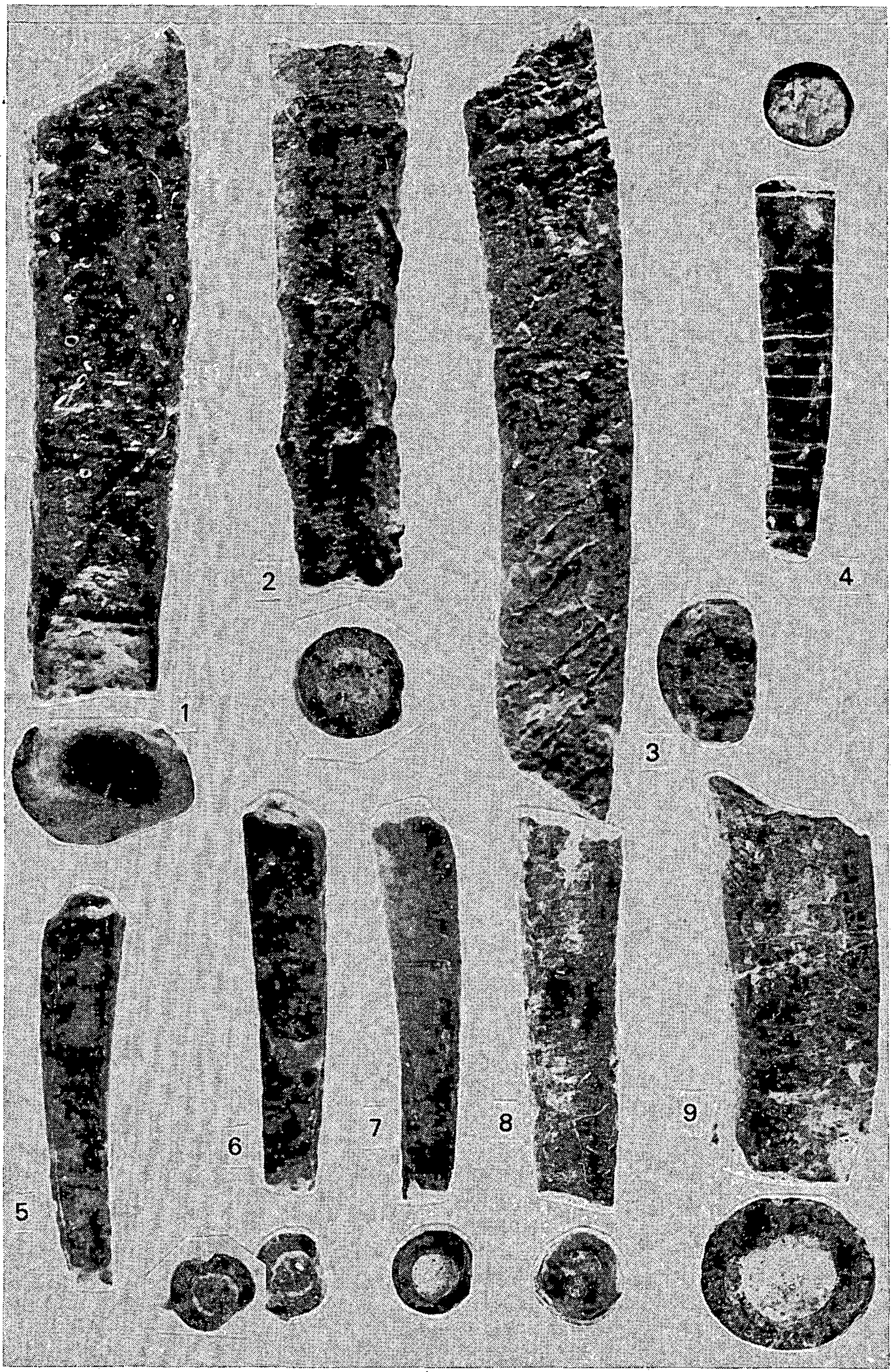

1
2
3

Plate III — III. tábla

2, 4—9 Siphonodentalium sp.
1., 3 ? Prodentalium sp.


1
2
3
4
5
6
7
8
9

UPPER TRIASSIC BRACHIOPODAL DOLOMITE IN THE GÁNT REGION

by

LÁSZLÓ GYALOG—CSABA DETRE—GÁBOR CSILLAG

Hungarian Geological Survey
Budapest, Stefánia út 14.
H-1143

UDC: 551.761.3(234.373.1):552.54

Keywords: Upper Triassic, lithofacies, biofacies, biostratigraphy, faunal list, Brachiopoda, new taxa, correlation, Vértes Mountains

The study describes a new Brachiopoda fauna collected in the area of Gánt (Vértes Mts). The most typical forms of the Brachiopoda fauna found in Upper Triassic dolomite is composed of several species of the genus Cruratula so far unknown in Hungary. These at the same time are index fossils of the Lower Carnian Cordevolian and Julian substages. The Cruratula facies can be observed at several localities of the Tethys region. The Gánt faunal site is one of the richest in brachiopods of the Triassic province.

In the course of the mapping preparatory work of the Central Range Department of the Hungarian Geological Survey preliminary perambulations were performed (L. GYALOG—G. CSILLAG), and two structural boreholes were deepened (1990) in order to obtain information about the Middle—Upper Triassic dolomite sequence underlying Hauptdolomit. Borehole Csákvár Csá 2 was drilled to 240.0 m, while the Csá 3 is 332.5 m deep. The bed sequences were studied by L. GYALOG and G. CSILLAG. In the course of these preliminary operations in the large dolomite quarry at Gánt—Bányatelep and in borehole section Csá 3 a large amount of brachiopods was found and then determined by CS. DETRE (Fig. 1).

Of the dolomites of the Vértes Mts little has been published so far in the literature. Earlier these were also considered to be at large Hauptdolomit (H. TAEGER 1909).

First GY. VIGH (1934) mentioned probably Ladinian diploporic dolomite from the Csákberény area and cherty limestone overlying it. In the SE part of the Vértes Mts and NE part of the Bakony Mts (Iszka Hill vicinity) similar stratigraphic succession was indicated by J. ORAVECZ—E. VÉGH-NEUBRANDT (1961), and the units underlying Hauptdolomit were also depicted. (On their 1:350 000- scaled map sketch the small scale does not permit a precise identification).

Stratigraphic setting

During the execution of our field traverses no cherty limestone mentioned in the literature was found. The dolomite layers known from the two boreholes can be divided into six rock groups and the large dolomite quarry and its vicinity in the Gánt—Bányatelep area can be correlated with a part of the borehole section Csá 3 (Figs. 2 and 3).

The bed sequence from down upwards:

1. Layered-thick-bedded dolomite: It was drilled in the lowermost 35-m-long part of borehole Csá 3 (295.6—332.5 m). Among the 0.4 to 1-m-thick creamy dolomite beds 0.1 to –15.0-cm-thick creamy, pink, lilac and yellow laminae can be observed.

2. Algal-laminated-brecciated and thick-bedded dolomite: It was explored by borehole Csá 3 in a real thickness of 190 m (85.3—296.5 m) while in the large dolomite quarry it comes to 140 m. In the quarry this is the rock group richest in brachiopods, which are also present in the corresponding part of the borehole section.

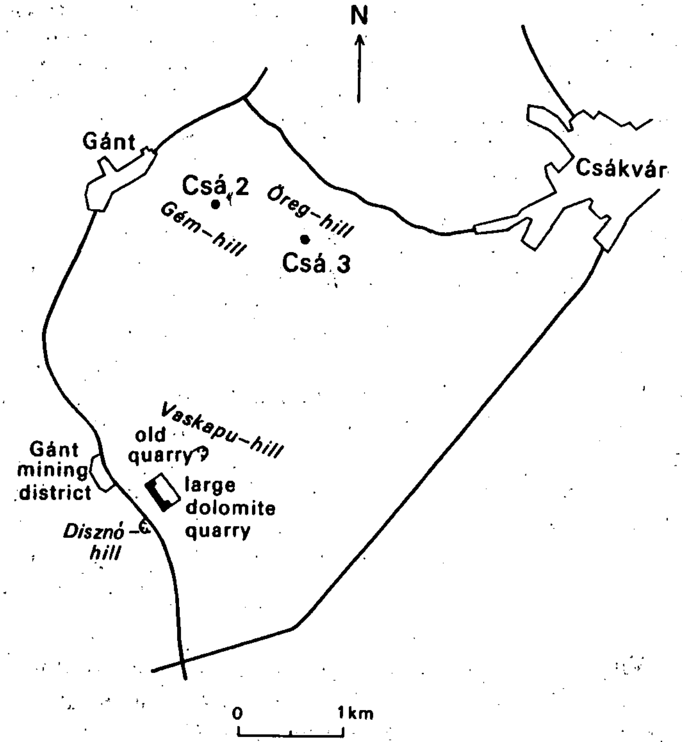


Fig. 1. Location map shoving the borehole sites Csákvár Csá 2 and Csá 3 and Brachiopoda localities in the Gánt mining district

1. ábra. A csákvári Cs. 2. és Cs. 3. sz. fúrások, valamint a Gánt-bányatelep környéki Brachiopoda lelőhelyek helyzete

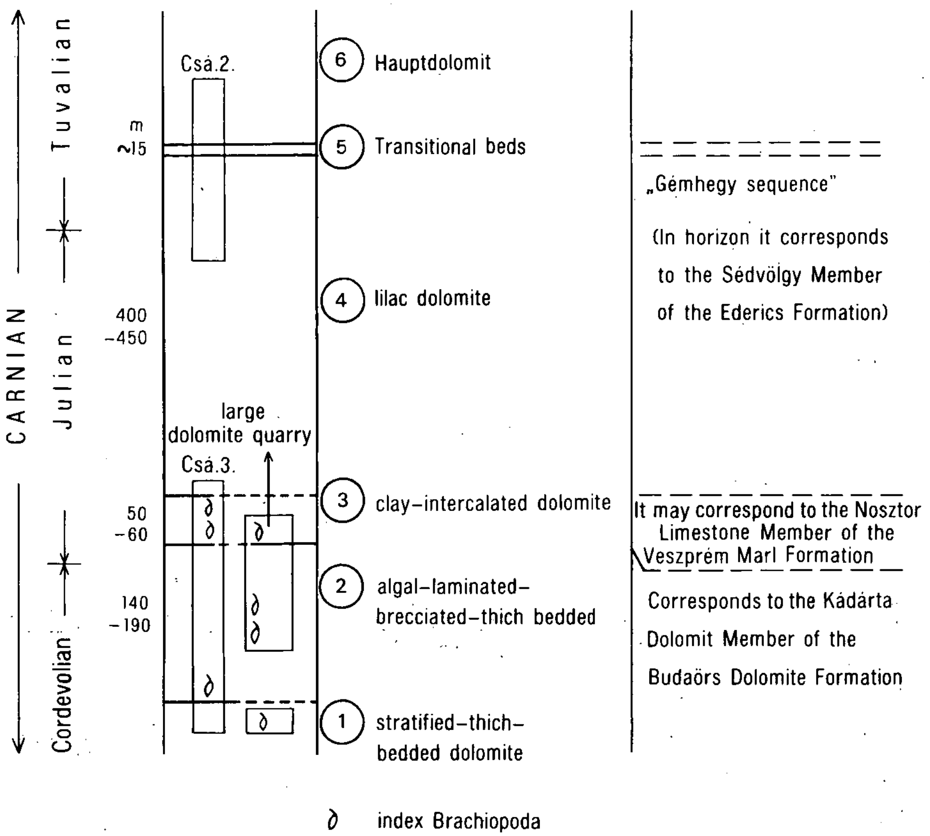


Fig. 2. The stratigraphic position of the borehole section Csá 2 and Csá 3 and that of the large dolomite quarry and its vicinity

2. ábra. A csákvári Csá. 2. és Csá. 3. sz. fúrások, valamint a Gánt-bányatelepi nagy dolomitbánya és környéke rétegtani helyzete

According to the rate of the different beds, this sequence can be divided into four parts:

a) algal-laminated-thick-bedded dolomite: In the borehole, between 237.3—295.6 m, the 0.5—1.0 m thick the creamy, pinky and pale lilac coloured beds 0.5—1.0 m thick alternate with 3-30-cm-thick algal laminae. Brachiopoda are also found therein.

b) Thick-bedded dolomite of fenestral structure: In the borehole (202.2—237.3 m), as included by 1 to 10-m-thick unstratified, thick-bedded yellow-lilac-creamy coloured rock intervals some 30 to 50 cm-thick unstratified, disturbed-structural beds with desiccation cracks, "bird's eye" marks and at places with algal laminae, are present. Here the Brachiopoda, especially the *Cruratula beyrichi* and *C. damesi*, are most frequent, and besides gastropods algal threads also appear.

c) Brecciated, bedded and thick-bedded dolomite: in the borehole (between 124.0 and 202.2 m) the 5-20-m-thick lilac-grayish-pink-creamy multicoloured

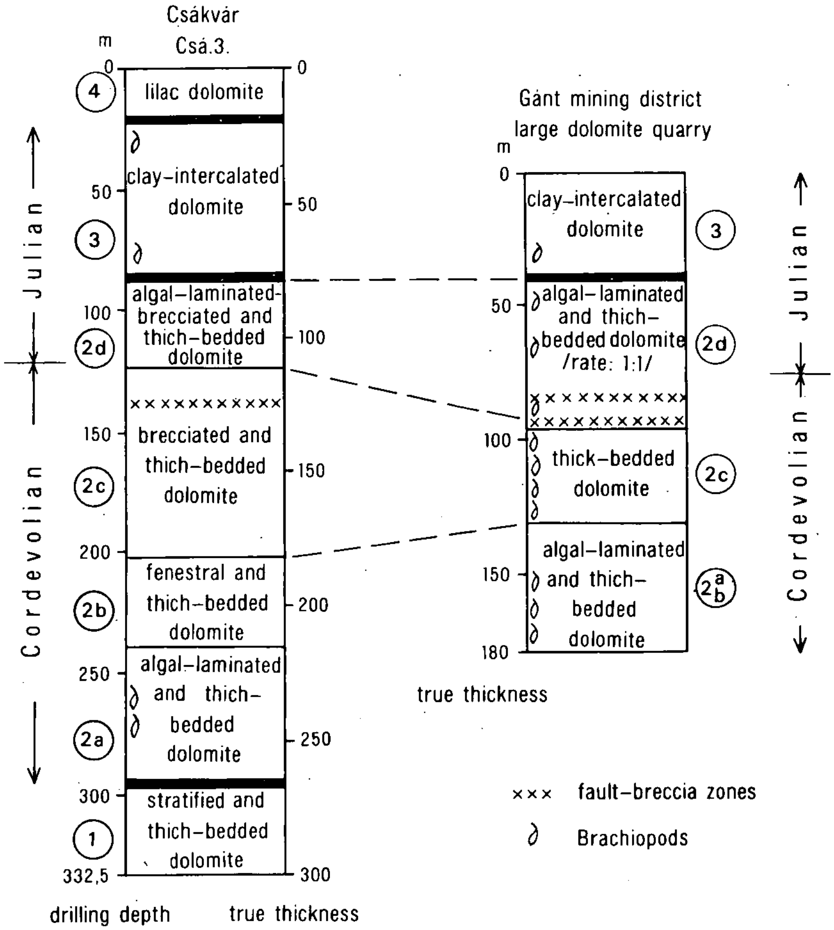


Fig. 3. Correlation of the beds drilled by borehole Csá 3 with these of the large dolomite quarry
3. ábra. A Csá. 3. sz. fúrás és a nagy dolomitbánya rétegeinek párhuzamosítása

and brecciated sequence intervals are divided by 1 to 3-m-thick, creamy or light lilac-coloured beds. In the quarry the brecciated intervals are not common, and the sequence is only 30 m thick. Brachiopoda (*Cruraluta beyrichi* and *C. damesi*) are frequent also here (Fig. 4).

d) Algal-laminated, brecciated, thick-bedded dolomite: Within the borehole its thickness is ca. 35 m (between 85.3—124.0) while in the mine it is ca. 50 m thick. Pink-creamy banks (C member of the Lofer cycle) are alternating with lilac-yellowish sections (B member) of the same thickness. A lot of brachiopods can be found in the mine both at the bottom and the top of the sequence.

3. Dolomite with clay intercalations: In the borehole it is 60 m thick (between 20.5 and 85.3 m), and in the dolomite quarry it exceeds 40 m (Fig. 5).

The green, red, white and altered intercalations are 20—30 cm thick in the mine, 5—10 cm in the borehole but at some places they appear only as

Fig. 4. Densely-situated Brachiopoda sections and dissolved shells seen on the SW wall of the large dolomite quarry (thick-bedded dolomite strata)

4. ábra. Sűrűn elhelyezkedő Brachiopoda metszetek és kioldódott héjak a nagy dolomitbánya DNY-i falán (vastagpados dolomit rétegek)

coating. In the mine the texture of the lower 15 m of the dolomite is similar to that of the underlying beds but above this interval it is of "limestone texture": greenish-grey or brown, micro cryptocrystalline, with nodular bed surface uneven by solution and coated by green clay.

Brachiopods occur both in the limestone-type dolomite and in its underlying horizon. In the borehole the above features are less apparent. In the upper part of the section brachiopods are crowded (*Adygella judica* and *Cruratula damesi*).

In the upper part of the layer sequence no brachiopods were be found and that is why these will be only briefly discussed:

4. Lilac dolomite: The upper 20 m (to 20.5 m) of borehole Csá 3 and the lower 140 m (between 101.2 and 240 m) of borehole Csá 2 can be classed here. The general strike direction and dip angle of about 320/20, allows to calculate a thickness of 400—450 m. It is a lilac-yellow, brecciated and thick-bedded dolomite of fenestral structure with little, some-mm-thick greenish-reddish clayey laminae in the upper part. As a stratigraphical unit it is called the "Gém-hegy sequence".

5. Transitional beds: In borehole Csá 2 a 15-m-thick section can be found (between 83.6—101.2 m) in which light grey, creamy and lilac parts are alter-

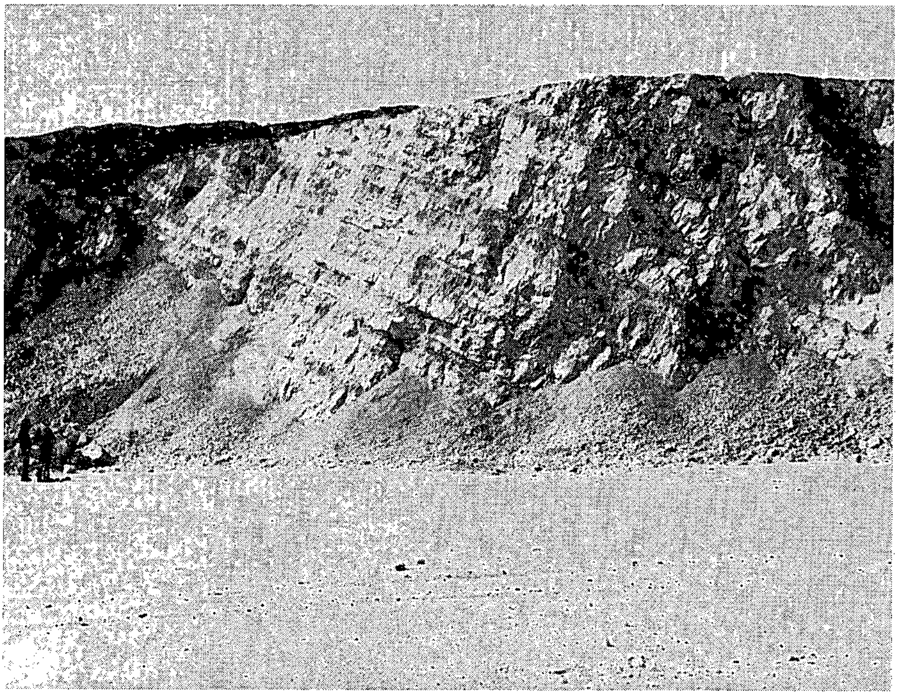


Fig. 5. Clay-interbedded dolomite of the SW wall of the large dolomite quarry
5. ábra. Az agyagbetelepüléses dolomit a nagy dolomitbánya DNY-i falán

nating with some 5—20-cm-thick porous, yellow dolomite intercalations. The upper boundary of the sequence is marked by the last lilac intercalation while the lower boundary can be traced by the lilac colour becoming predominant.

6. Hauptdolomit: It was crossed in the upper 83.6 m of the borehole section Csá 2. It is predominantly light-brown-creamy in colour, compact and in the lower part it is light gray-creamy. It is divided by thick lilac-yellow, flat, thinly laminated banks and breccial intercalations 5 to 15 cm thick (max. 1.5 m).

Biostratigraphic interpretation and stratigraphic correlation

An attempt was made to correlate this sequence with the Upper Triassic sequence of the Balaton Highland. The stratified dolomite (1) and the algal-laminated-brecciated-thick-bedded dolomite (2), based on the stratigraphic position, may correspond to the Kádárta Member of the Budaörs Dolomite Formation.

The bulk of brachiopods were found in these beds. The brachiopods, are largely situated without any orientation in the rock. No nests i.e. marked groupings can be observed in their dispersion. The overwhelming majority of the fossils are internal casts or imprints. Sometimes also strongly recrystallized shell remains and calcinated stubs of brachidium can also be found.

On some internal casts the imprint of brachidium can be observed. Regarding dolomites, their state of preservation can be considered excellent. In the small quarry of the SW slope of Vaskapu-hegy that corresponds to the level of the laminated-bedded dolomite the fauna is Cordevolian, and within this it can be considered Lower Cordevolian (Fig. 6):

Cruratula eudora (LAUBE)
C. faucensis (ROTHPLETZ)
C. beyrichi BITTNER
"Rhynchonella" pichleri BITTNER
"Terebratula" debilis BITTNER

On the SW wall of the great quarry of Gánt—Bányatelep, in almost each layer of the algal-laminated-brecciated-thick-bedded dolomite two Cruratula species are extremely frequent and some gastropods can be also found here. The fauna is enlisted below:

Cruratula beyrichi BITTNER
C. damesi BITTNER
Amphiclina amoena BITTNER
"Spriferina" div. sp.

This faunal assemblage can be found W of the highway in the quarry at the E foot of the Disznó-hegy:

Cruratula damesi BITTNER
"Spiriferina" cf. *halobiarum* BITTNER
"Spiriferina" sp.

Brachiopod imprints were be also found in the corresponding horizon of borehole Csá 3 (from 268.8 m) but it was impossible to determine them.

The age of the sequences, on the basis of the *Cruratula beyrichi* and *C. damesi* ranges (Fig. 6) can be put to the Cordevolian—Julian.

The Lofer cycles are characteristic of the greater part of the layer sequence. In the (1—2a—2b) layers the rate of the B:C members is ca. 1:5. Above this the (2c) layer is homogeneous, then Lofer cycles follow again (2d) but here the rate of the B:C members is already 1:1. The clay-intercalated dolomite (3) can be correlated with the Nosztor Limestone Member of the Veszprém Marl Formation in the Balaton Highlands. This, besides the stratigraphic position, is also proved by the clay intercalations and the limestone-type texture. In the larger dolomite quarries Cruratulae are frequent also in this horizon:

Cruratula beyrichi BITTNER
C. damesi BITTNER.

In borehole Csá 3 brachiopods were found in two samples from this horizon:

32.3 m: *Adygella julica* (BITTNER)
Cruratula damesi BITTNER
78.0 m: *Adygella julica* (BITTNER)

The above faunal assemblage (the joint occurrence of *Adygella julica* and *Cruratula damesi*) refer to the Julian Substage (Fig. 6).

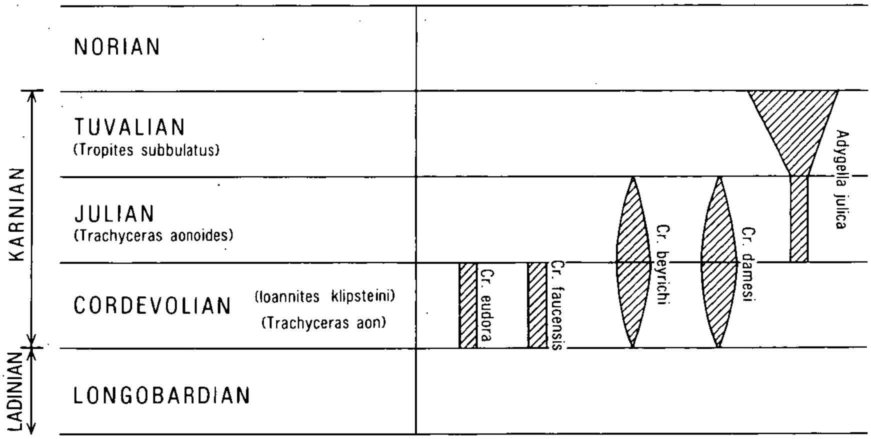


Fig. 6. Biochronocoenose of the Brachiopoda species of Gánt
6. ábra. A gánti Brachiopoda fajok biochronocönózisa

The intercalations, the limestone-type texture and the lack of Lofer cycles indicate subtidal sedimentation.

From the lilac dolomite (4) (Gém Hill sequence) no fossils were found in the studied area. This sequence can be correlated with the Sédvölgy Member of the Ederics Formation of the Balaton Highlands.

Taxon-composition of the fauna and biostratigraphic conclusions

At the studied localities the Brachiopods are overwhelmingly abundant. Some Gastropod remains were found only in the large dolomite quarry E of Gánt—Bányatelep.

Within the Brachiopoda fauna the Cruratula genus is the predominant representing ca. 95 per cent of the fossils. Accordingly the whole brachiopodal sequence belongs to the "Cruratula biofacies" zone. It means that the predominance of the zone is strong everywhere and the representatives of the Cruratula genus can be found only scarcely in other faunal assemblages. The generation range of the Cruratula genus was the shortest in Triassic time: all its species were to have appeared, within the Carnian, to the Cordevolian and Julian substages. The *C. eudora* and *C.faucensis* occurring also in the Gánt fauna are restricted exclusively to the Cordevolian (Fig. 6).

Biostratigraphic summary

The finding of new Brachiopoda localities in the Gánt area allowed to have acquainted ourselves with species and biofacies so far unknown in Hungary. The newly found "Cruratula facies" is detectable in several Alpine localities. It is known from the Little Carpathians, however, it has not yet been studied there in details, or the pertinent results have remained unpublished till now.

From the N Caucasus it has been only mentioned. It seems probable that at all localities it is mainly bound to dolomitic lithofacies. The recognized Cruratula species are extremely good index fossils of the Cordevolian and Julian substages. This fact permits to say that our contribution is important to the knowledge of Triassic stratigraphy, not only of the area of study but of the whole Vértes Mts.

From the studied area also the Adygella julica Terebratulida (Dielasmatidae) that is rather frequent in the Carnian and is wide spread in the whole Thetys region. By summing up the newly obtained paleontological data it can be concluded that in the whole Thetys region a locality with exceptionally successive and selective Brachiopoda zonation have become known.

Paleontological descriptions

The systematic classification was carried out upon the work AGER, D. et al. (1965).

Phylum: Brachiopoda DUMERIL, 1806
Classis: Articulata HUXLEY, 1869
Ordo: Spiriferida WAAGEN, 1883
Subordo: Spiriferidina WAAGEN, 1883
Superfamilia: Spiriferinacea DAVIDSON, 1884
Familia: Spiriferinidae DAVIDSON, 1884
Genus: Spiriferina D'ORBIGNY, 1847 (sensu lato)

"Spiriferina" cf. *halobiarum* BITTNER, 1890
(Plate II, Fig. 3a, 3b)

1890. *Spiriferina halobiarum* BITTNER: p. 248, 276. (Taf. XIV, Figs 6—16)

It is the only specimen from the old quarry at Gánt that cannot be fully extracted from the embedding rock.

The nearly equivalve shells and double umbo of nearly the same size can be observed. This feature is characteristic of this species only, regarding Spiriferinae. Since no complete specimen is available, only the "nomenclature aperta" can be applied for determination.

The species, by the way, is known from the Cordevolian formations of the N Alps.

Ordo: Terebratulida WAAGEN, 1883
Subordo: Terebratulidina WAAGEN, 1883
Superfamilia: Terebratulacea GRAY, 1840
Familia: Terebratulidae GRAY, 1840
Superfamilia: Terebratulinae GRAY, 1840
Genus: Terebratula MÜLLER, 1776 (sensu lato)

"*Terebratula*" *debilis* BITTNER, 1890
(Plate I, Fig. 4)

1890. *Terebratula debilis* BITTNER: p. 61., (Table I, Fig. 8)
1910. *Terebratula debilis* BITTN; SIMIONESCU, p. 18., (Fig. 15)
1920. *Terebratula debilis* BITTN; DIENER: p. 84.

At least one specimen can surely be classed with this species collected from the old Vaskapu-hegy quarry. The specimen, with its dorsal shell, rests in the rock. Characteristic features are the rather long ventral valve and the great, ca. 1:2 rate of width and length. The contour of the ventral valve is slightly pentagonal. Besides this specimen, about some ten fragmentary remains also belong to this species.

The species has so far been known from the Lower Carnian formations of the S Alps and Dobrudja.

The measurable size of the well-preserved specimens are: Length: 15 mm, Width: 8 mm.

Superfamilia: Dielasmatacea SCHUCHERT, 1913
Familia: Dielasmatidae SCHUCHERT, 1913
Subfamilia: incerta
Genus: Cruratula BITTNER, 1890

BITTNER's (1890) Cruratula genus may probably include some circles of forms genetically remote from each other. This is why the position of AGER et al. (1965, p. 772) taken up in the question of assigning the genus to a subfamilia has been uncertain.

The large majority of the Triassic Brachiopoda of the locality of Gánt belong to the species of this genus.

The exact taxonomic classification of the genus can be realized only after a genus revision embracing all the localities.

Cruratula eudora (LAUBE, 1865)
(Plate I, Figs. 1, 2)

1865. *Waldheimia eudora* LAUBE: p. 8., Taf. XI, Fig. 12.
1886. *Aulacothyris eudora* LAUBE; ROTHPLETZ: p. 84, 127.
1890. *Cruratula eudora* LAUBE; BITTNER: p. 67, Taf. I, Fig. 11. Taf. VII, Fig. 27.
1920. *Cruratula eudora* LAUBE; DIENER: p. 95. (cum syn.)

It is the most frequent Brachiopoda of the old small quarry. Several dozen specimens were found, though the intact specimens are scarce. No specimen has been found completely removable from the rock. The most typical morphological feature is the extremely large inclined ventral umbo, "beak" among the Cruratulae. The imprint of the wide, long brachidium running along almost the total length of the value can be seen on several specimens.

It is rather a terebratellid feature questioning the systematic classification of the Bittner genus into Terebratulidinae. To solve this problem, however, better preserved brachidiums are required. The shell is of slightly trigonal shape and its width exceeds its length. This is also a peculiar feature of Dielasmadidae, comprising on additional factor of uncertainty regording the systematic classification.

It is known from several localities of the S Alps, and can be considered a paraindex fossil of the Cordevolean *Trachyceras aon* zone.

In Hungary, it was found for the first time.

Cruratula faucensis (ROTHPLETZ, 1886)

(Plate I, Figs. 3, 5)

1886. *Rhynchonella faucensis* ROTHPLETZ, p. 134, Taf. XIII, Figs 6, 9—11.
1890. *Cruratula faucensis* ROTHPL. BITTNER, p. 204, Taf. VII, Figs 21, 22.
1920. *Cruratula faucensis* ROTHPL. DIENER, p. 96. (cum syn.)

The two well-preserved specimens figured undoubtedly belong to this genus and probably some fractured specimens also belong to here. All the specimens were found in the old quarry.

As with *C. eudora*, their width exeeds their height, the contact line of the valves is, however, more rounded i.e. less trigonal.

The umbo is thinner, it is less protruding and inclined.

On the two well-preserved specimens the imprint of brachidium can be observed. This approximately runs down to half height of the valve, and is less wide than in the case of *C. eudora*. Accordingly, it is Terebratulid type rather than Terebratellid type.

Its range is restricted to the Cordevelean substage. So far it has been unknown in Hungary.

Cruratula byrichi BITTNER, 1890

(Plate II, Fig. 1)

1890. *Cruratula beyrichi* BITTNER: p. 201, Taf. VI, Figs 1—4.
1920. *Cruratula beyrichi* BITTN. DIENER: p. 94. (cum syn.)

It is the most frequent form of the Brachiopoda fauna of the large quarry at Gánt. In the collection of fossils far several hundred specimens of this species have been identified, some of them with completely intact moulds.

Its external morphology resembles the typical, pentagonal contour of valve shells of Dielasmatidae. The shell is longer than it is width, and it is also less thick than *C. eudora* and the *C. faucensis*.

The brachidium, according to the imprints, is thin, gracile, and runs down to the half of the shell length. The beak is short, not inclined and protruding.

The species has not been found so far in Hungary. It is known from the Cordevolian and Julian localities of the Alps, and from the dolomite formations of the Upper Ladinian, probably Cordevolian layers of the Little Carpathians (oral communication by J. PEVNY). It is also known from the Cordevolian and Julian formations of the N Caucasus (see DAGIS 1970, without paleontological description).

Cruratula damesi BITTNER, 1890
(Plate II, Fig. 2.)

1890. *Cruratula damesi* BITTNER: p. 112, 113, 114, 203, Taf. VI, Figs 9—12., Taf. XXXVIII, Fig. 13.

1890. *Cruratula Damesi* BITTN., DIENER: p. 95.

It is the second most freguent Brachiopoda species of the great quarry of Gánt. From the material collected so far, together with some fragments probably belonging to here and imprints of at least one hundred specimens have been examined. Completely intact mould, however, is not available yet. The outline of the frame is roundedly pentagonal, slightly elongated towards the umbo which is straightly protruding.

On some specimens the imprint of the brachidium can be studied. It is relatively wide and slighty extend over the half of the length of the valve. Practically it represents a transition between the brachidiums of terebratulid and the terebratellid types.

The species has been, so far, unknown in Hungary, although BITTNER (1900, p. 11., Taf. I, Fig. 1.) describes a specimen from the Lower Carnian of the Balaton Highlands calling it *C.* sp. ind. aff. *damesi.*

The species is known from the Cordevolian and Julian formations of the N Alps.

REFERENCES — IRODALOM

AGER, D. V. et al. 1965: Systematic descriptions. In: MOORE, R. C. (dir. et ed.): Treatise on Invertebrate Paleontology, Part H, Brachiopoda. — Geol. Soc. of Amer., Univ. of Kansas Press.

BITTNER, A. 1890: Brachiopoden der alpinen Trias. — Abhandl. Geol. Reichsanstalt, Bd. 14.

BITTNER, A. 1894: Über Rhyanchonella faucensis ROTHPLETZ. In: Einige Bemerkungen zu A. Rothpletz. — Verh. Geol. Reichsanstalt, 97.

BITTNER, A. 1900: Brachiopoden aus der Trias des Bakonyerwaldes. — Resultate der wissenschaftl. Erforschung d. Balatonsees. Palaeont. Anhang zum 1. Teil d. 1. Bandes, Budapest.

DAGISZ, A. SZ. 1965: Triaszovüje brachiopodü Szibiri. — Akad. Nauk. SzSzSzR. Otgyel., Izd. Nauka, Moszkva.

DAGISZ, A. SZ. 1970: Triaszovüje brachiopodü. Morfologija, szisztema, filogenija, sztratigraficseszkoje znacsenyje, biogeografija. — Akad. Nauk. SzSzSzR, Novoszibirszk.

DETRE CS. 1970: A Brachiopodák elterjedése a triász időszakban. — Ősl. Vit. (Discussiones Palaeontologicae) 15, 47—67.

DIENER, C. 1920: Brachiopoda Triadica. — Fossilium Catalogus, I: Animalia, Pars 10., Berlin.

LAUBE, G. 1865: Die Fauna der Schichten von St. Cassian. II. Brachiopoden und Bivalven. — Denkschr. Akad. Wien, Bd. XXV., 1—31.

ORAVECZ J.—VÉGHNÉ NEUBRANDT E. 1961: A Vértes és Bakony-hegységi triász rétegtani és szerkezeti kapcsolatai. — Földt. Közl. 91.: 162—172.

ROTHPLETZ, A. 1886: Geologisch-palaentologische Monographie der Vilsen Alpen mit besonderer Beruchsichtigung der Brachiopoden-Systematic. — Palaeontographica, Bd. 33.

SIMIONESCU, J. 1910: Studii geologice si palaentologice din Dobrogea. — Acad. Romana, Publ. Adomanchi, IV. Bucuresti.

TAEGER, H. 1909: A Vértes hegység földtani viszonyai. — Földt. Int. Évk. 17.: 1—256.

VÉGHNÉ NEUBRANDT E.—ORAVECZ J. 1961: A gerecse- és vértes hegységi felső-triász dolomit és mészkőösszlet. — Földt. Int. Évk. 49. (2): 291—294.
VIGH GY. 1934: Neuere Triasfunde im Ungarischen Mittelgebirge. — Neues Jb. f. Miner. Geol. Paläont., 72, Abt. B., 45—53.

FELSŐ-TRIÁSZ BRACHIOPODÁS DOLOMIT GÁNT KÖRNYÉKÉN

GYALOG LÁSZLÓ—DETRE CSABA—CSILLAG GÁBOR

Magyar Állami Földtani Intézet
Budapest, Stefánia út 14.
H-1143

ETO: 551.761.3 (234.373.1):552.54

T á r g y s z a v a k : felső-triász, litofácies, biofácies, biosztratigráfia, faunalista, Brachiopoda, új taxon, korreláció, Vértes hegység

A Vértes DK-i részén, Gánt—Csákvár térségében mélyfúrások és felszíni vizsgálatok során a fődolomit feküképződményeiből gazdag, szintjelző Brachiopoda fauna került elő. Ennek segítségével a vizsgált terület rétegsorát párhuzamosítottuk a balaton-felvidéki felső-triász rétegsorral.

Ezek az új Brachiopoda lelőhelyek Magyarországról eddig még le nem írt fajokat és biofáciest tártak elénk. A most megismert "cruratulás fácies" az Alpokban, a Kis-Kárpátokban, az É-Kaukázusban ismert, mindenhol elsősorban dolomitos litofácieshez kapcsolódik. A megismert Cruratula fajok a cordevolei és juli alemeleteknek igen jó indexfossziliái. A területről előkerült a karniban gyakori *Adygella julica* faj is.

Plate I — I. tábla

1a., 1b., 1c., 1d. Cruratula eudora (LAUBE)

2. *Cruratula eudora* (LAUBE) near umbo fragment

3a., 3b., 3c. Cruratula faucensis (ROTHPLETZ)

4. *"Tereblatula" debilis* BITTNER

5a., 5b., 5c. Cruratula faucensis (ROTHPLETZ)

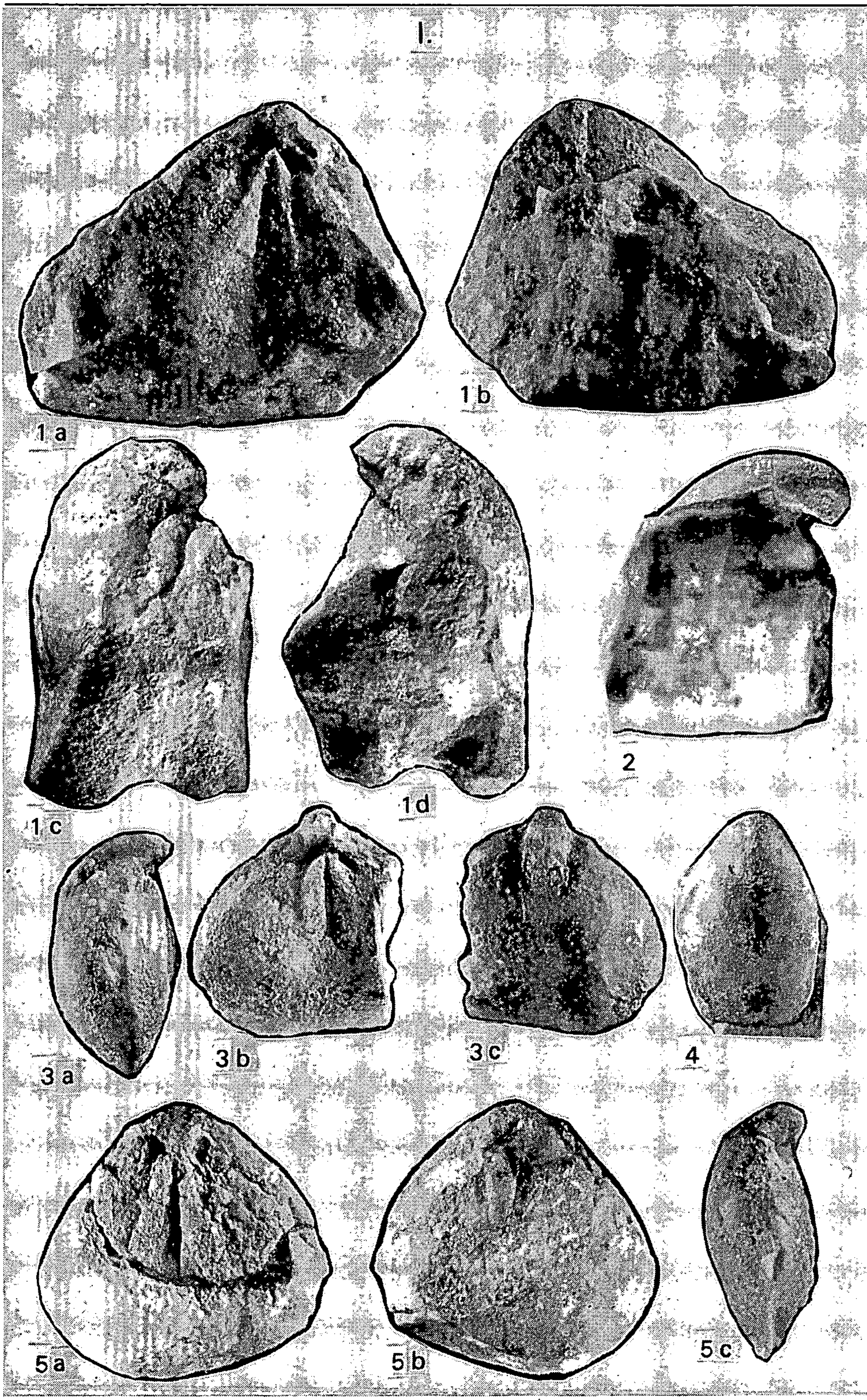
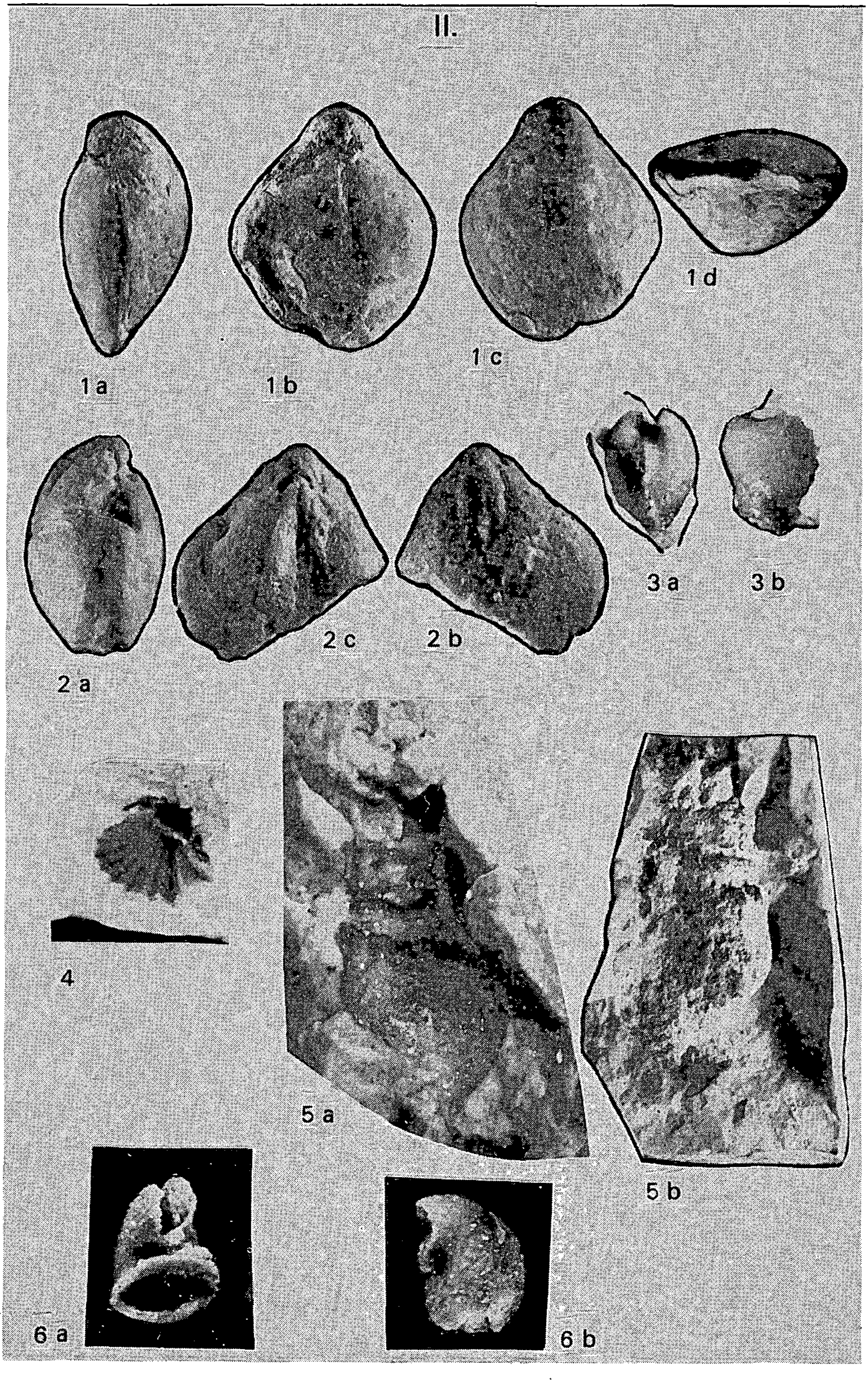

I.
1a
1b
1c
1d
2
3a
3b
3c
4
5a
5b
5c

Plate II — II. tábla

1a., 1b., 1c., 1d. Cruratula beyrichi BITTNER
2a., 2b., 2c. Cruratula damesi BITTNER
3a., 3b. "Spiriferina" cf. *halobiarum* BITTNER
4. "Spiriferina" sp.
5a. Omphaloptycha sp. imprint.
5b. Omphaloptycha sp. mould.
6a., 6b. Naticella sp.
Enlargement of figures: turice actual size
Photo: M. PELLÉRDY


II.
1 a
1 b
1 c
1 d
2 a
2 c
2 b
3 a
3 b
4
5 a
5 b
6 a
6 b

A STUDY OF MICROFAUNA AND CALCAREOUS ALGAE OF THE REFERENCE SECTION OF CIGÁNY-ÁROK NEAR ZIRC EXPOSING THE TÉS CLAYMARL FORMATION (MIDDLE ALBIAN, N BAKONY MTS)

by

ILONA BODROGI

Hungarian Geological Survey
Budapest, Stefánia út 14.
H-1143

UDC: 552.5 (234.373.1)
551.763.13 (234.373.1)

Keywords: Tés Claymarl Formation, Middle Albian, microfauna, microflora, faunal list, Orbitolina, Munieria, paleoenvironment, correlation, Bakony Mts (Hungary)

More than one hundred years ego M. HANTKEN (1889, 1890) reported on the foraminiferous beds, called now as Tés Claymarl Formation. He also recognized the freshwater Chara remains and the so far unknown calcareous algae described then by W. DEECKE (1883) as *Munieria baconica.*

The exposure and its vicinity is the Orbitolina locality known for nearly 50 years (NOSZKY, J. 1943, MAJZON, L. 1943, 1946, MÉHES, K. 1964). From the laminated-bedded orbitolinite and the poorly preserved Orbitolinae that got themselves free by weathering from the upper part of the Tés Claymarl, K. MÉHES described the species *Orbitolina baconica* MÉHES (1964). On the basis of angiosperm pollen grains, M. JUHÁSZ (1979) assigned the formation to the Middle Albanian. This well-known exposure was also shown to the participants of the 21st European Micropaleontological Colloquium held in Hungary in 1989. The rather thin upper part of the section displays freshwater and marine beds of cyclic sedimentation, with reworked, bad-preserved specimens of *Munieria baconica* and freshwater ostracods, medium-rich, well-preserved foraminifera fauna including the characteristic species *Involutina hungarica* (SIDÓ) and *Choffatella decipiens* SCHLUMBERGER in the marine rocks. The study results of the biogenic limestone debris of A, B and C types collected during the colloquium from the upper part showing solifluction is described here.

Introduction

The study of one of the reference sections of the Tés Claymarl Formation discovered between Zirc—Borzavár more than 100 years ago, began in 1989, on the occasion of the 21st European Micropaleontological Colloquium held in Hungary. The exposure can be found in the ravine Cigány-árok.

From here, i.e. from the vicinity of Zirc collected M. HANTKEN the so far unknown calcareous alga and sent the fossil to W. DEECKE in Vienna, who described it as *Munieria baconica* in 1883.

This is the first calcareous alga species that in spite of all misunderstandings found in literature is an endemic species known only from the Bakony Mts and its northern forelands. The exposure and its vicinity is a well-known Orbitolina locality for about 50 years.

History of research

The Cigány-árok profile is cut into a major superficial patch of rock of the Tés Claymarl Formation found W of Zirc on both sides of the road winding towards the village of Borzavár. It was also depicted on the geological map E´ 8 published in 1880 (scale 1:144.000) marked by No. 20 in symbols as Lower Cretaceous foraminiferal clay and claymarl. The mapper must have been M. HANTKEN, however, his name does not appear on the sheet. He was the first to recognize the typical fossils of the locality (foraminifers, calcareous algae). He turned to W. DEECKE for the description of the new calcareous algal species, and prepared the first lithobiostratigraphic description of the Tés Claymarl (Munieria Marl) (1884), recognizing the ecological role of Chara jointly occurring with Munieria. The Cigány-árok and its vicinity (ecposures at Kő utca, at the end of the village, and at Tündérmajor to the west of it are Orbitolina localities known for about 50 years. First description of the orbitolinite in the laminated, thin-beded biogenic limestone of the upper part of the Tés Claymarl and of the large number of isolated Orbitolina species occuring in the marl itself was given by NOSZKY J. (1943), MAJZON L. (1943) and MÉHES K. (1964, 1965) K. MÉHES described the species *Orbitolina baconica* MÉHES (1964) from this site.

The palynomorphs of the Tés Clay marl Formation were studied by JUHÁSZ, M. (1979) who called the attention to the angiosperm pollen grains and their chronostratigraphic importance. The first detailed study of smaller foraminifers was carried out by SIDÓ, M. and BODROGI, I. (in CSÁSZÁR, G. 1986). CSÁSZÁR, G. and BODROGI, I. 1985, in a study entiled "Munieria in the Cretaceous of Hungary" described the calcareous algae of the formation, among others the new *Munieria grambasti* BYSTRICKY sarda CHERCHI et al. subspecies.

A new species, *Munieria tesensis* spec. nov. was also described by them. A new orbitolinite occurence was described by KNAUER, J. and GELLAI, M. B. (1989) from the bauxite exploratory borehole section Csetény 25 drilled in the northern Bakony Mountains.

The Cigány-árok profile

The location of this profile is shown in Fig. 1 while the bed sequence and the microfaunal-floral composition can be seen in Fig. 2.

The Tés Claymarl Formation is lying unconformably on the Upper Aptian Tata Limestone Formation (crinoidal limestone) (CSÁSZÁR, G.'s oral communication 1989), however, the contact has not yet been recovered in the section referred to. On the other hand, in the Faluvégi quarry near the road to village of Borzavár and in front of the outcrop, the contact between the two formations is exposed. Here, in a sample (11.) taken from the weathered surface of the Tata Limestone, SIDÓ (1980) determined forams fauna in which there is a form indicating the Upper Aptian zone: *Hedbergella trocoidea* (GANDOLFI), *Hedbergella infracretacea* (GLAESSNER), *Hedbergella sp.*, *Globigerinelloides cf. algerianus* CUSHMAN et TEN DAM, *Globigerinelloides sp.*, *Ticinella sp.*, *Textularia sp.*, Metazoa: Echinodermata, Spongia-colony, Spongia-spicule, Molluscan shell fragment.

The sample (12.) from the base of the Tés Claymarl only contained redeposited microfauna of the Tata Limestone in which Munieria did not appeared yet.

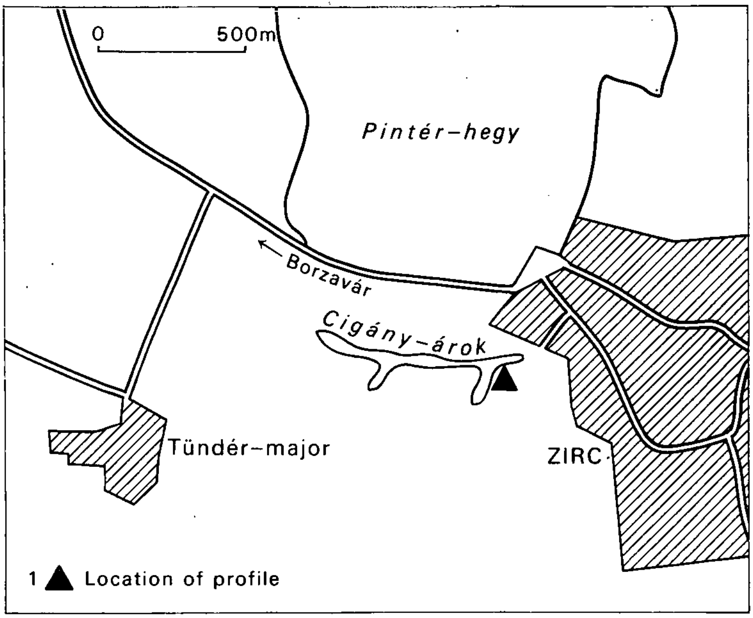


Fig. 1. Location map of Cigány-árok near Zirc — *1. ábra.* A zirci Cigány-árok helyszínrajza
1. The site of section — *1.* A szelvény helye

Bed sequence

Of the 4 m thick incomplete section only the upper 2.2 was studied in details. Its lithological description has been given by CSÁSZÁR, G. (1989. in manuscript). In the lowermost 40 cm of the section recovered yellowish-gray clay is found (sample 1), followed by brownish-grey marl, nodular marl (18 cm, sample 2). Upon these it follows a yellowish-grey clay (22 cm, sample 3), then a yellowish-brown grey-spotted clay with detritus 2—10 cm large in

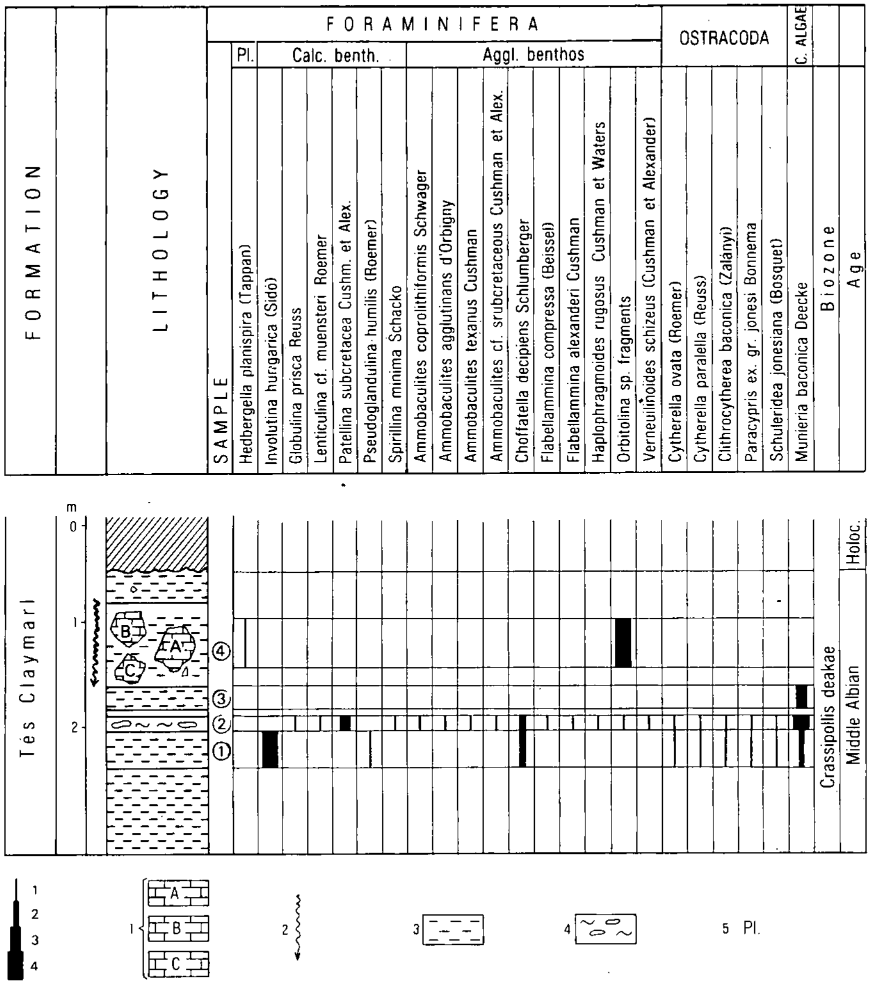


Fig. 2. Fossils of the Tés Claymarl Formation (Zirc, Cigány-árok)
1. biogen limestone, *2.* solifluction, *3.* clay, *4.* nodular claymarl, *5.* plankton (Pl.)

2. ábra. A Tési Agyagmárga Formáció fosszíliái (Zirc, Cigány-árok)
1. biogén mészkő típusminták, *2.* szoliflukció, *3.* agyag, *4.* gumós márga, *5.* plankton (Pl.)

diameter and laminae of Orbitolina and Munieria limestone (110 cm, sample 4). The last part of the sequence is a 30-cm-thick ochre-coloured clay with Munieria and Orbitolina limestone debris with pieces 2—5 cm a large. The two uppermost situated show evidences of sliding, slumping and solifluction. On top of the latter Holocene accumulations appear.

Microfauna and flora

Samples were collected from layers 1—4 and from the detritus of biogenic limestone during the Colloquium (Types A, B and C), from the 1.0—1.5 m part of the section. Simultaneously with the study of foraminifers and calcareous algae, M. MONOSTORI (MONOSTORI—BODROGI—CSÁSZÁR, 1989) described the poorly preserved, reworked assemblage of freshwater ostracods (Fig. 2).

Foraminifers

In the foraminiferal assemblage composed of 16 species benthonic forms, more closely agglutinated benthonic ones prevail (10 species), mainly larger, Ammobaculites and Flabellamina species built of coarse cement material. The appearance and the number of specimens of *Choffatella decipiens* SCHLUMBERGER are conspicuous.

The calcareous benthonic group is represented by the taxa of Lagenidae, Patellina and Spirillina, living also in shallow waters, however, only *Patellina subcretacea* CUSHMAN et ALEX. is more frequent. Each of the four samples shows a conspicuous difference from the others: sample 1 is poor in species, but it prevails therein *Involutina hungarica* (SIDÓ) and the globular primitive planktonic form of *Hedbergella planispira* (TAPPAN) of long time range, appearing with the insets of the first marine ingressions, which is absent in the overlying nodular marl (sample 2), and at the same time it appears together with reworked specimens of *Munieria baconica* DEECKE of bad state of preservation. The benthonic foraminiferal assemblage of sample 2 is rich in species but poor in specimens, merely *Patellina subcretacea* CUSHMAN et ALEXANDER and *Choffatella decipiens* SCHLUMBERGER are a bit more numerous (mean and few, respectively). Many poorly preserved, reworked *Munieria baconica* DEECKE (Plate I, figs. 1, 5), a few enchinoid spines and some fish teeth are also present (Plate I, Fig. 9 and Plate IV, fig. 4). Sample 3 contains only reworked, badly preserved *Munieria baconica*, accompanied by a few *Hedbergella planispira* in sample 4 (Plate I, fig. 2).

During the field trips of the Colloquium I took sample from the biogenic limestone detritus embedded in the yellowish-brown, grey-spotted clay (from an interval ranging from 1.0 to 1.5 m), distinguishing three types (A, B and C) of the concerned rock upon microfaunal characteristics.

Detritus of biogenic limestone, type A

The type in concern contains remains of Orbitolina, Involutina, Munieria, Bivalvia and Gastropoda, and is made of biosparite with coarse sparite matrix. The fossils are rounded, corroded and encrusted, but the segments of *Munieria baconica* are mostly integer and coated with thin, brown-colured, micritic sedimentary crust (Plate II, Fig. 3). Orbitolinae are of different state of preservation: they are in part fragmentary, forming intra-bioclasts, and partly they are rounded without embryonic apparatus and marginal zone. Among them, an only one specimen has preserved its embryonic apparatus, enabling me to identify it with *Orbitolina (M)texana* (ROEMER) (Plate II, Fig. 1).

An assemblage of smaller bentonic Foraminifera

Here *Involutina hungarica* (SIDÓ) is most characteristic, as occupying the second place in dominance behind Orbitolina in the faunula (Plate I, Fig.6; Plate II, Fig. 2; Plate IV, Fig. 3). Subordinate are Miliolinae (small-and-medium-sized Quinqueloculina, larger *Quinqueloculina robusta* NEAGU and *Hauerina* sp. (Plate I, Fig. 10) are obserwable with limonite-coloured tests, moreover some *Flabellammina* sp. and *Marssonella* sp. are also present. Plankton is reprezented by a single small *Hedbergella* sp. only.

Calcareous algae

Calcareous algae are reprezented by *Munieria baconica* DEECKE, *Munieria grambasti* BYSTRICKY, *Marinella lugeoni* PFENDER, *Paraphyllum primaevum* LEMOINE, rags of *Corallinaceae, Salpingoporella* sp., Chara-gyrogonites, *Acicularia* sp. (Plate I, Fig. 1), *Acicularia elongata* (CAROZZI) (Plate IV, Fig. 2) and *Russoella* sp. The first species is frequent and the fourth one medium-frequent; Aciculariae are relatively frequent and varied, whereas the resting taxa are sporadic.

Metazoa

Bivalvia, Gastropoda, Ostracoda, Bzyozoa, Echinoidea, Crinoidea and Serpula belong to here. Bivalvia are mostly Pachyodonta of thick shell, with them structured shell fragments of Radiolitidae also occur. All are stongly rounded, encrusted and corroded. Echinoidea (plates and spines). Gastropoda and Ostracoda are medium frequent. Some Crinoidea, Bryozoa and Spongia also appear.

Incertae sedis

Sporadic *Pieninia oblonga* MIŠIK and *Stomiosphaera sphaerica* BONET (det. by KNAUER, J.) are of concern.

Paleoenvironmental conditions

As for this, a shallow sub-littoral zone with heavy waring is presumed to have existed. The rock is of tempestite type. The freswater calcareous algae evidently are redeposited, and originating from sediments partly or completely consolidated, which had protected them against disintegration, fragmentation. The way of transport may have been short, too.

The concerned rock I consider as a base bed of the Zirc Limestone, produced by a speedy transgression inundating the Zirc bay with an overwhelming force, and reworking the freshwater clay derivable from an earlier-formed or heteropical facies.

Ecological factors

Normal salt content, warm and agitated water of the photic zone, good oxygen supply and muddy-sandy bottom are presumable for the concerned deposition, after taking into consideration the environmental demands of Orbitolinae living in tropical waters in symbiosis with Zooxantellae.

Detritus of biogenic limestone, type B

Serpulite

Serpulite is here limonitic, microsparite-spotted biogenic limestone with calcirudite matrix and overabundant Serpulidae fossils. The rock contains much limonitizing Fe mineral (? pyrite or marcasite) in spots and fine disperzion.

Serpulidae
(Phylum Annelida, ordò Sedentaria)

They are tube-dwelling worms, selecting their dwelling tubes from calcite and aragonite. Serpulidae are of high adaptability, stocking different habitats ranging from the continent to the deep sea, and displaying varied ways of living (sessile and vagile benthos, plankton) (GÉCZY, B. 1985, 1986). Part of them are "inbenthos" organisms living in the loose sediments (filter feeder, mud-glooting), while others can move restrictedly, dragging themselves along on the sands of the backreef platform, as exemplified by the Section Jásd 2 of the Mesterhajag member of the Zirc Limestone. They also can grow on the solid bottom or encrusting skeletons of animals, living or dead. Some serpulids crowd sea bays, lagoons, and from patch reefs. Recent Serpulae are living in larger quantities along the outer margin of the continental threshold, where their skeletal fragments may amount to 10% in the carbonate fraction of the sediment. Tubes can grow at a velocity of 5 to 10 cm per year. Only a minor part of them are terrestrial, they are marine organisms in the main. When being "inbenthonic", they are agents of active bioturbation, causing changes in the structure and chemism of the sediment.

Paleoenvironmental conditions

As for the serpulite of type B rock sample, a shallow sublitoral belt is considered for its depositional environment and, maybe, the pre-existence of patch reef can also be taken into account. The question needs further studies. Now the rock is interpreted as Serpula-bearing facies of the basal beds of the Zirc Limestone Formation.

The stratigraphic range of Serpulae

They are persistent organisms from the Cambrian to recent times.

Detritus of biogenic limestone, type C

C-type rock in detritus is a biogenic, *Munieria baconica* bearing limestone, with fairly much sharp quartz grain and micritic matrix showing pathes and nests of limonite. The *Munieria thalli* stick together, and are of good state of preservation.

The detritus is derivable from the Munieria-bearing freshwater limestone closing the Tés Claymarl Formation. This limestone has turned to be eroded off, leaving behind nothing but detritus.

Paleoenvironment

Shallow, freshwater, coastal lagoons.

Ecological factors

On modern analogies of recent Chara related to Munieria, the latter may have lived in the shallow waters of coastal lagoons. Out of them, *Munieria baconica* is an endemic taxon appearing only in Hungary (CONRAD, M. A. et RADOICIC, R. 1971; BYSTRICKY, J. 1976). Modern Chara organisms, assimilating and of high light demand, are living in photic and clear waters, in shallow-water, quiet and protected lagoons, and on the bottom covered with clay or fine sand, demanding photic, warm and hard water (CSÁSZÁR, G. et BODROGI, I. 1985). Regarding the water depth required by them, it is between a few centimeters and 5 to 30 meters, averaging 10 m (WRAY, J. 1977; HILTERMANN, H. et MÄDLER, H. 1977).

The iron mineral observed in thin sections may have been originally bacterial pyrite, the presence of which is indicative of rather anoxic stagnant water.

Age of the formation

The beds of the Tés Claymarl and of the detritus found in the upper part of our section are nearly of the same age.

Age of the Tés Claymarl in the reference section of Cigány-árok.

The Tés Claymarl and the detritus of Munieria limestone collected from its upper bed No. 4 (detritus of C-type biogenic limestone) are as old as Middle Albian dated upon angiosperm by JUHÁSZ, M. (1977).

A similar or younger age is indicated by the species *Involutina hungarica* (SIDÓ, M. 1952) also indentified in the concerned formation, and being present at many localities, in similar stratigraphic horizons of the peri-Mediterranean province, too (AZEMA, J.—CHABRIER, G.—CHAUVE, P. et FOURCADE, E. 1979;

MOULLADE, M. et PEYBERNES, B. 1974; REITNER, J. 1987: Spain; BOUROULLEC, J. et DELOFFRE, R. 1976: France; REY, J.—BILOTTE, M.—PEYBERNES, B. 1977: Portugal), moreover it is known from Austria, the North Calcareous Alps and from the boulders of Urgonian limestone situated at the base of Gosan (SCHLAGINTWEIT, F. 1987, 1990; WAGREICH, M. et SCHLAGINTWEIT, F. 1990). It turned to be identified in Uppon Cenomanian and Lower Turonian beds (Galala Formation) of North Egypt by KUSS, J. et MALCHUS, N. (1989).

Age of the detritus of biogenic limestone of A and B types considered as base beds of the Zirc Limestone Formation.

In A-type pieces of Orbitolina limestone I identified Orbitolina (M) texana (Roemer, 1849) and, consequently, the base beds of the Zirc Limestone must have been formed at the end of Middle Albian time. According to SCHROEDER & NEUMANN (1985) Orbitolina (M) texana (ROEMER) ranges from the Upper Aptian to the Middle Albian.

From a variety of this rock a little more rich in Orbitolina, MÉHES, K. determined *Orbitolina baconica* MÉHES, 1964, a new species with stratum ranged into the Upper Aptian. On the type specimens of Méhes' collection, stored at the Museum of MÁFI, GÖRÖG, Á. (1990) made statistical analysis. Upon this, out of five type specimens with embryonic apparatus, four ones have been re-determined as beloging to *Orbitolina subconcava* LEYMERIE 1878, and another specimen has turned out to be *Orbitolina* (M) *texana* (ROEMER, 1849).

Orbitolina (M) *subconcava* LEYMERIE ranges from the Upper Aptian into be Albian (SCHROEDER & NEUMANN, 1985). *Orbitolina aperta* (ERMAN, 1854) appearing first in the Upper Albian, was not found in our exposure.

Correlation of the Orbitolina limestone (type A)

The rock in concern seems to be correlatable with the orbitolinite drilled by the bauxite exploratory borehole Csetény 25 (KNAUER, J. and GELLAI, M. B. 1989). The Csetény Limestone is detectable in the area between Zirc and Mór, and was also penetrated by coal exploration drillings around Dudar (D 64, 81, 227, 245 and 248). The dark, argillaceous, at places nodular limestone has developed with unbroken sedimentation from the arenaceous closing beds of the Tés Claymarl as containing Munieria, Ostracoda and Ostraea remains. This limestone is similar also to the Orbitolina limestone found in the NW foreland of the Vértes Mountains. A great majority of Orbitolinae figured in photoplates 3—5 of the two authors are identical with Orbitolina (M) texana (ROEMER) (axial and subaxial sections with marginal zones). Plate VII, photos 1 and 2, moreover Plate VIII, photos 1 and 4 show *Involutina hungarica* (SIDÓ L. 1952). *Hensonina lenticularis* (HENSON), owing to the revision made by PILLER and SCHLAGINTWEIT (1990), has been put on the list of synonyms.

Aknowledgement

My thanks go to PROF. DR. ANTONIETTE CHERCHI (Cagliari) and PROF. DR. ROLF SCHROEDER (Frankfurt) who helped me by consulting throughout the Colloquium, and by their questions put at the meeting they were my inspiration in starting with the collection and study of the biogenic limestone that has been the subject of the present paper.

REFERENCES — IRODALOM

BOUROULLEC, J.—DELOFFRE, R. 1976: Relation Faciés-environnement au Crétacé Moyen en Aquitaine occidentale. — Bull. Centre Rech. — Explor. Prod. Elf-Aquitaine, 10. (2.) 535—583. Pau.

CSÁSZÁR, G.—KOVÁCSNÉ-BODROGI, I. 1985: Munieriák a magyarországi krétában. — Földt. Int. Évi Jel. 1983-ról: 167—212, Budapest.

CSÁSZÁR, G. 1986: A Dunántúli-Középhegységi középső-kréta formációk rétegtana és kapcsolata a bauxitképződéssel. — Geol. Hung. Ser. Geol. 23. 1—207, Budapest.

DEECKE, W. 1883: Über einige neue Siphoneen. — N. Jb. Mineral. Geol. Paläont. 1. 1—14, Wien.

GÉCZY, B. 1985: Ősállattan. — Egyetemi jegyzet, ELTE, TTK: 188—190, Budapest.

GÉCZY, B. 1986: Ősállattan. Tankönyv kiadó, 474., Budapest.

GÖRÖG, Á. 1990: Jelentés a dunántúli-középhegységi orbitolinák vizsgálatáról. — ELTE, TTK, Őslénytani tanszék, 155., Budapest. Földt. Int. Adattára: T 15202.

HILTERMANN, H.—MÄDLER, K. 1977: Charopyten als paleoökologische Indikatoren und ihr Vorkommen in den Sinterkalken von Bad Laer.-Paläont. — Zeitschr. 51. /3/4/, 135—144. Stuttgart.

KNAUER, J.—GELLAI, M. B. 1989: Új orbitolinit kifejlődés az ÉK-i Bakonyban. — Földt. Int. Évi Jel. 1987-ről: 60—83. Budapest.

MAJZON, L. 1943: Előzetes jelentés a Zirc—Bakonycsernye közötti terület földtani viszonyairól. — Földt. Int. Évi Jel. 1939—40-ről, Budapest

NOSZKY, J. 1943: Földtani vázlat az Északi Bakony belső részéből. — Földt. Int. Évi. Jel. 1939—40-ről, Budapest.

NOSZKY, J. 1943: Adatok az Északi-Bakony kréta képződményeinek ismeretéhez. — Földt. Közl. 64., 99—136, Budapest

JUHÁSZ, M. 1979: A dunántúli alsó- és középsőkréta palinológiája. — Kandid. értekezés, Szeged.

KUSS, J.—MALCHUS, N. 1989: Facies and Composite Biostratigraphy Late Cretaceous Strata from Northeast Egypt. — in: WIEDMANN, J. ed.: Cretaceous of the Western Tethys. — Proc. 3rd Int. Cret. Symp., Tübingen 1987. 879—910, Stuttgart (Schweizerbart).

MÉHES, K. 1964: The foraminiferal genus Orbitolina from Hungary. — Acta Geol. 8. (1—4), 265—281. Budapest.

MÉHES, K. 1965: Magyarországi Orbitolina-vizsgálatok. — Földt. Int. Évi Jel. 1963-ról: 95—105.

MONOSTORI, M.—BODROGI, I.—CSÁSZÁR, G. 1989: Zirc, Cigány-árok. — XXI st European Micropaleontological Colloquium, 4—13. IX. 1989. Hungary. Guidebook, 248—251. Budapest.

NEUMANN, M.—SCHROEDER, R. et al. 1981: Tableau dé répartiton stratigraphique des Grand Foraminiféres caractéristiques du Crétacé moyen de la region méditerranéenne. — Cretaceous Res. 2. 383—395, London.

REITNER, J. 1987: Mikrofazielle, palökologische und paläogeographische Analyse ausgewählter Vorkommen flachmariner karbonate im Basko-Kantabrischen Strike Fault-Becken-System (Nordspanien) an der Wende von der Unterkreide zur Oberkreide. — Documenta Naturae, 40., 1—239. München.

REY, J.—BILOTTE, M.—PEYBERNÉS, B. 1977: Analyse biostratigraphique et paléontologique de l' Albien marin d'Estremadura (Portugal). — Géobios, 10. (3), 369—393. Lyon.

SCHLAGINTWEIT, F. 1987: Allochthone Urgon-Kalke aus Konglomeraten der basalen Gosau (Coniac) von Oberwössen (Chiemgau-Nördliche Kalkapen). — Mitt. Bayer. Staatsslg. Paläont. hist. Geol. 27. 145—158. München.

SCHLAGINTWEIT, F. 1990: Allochthone Urgonkalke im Mittleren Abschnitt der Nördlichen Kalkalpen: Fazies, paläontologie und Paläogeographie. — Dissertation Univ. München: 151 S., München.

SCHROEDER, R.—NEUMANN, M. 1985: Les Grandes Foraminiferes du Crétacé Moyen de la Région Mediterranéenne. — Geobios, Memorie Special No. 7. 1—161., Ed. de Univ. Clode Bernard, Lyon.

SIDÓ, M. 1952: Az úrkúti mangánösszlet fedőrétegének Foraminiferái. — Földt. Közl. 82..: 386—396. Budapest.

SIDÓ, M. 1975: A Tatai Formáció Foraminiferái (felső apti). — Földt. Közl. 105.: 155—187. Budapest.

SIDÓ M. 1980: A Tési Agyagmárga Formáció Foraminiferái. — MÁFI Őslénytani Osztály AD, 31 16 tábla, Budapest.

Szerző nélkül 1880: E:8 1:144 000 földtani térkép.

A TÉSI AGYAGMÁRGA FORMÁCIÓ ZIRC, CIGÁNY-ÁRKI REFERENCIA SZELVÉNYÉNEK MIKROFAUNA ÉS MÉSZALGA VIZSGÁLATA (É-BAKONY, KÖZÉPSŐ-ALBAI)

BODROGI ILONA

Magyar Állami Földtani Intézet
Budapest, Stefánia út 14.
H-1143

ETO: 552.5 (234.373.1)
551.763.13 (234.373.1)

Tárgyszavak: Tési Agyagmárga Formáció, középső-albai, mikrofauna, mikroflóra, faunalista, Orbitolina, Munieria, őskörnyezet, korreláció, Bakony

Több, mint 100 évvel első felismerése és térképi ábrázolása után 1989-ben került sor a Tési Agyagmárga F. Zirc—Borzavár közti nagyobb felszíni előfordulása egyik referncia szelvényének, a Cigány-árki szelvénynek feldolgozására és bemutatására a hazánkban megrendezett XXI. Európai Mikropaleontológiai Kollokvium alkalmából.

Erről a területről, Zirc környékéről gyűjtötte be és küldte el HANTKEN M. W. DEECKÉnek azt az ismeretlen mészalgát tartalmazó kőzetmintát, melyből DEECKE 1883-ban a *Munieria baconica* fajt leírta. Ez az első Magyarországról leírt mészalga, mely a szakirodalomban nyomon követhető számtalan félreértés ellenére endemikus édesvízi faj, csak a Bakonyból és ÉK-i előterérből ismert.

A Tési Agyagmárga Formáció diszkordánsan települ a felső apti Tatai Mészkő Formációra (*Globigerinelloides algerianus* zóna, SIDÓ 1975), fedőjét tetemes üledékhézaggal holocén képződmények alkotják, de konkrétan a cigányárki szelvényben a Tési Agyagmárga Formáció és a Tatai Mészkő Formáció kontaktusa nincs feltárva, viszont a feltárással szemben, a Borzavárra vivő műút mellett a Faluvégi kőfejtő feltárja a két formáció kontaktusát. A Tatai Mészkő mállott felszínéről vett mintából (11.) SIDÓ M. (1980) az alábbi Foraminifera faunát határozta meg, melyben a felső apti zónajelző taxon is előfordul: *Hedbergella trocoidea* (GANDOLFI), *Hedbergella infracretacea* (GLAESSNER), *Hedbergella sp.*, *Globigerinelloides cf. algerianus* CUSHMAN et TEN DAM, *Globigerinelloides sp.*, *Ticinella sp.*, *Textularia sp.*, Metazoa: Echinodermata, Spongia-telep, Spongia-tű, Mollusca héjtöredék.

A Tési Agyagmárga bázisáról származó minta (12.) csak a Tatai Mészkő áthalmozott mikrofaunáját tartalmazta, melyben még nem jelentek meg a Munieriák.

A fúrásokkal feltárt, édesvízi-brakkvízi-tengeri üledékekből álló ciklikus felépítésű sorozatból a feltárás csupán mintegy 4 m-t képvisel, melynek felső szakaszát vizsgáltuk. A 3-as réteg *M. baconica* tartalmú édesvízi agyag (2. ábra), az alatta települő 1. és 2. réteg tengeri foraminiferás gumós agyagmárga és agyag, áttelepített rosszmegtartású, édesvízi Ostarcodákkal (MONOSTORI M. det.) és *Munieria baconicá*val. A 16 fajból álló Foraminifera együttesben a nagytermetű, durvahomokos házú Ammobaculites és Flabellammina fajok uralkodnak. A fauna jellegzetes eleme a bonyolult felépítésű *Choffatella decipiens* SCHLUMB. és *Involutina hungarica* (SIDÓ).

Az *Involutina hungarica* fajt SIDÓ M. (1952) a tárgyalt formációból írta le és számos lelőhelyről azonosította (Sidó M. 1980). Sok hivatkozás bizonyítja a faj nagy földrajzi elterjedését (Perimediterrán-provincia, É-Afrika), első megjelenése a középső-albaira datálható összhangban JUHÁSZ M. (1979) adataival, aki zárvatermő pollenszemcsék alapján a formációt a középső-albaiba sorolta (*Classipollis deakae* zóna).

Megvizsgáltuk a szelvény felső másfél méretéből származó biogén mészkő törmeléket is, melynek 3 típusát (A, B, C) különítettük el: A., orbitolinás, involutinás, munieriás, molluszkás biopátit, B., serpulit: féregjáratos, ostracodás biosparit, C., *Munieria baconica* tartalmú intrabiomikrit. Az A-típusban orbitolinák figyelhetők meg (többségük erősen koptatott, peremi zóna- és embrionális apparátus nélküli), kisebb részükön még látható a permi zóna, így a Mezorbitolinákhoz sorolhatók, közülük egy példány fajra is határozható (2. tábla, 1. ábra) és az *Orbitolina (M) texana* (ROEMER) fajhoz sorolható, mely a lepusztult kőzettörmelék középső albai, vagy annál fiatalabb kora mellett szól. Kísérője: a Corallinaceae-hez tartozó *Paraphyllum primaevum* LEMOINE vörös alga.

A, B és C-típusú biogén mészkő korjelző index fossziliát nem tartalmazott.

PLATES — TÁBLÁK

Plate I — I. tábla

1. *Munieria baconica* DEECKE
Sample 2, SEM photo
30 X

2. *Hedbergella planispira* (TAPPAN)
Sample 4, SEM photo
300 X

3. *Acicularia* sp.
From the detritus of biogenic limestone, type A, bed No. 4, 1st thin section
136 X

4. *Pieninia oblonga* BORZA et MIŠIK
From the detritus of biogenic limestone, type A, bed No. 4, 1st thin section
136 X

5. *Munieria baconica* DEECKE
Sample 2, SEM photo
240 X

6. *Involutina hungarica* (SIDÓ)
From the detritus of biogenic limestone, type A, bed No. 4, 1st thin section
53 X

7. *Choffatella decipiens* SCHLUMBERGER
Sample 3, SEM photo
25 X

8. *Ammobaculites agglutinans* (D'ORBIGNY)
Sample 2, SEM photo
75 X

9. Fish tooth
Sample 2, SEM photo
650 X

10. *Hauerina* sp.
From the detritus of biogenic limestone, type A, bed No. 4, 1st thin section
136 X

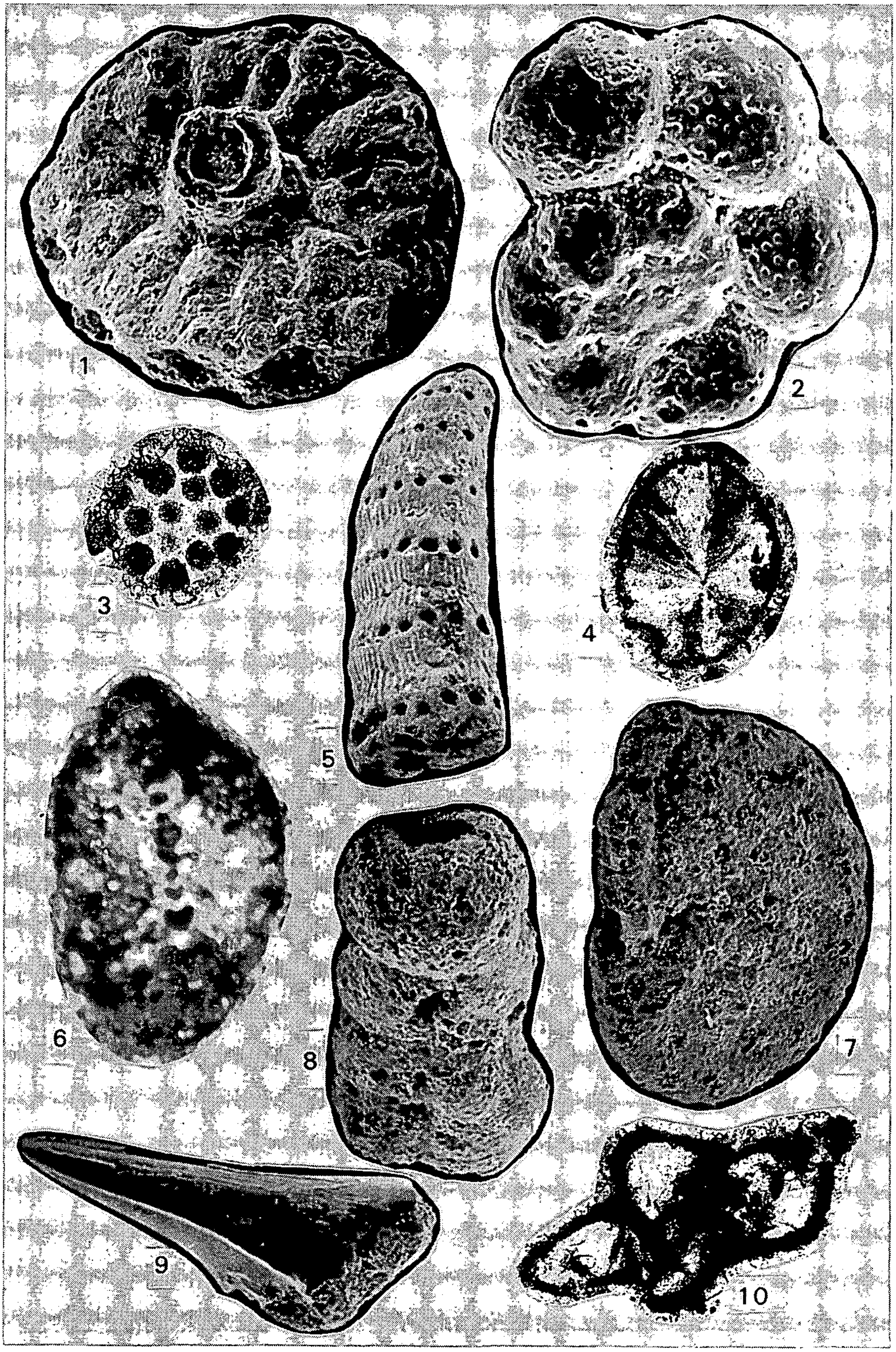

1
2
3
4
5
6
8
7
9
10

Plate II — II. tábla

1. *Orbitolina (M) texana* (ROEMER)
From the detritus of biogenic limestone, type A, bed No. 4, 2st thin section

40 X

2. *Involutina hungarica* (SIDÓ)
From the detritus of biogenic limestone, type A, bed No. 4, 3st thin section

53 X

3. *Munieria baconica* DEECKE
From the detritus of biogenic limestone, Type C, bed No. 4, 4st thin section

20 X

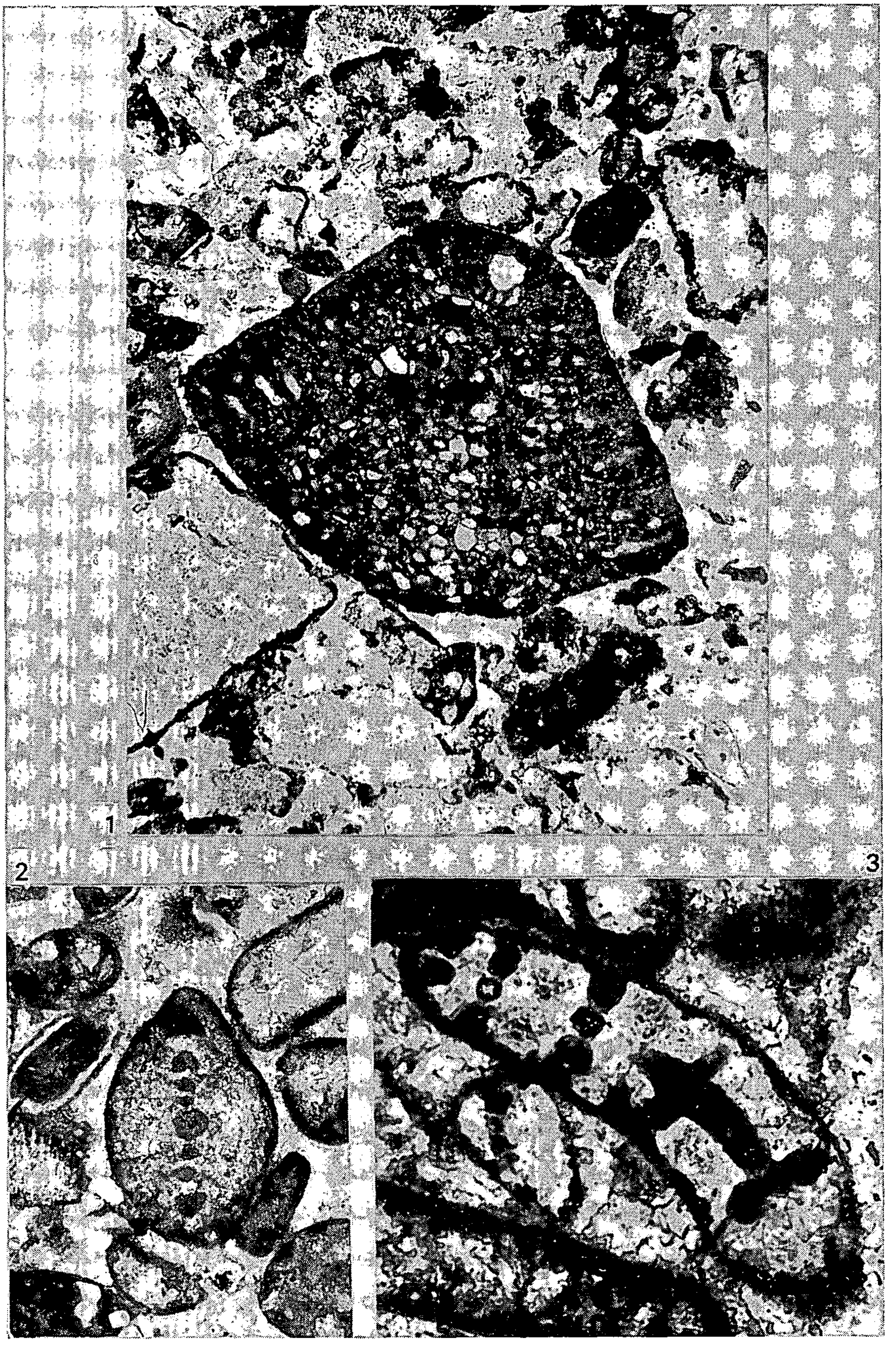

1
2
3

Plate III — III. tábla

1—2. Serpulite
Detritus of Biogenic limestone type E 5th thin section

8 X


1
2

Plate IV —IV. tábla

1—3. Detritus of biogenic limestone type A (from sample 4)

1. *Paraphyllum primaevum* LEMOINE
1st thin section
53 X

2. *Acicularia elongata* (CAROZZI)
1st thin section
212 X

3. Fish tooth
Sample 2, SEM photo
600 X

4. Intrabiopatite
(Detritus of biogenic limestone type A from sample 4th):
Involutina hungarica (SIDÓ), *Munieria baconica* DEECKE, Orbitolina detritus, Ostracoda, Molluscan shell detritus, Rhodophytic shred

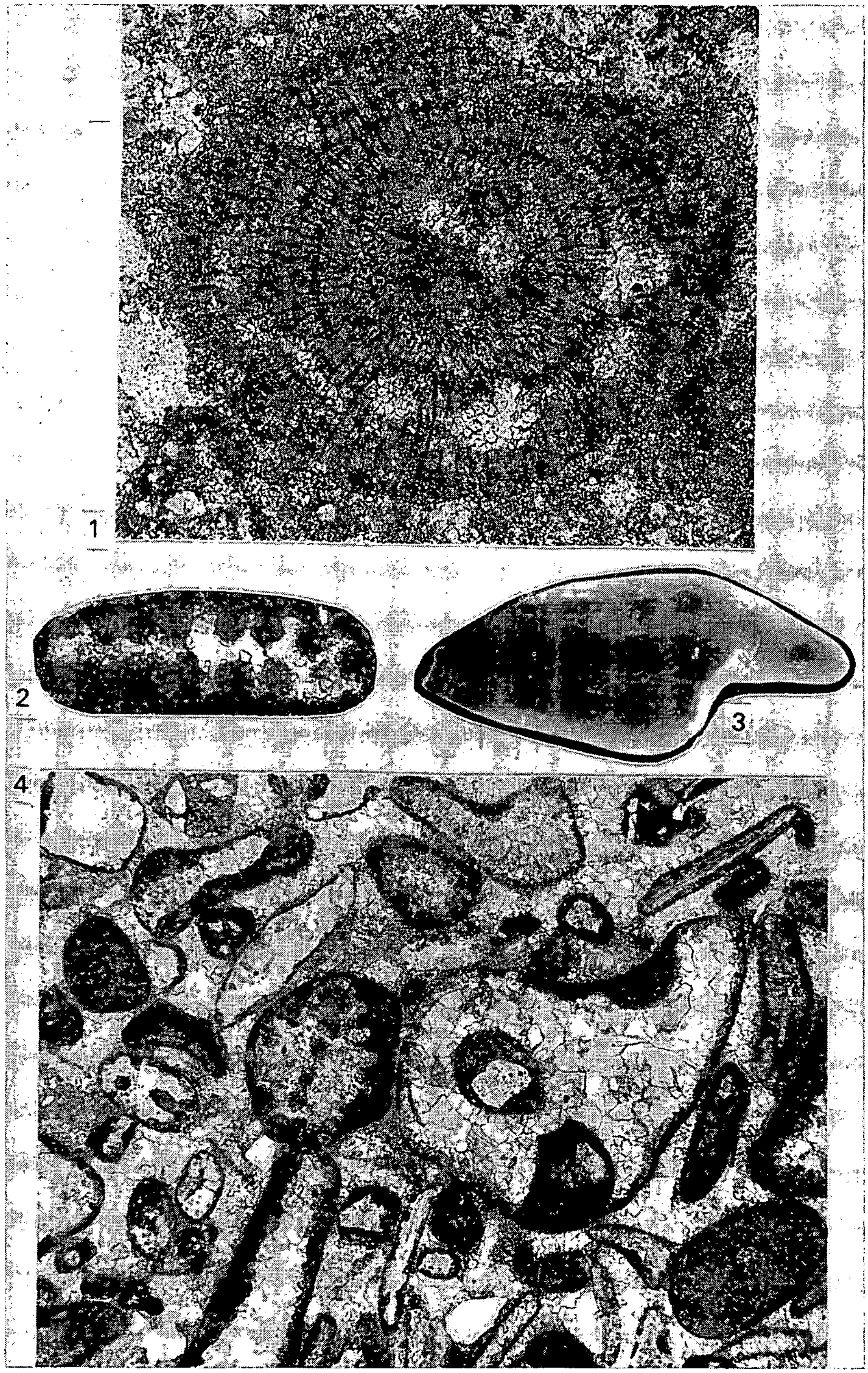

1
2
3
4

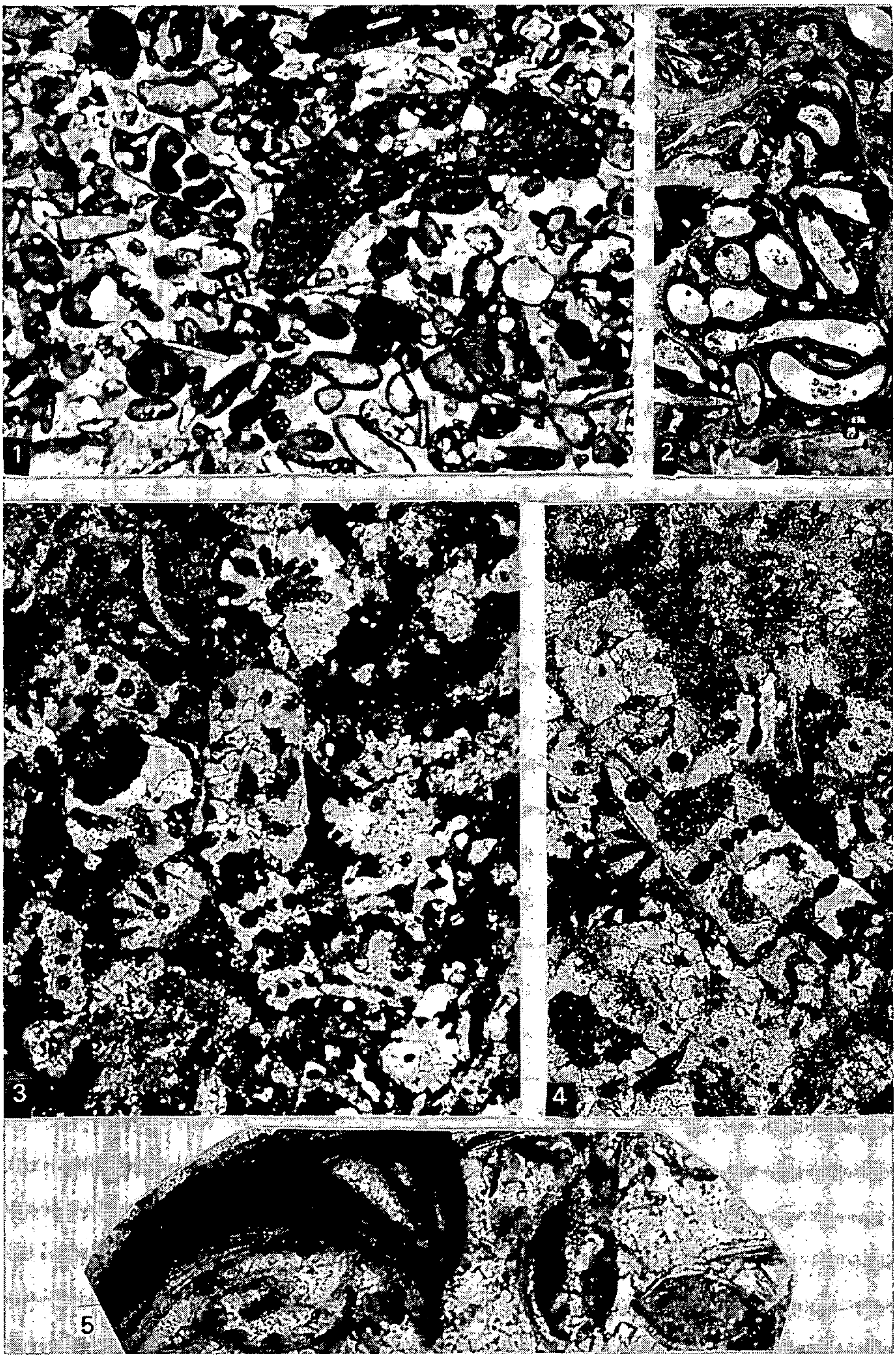
Plate V —V. tábla

1. Detritus of biogenic limestone type A, bed No. 4:
Orbitolina (Mezorbitolina) sp., *Munieria baconica* DEECKE, Gastropoda, Serpula, Molluscan shell detritus, 1st thin section
8 X

2. Detritus of biogenic limestone type B: serpulite, 5th thin section
8 X

3—4. Detritus of biogenic limestone type C, bed No. 4 with *Munieria baconica* DEECKE, 6th thin section
31 X

5. Detritus of biogenic limestone type B, bed No. 4:
Serpula Ostracoda
31 X


1
2
3
4
5

A REVISION OF STRATOTYPE SECTIONS OF THE ZIRC LIMESTONE FORMATION WITH THEIR STRATIGRAPHIC DIVISION ON THE BASIS OF FORAMINIFERS AND CALCAREOUS ALGAE (UPPER ALBIAN, N BAKONY MTS, HUNGARY)

by

ILONA BODROGI

Hungarian Geological Survey
Budapest, Stefánia út. 14.
H-1143

UDC: 561.26.026(234.371.1)
563.12(234.371.1)

Keywords: Foraminifera, calcareous alga, N Bakony Mts, Upper Albian, Zirc Limestone Formation

The Zirci Limestone Fm. of the Northern Bakony, developed in Urgonian facies, belongs to the Upper Albian. Stratotype sections of its three members — Eperkés-hegy Member, Mesterhajag Member, Gajavölgy Member — can be studied at the Eperkés-hegy and in the Jásd 2 and Bakonynána 1 outcrops.

In the present paper the first occurrence of the *Salpingoporella hasi* CONRAD, RADOIČIĆ & REY species in Hungary is identified from the Eperkés-hegy Member. The Orbitolina assemblage consists of *Orbitolina (M.)* gr. *subconcava* LEYMERIE, *Orbitolina (M.) aperta* (ERMAN). The Mesterhajag Member is characterized by the prasence of *Orbitolina (C.) conica* (D'ARCHIAC), while the youngest Gajavölgy Member contains *Rotalipora appenninica* (RENZ) *Planomalina buxtorfi* and *Coskinolinella* n.sp. The Salpingoporella species are missing from both of them. The Vimportalgae (*Paraphyllum primaevum* LEMOINE), *Kymalithon belgicum* (FOSLIE), *Archaeolithothamnium rude* LEMOINE are considered as new elements.

The Upper Albian index fossil of the southern margin of the Tethys, the *Salpingoporella dinarica* RADOIČIĆ is lacking either in the Northern Bakony and the Villány platform fragments or in the Apátvarasd Limestone Fm, outcropping in allochtonous position inside the Vékény volcanosedimentary sequence of the Mecsek. On the contrary the *Coskinolinella* n.sp. is present in each of the three area mentioned above. Its description is under way.

Introduction

A study for revising the foraminiferal and calcareous-algal associations encountered in the rocks of surface geological sections representing stratotype (Olaszfalu, Eperkés-hegy, Jásd 2, Bakonynána 1) of the Zirc Limestone Formation and a field trip for demonstration were done at the request of the Hungarian Geological Society on the occasion of the XXIth European Colloquium on Micropaleontology held in 1989 in Hungary.

A brief review of the history of research

F. HAUER (1861) was the first to identify this rock unit in the N Bakony Mountains near Bakonybél and Zirc, describing them as Zirc Beds and Lókút Beds of reef limestone facies assignable to the Gault. Their South-Alpine facies was first stated by G. STACHE (1881—82), classifying the Caprotina-bearing limestone to the Neocomian. He also said this unit to be similar to the Schrattenkalk in Voralberg, near Geneve. The latest paper dealing in detail with the history of research of this formation, including its comprehensive description has been made by CSÁSZÁR G. (1986). The location of profiles is shown in Fig. 1.

Description of profiles

The visual, lithological description of each section and the geological columns concerned as well as the related system of symbols applied have been taken over from CSÁSZÁR G. (1986). No continuous stratotype sections of member rank of the Zirc Limestone Formation can be studied along the section lines concerned. The limiting superficial stratotype between the Zirc Limestone

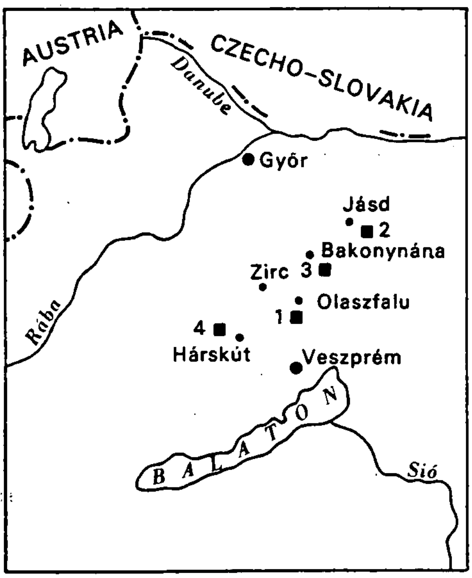


Fig. 1. Localities of investigated profiles — *1. ábra.* A vizsgált szelvények helye
1. Olaszfalu, Eperkés-hegy; *2.* Jásd; *3.* Bakonynána; *4.* Hárskút

Formation and the underlying Tés Claymarl Formation has not been marked out yet.

Olaszfalu, Eperkés-hegy (Eperkés-hegy Member)

The stratotype profile of the lower member, referred to as Eperkés-hegy Member, of the Zirc Limestone Formation is exposed in a cliff atop the hill including its karstified continuation recovered (Fig. 3). For the site of the exposure, see Fig. 2.

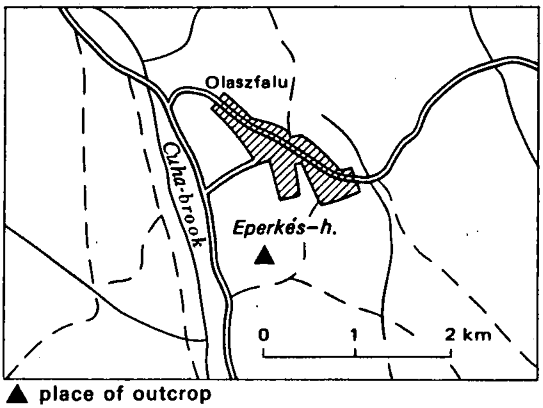


Fig. 2. Site of the exposure of Eperkés-hegy Member, Upper Zirc Limestone Formation, at Eperkés-hegy near Olaszfalu

2. ábra. A Zirci Mészkő Formáció alsó, Eperkés-hegyi Tagozatának helye az olaszfalui Eperkés-hegyen

Description

A 26-m-thick unit of bioclast-bearing limestone with frequent rudistids (mainly Agriopleura species) is concerned here. The lower part of the rock is thick-bedded, whereas in the upper part the thick beds are intercalated by thin ones.

In its upper part comprising the lower portion of the Mesterhajag Member, its transition into microfaunal limestone is also visible. As shown by thin section studies, a strongly homogenized, lithified cryptalgal material derivable from Rhodophyta being, in addition to rudistids, a main reef-building one is frequently encountered in almost all samples.

The results of microfaunal and the floral examination are shown in Fig. 4.

Foraminifers

Benthonic forms, large or of differentiated test, are prevailing. *Involutina hungarica* (SIDÓ), *Nezzazatinella picardi* (HENSON), *Nezzazata simplex* OMARA and *Dobrogelina ? angulata* CALVEZ are noteworthy.

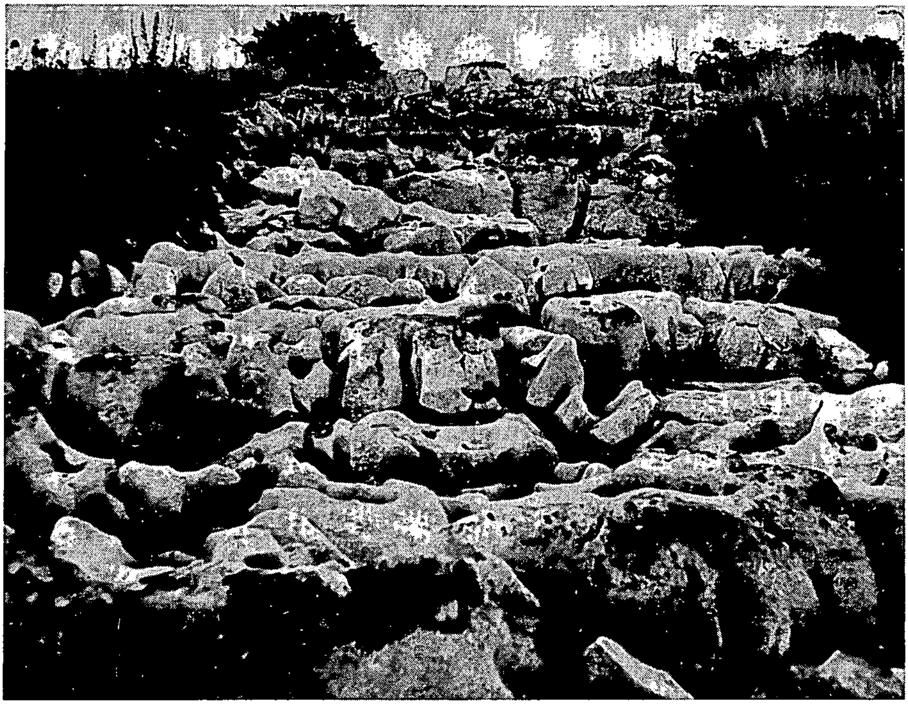


Fig. 3. The stratotype profile of Eperkés-hegy Member, Zirc Limestone Formation, on the hillside of Eperkés-hegy near Olaszfalu

3. ábra. A Zirci Mészkő Formáció Eperkés-hegyi Tagozatának sztratotípus szelvénye az Olaszfalu melleti Eperkés-hegyen

Planktonic elements are sporadical with presence restricted to the two lower samples (samples 1 and 4) and sample 19. They are represented by *Hedbergella* sp. and *Praeglobotruncana* sp. The greatest number of specimens is exhibited by Textulariidae and *Charentia cuvillieri* NEUMANN, with their frequency maxima coinciding, in the lower part of the sequence, with the occurrences of the large *Dicyclina schlumbergeri* MUNIER—CHALMAS, ? *Choffatella* sp. *Nautiloculina* cf. *bronnimanni* PEYBERNES of differentiated makeup as well as the primitive Orbitolina-related taxa (Cuneolina, Sabaudia, Vercorsella).

Orbitolina are encountered in the upper part of the sequence. Of them, *Orbitolina* (M) *subconcava* (LEYMERIE) specimens have been identified (Plate V, Fig. 10).

The following taxa are not indicated in the microfaunal profile: *Cyclogyra ?* sp., *Pseudotriloculina* sp., *Haplophragmoides* sp., *Glomospirella* sp., *Reophax* sp., *? Flabelammina* sp., *Lenticulina* sp. and *Nubecularia reicheli* RAT. Of them, the first taxon occurs in almost every sample, whereas the rest are sporadical and can only be observed as encrusting the rounded and corroded shells of rudistids in a few of the last samples (samples 15, 5 and 21b). They all are transient forms.

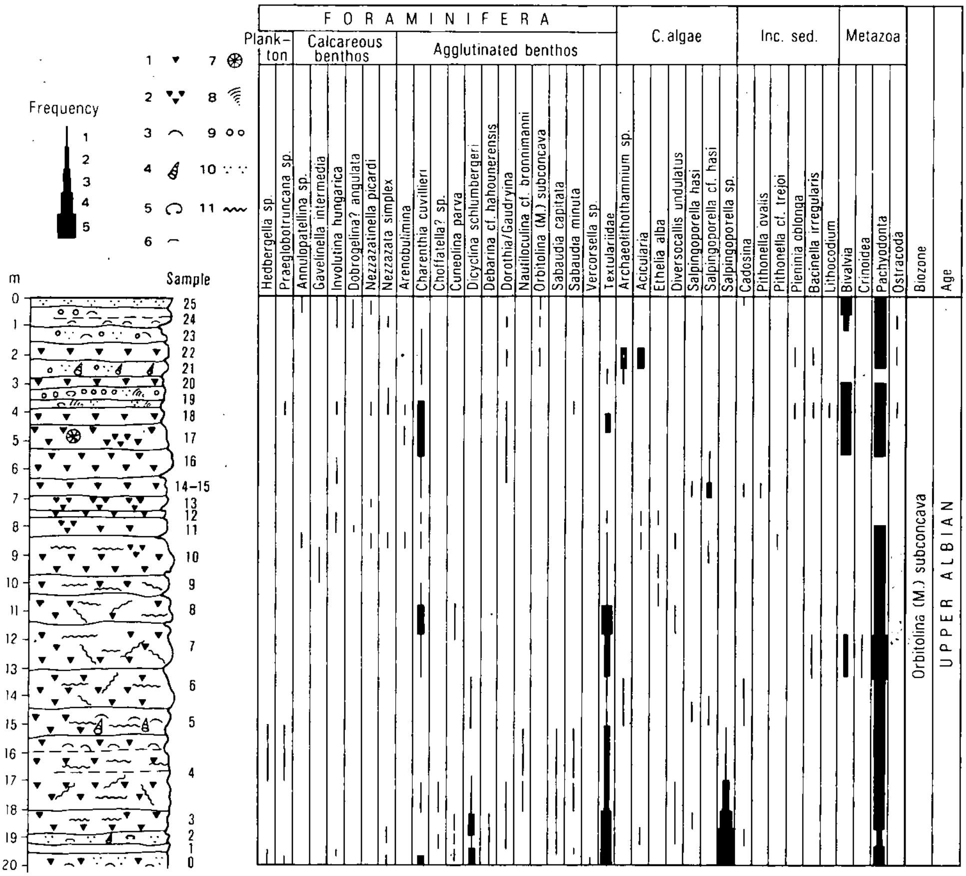


Fig. 4. Results of microfaunal study of the lower interval of the Zirc Limestone Formation in Eperkés-hegy at Olaszfalu

Geological log: *1*. Rudista, *2*. small rudistids in clusters, *3*. other bivalves, *4*. gastropods, *5*. sea urchinns, *6*. Orbitolina, *7*. corals, *8*. Archaeolithothamnium, *9*. oncoids, *10*. oöids, *11*. clay film; *0—25*: number of strata; frequency: *1*. sparse, *2*. few, *3*. mean, *4*. frequent, *5*. abundant

4. ábra. A Zirci Mészkő alsó szakaszának (Eperkés-hegyi Tagozat) mikrofauna vizsgálatának eredménye

Rétegoszlop: *1*. Rudista, *2*. aprótermetű Rudista-kolónia, *3*. egyéb kagyló, *4*. csiga, *5*. tengeri sün, *6*. Orbitolina, *7*. korall, *8*. Archaeolithothamnium, *9*. onkoid, *10*. ooid, *11*. agyagfilm; *0—25*: rétegszám; gyakoriság: *1*. szórványos, *2*. kevés, *3*. közepes, *4*. gyakori, *5*. tömeges

Calcareous algae

Salpingoporella hasi CONRAD, RADOICIC & REY including its fragments are observed in the lower part of the sequence (samples 0 through 5) and in samples 10 through 16 (Plate 1, Fig. 1 and Plate II, Fig. 2). Fragments of Salpingoporella observed in samples 0 through 5 is also likely to correspond to this species identified for the first time Hungary. Additional calcareous algal taxa occurring sporadically and in small amounts are *Ethelia alba* PFENDER, *Diversocallis undulatus* DRAGASTAN, *Acicularia* sp. and *Archaeolithothamnium* sp. The last two taxa occur in the upper part of the sequence (samples 22 and 23), and their quantity is fair. The greater part of the lithified red algal derivatives are likely to have originated from Archeolithothamnium.

Incertae sedis

It is represented by *Cadosina* sp., *Pithonella ovalis* KAUFMANN, *Pithonella* cf. *trejoi* BONET sporadically, as well as *Bacinella irregularis* RADOICIC and *Lithocodium* sp. In a single sample (sample 15) *Cercidina supracretacea* VOGLER (Det. RADOIČIĆ) is observed (Plate 7, Fig. 3).

Metazoa

Pachyodonta shells and other bivalves are frequent or abundant, whereas gastropods and crinoids are only observed here and there. *Pieninia oblonga* MISIK which is, according to R. RADOICIC, an *Alcyonaria spicule*, non-algal remain (pers. comm.) is also sporadically observed.

Stratigraphy

In regard to stratigraphy, the noteworthy species include *Involutina hungarica* SIDÓ and species of Nezzazatidae: *Nezzazatinella picardi* (HENSON), *Nezzazata simplex* OMARA, *Dobrogelina (?) angulata* CALVEZ, *Cuneolina pavonia* (D'ORBIGNY), *Orbitolina subconcava* (LEYMERIE) and *Sabaudia capitata* ARNAUD-VANNEAU. For their greater part, the occurrences are shown in Fig. 5. The author describing *Sabaudia capitata* ARNAUD-VANNEAE deems that this species disappearrs from rocks of the Vercors platform in France in the Middle Albian (ARNAUD-VANNEAU 1978). In disfavour of the disappearing species, the appearing ones such as *Nezzazatinella picardi* (HENSON) and *Nezzazata simplex* OMARA entering in the Late Albian (Fig. 5) should be preferred. *Orbitolina (M) subconcava* (LEYMERIE) is a species of long range (Late Aptian-Late Albian).

The age of the member

B. PEYBERNES (1979) has identified *Orbitolina (O) concava* (LAMARCK) and *Orbitolina (M) aperta* (ERMAN) species from the locality Eperkés-hegy, without giving a sketch of profile or sampling site. K. MÉHES (in CSÁSZÁR, G. 1986, a reference to pers. comm.) also deems that an occurrence of *Orbitolina (O) concava* and *Orbitolina (M) aperta* is concerned. According to SCHROEDER and NEUMANN (1985) *Orbitolina (O) concava* is a species appearing in the Early Cenomanian. However we have no evidence proving that the member in concern would be younger than the latest Albian. This is also supported by the appearing Praeglobotruncana. *Orbitolina (M) aperta* ERMAN species has recently been identified by GÖRÖG, Á. (1990) in the youngest part of the sequence (bed 27, Mesterhajag Member). This also backs up our opinion.

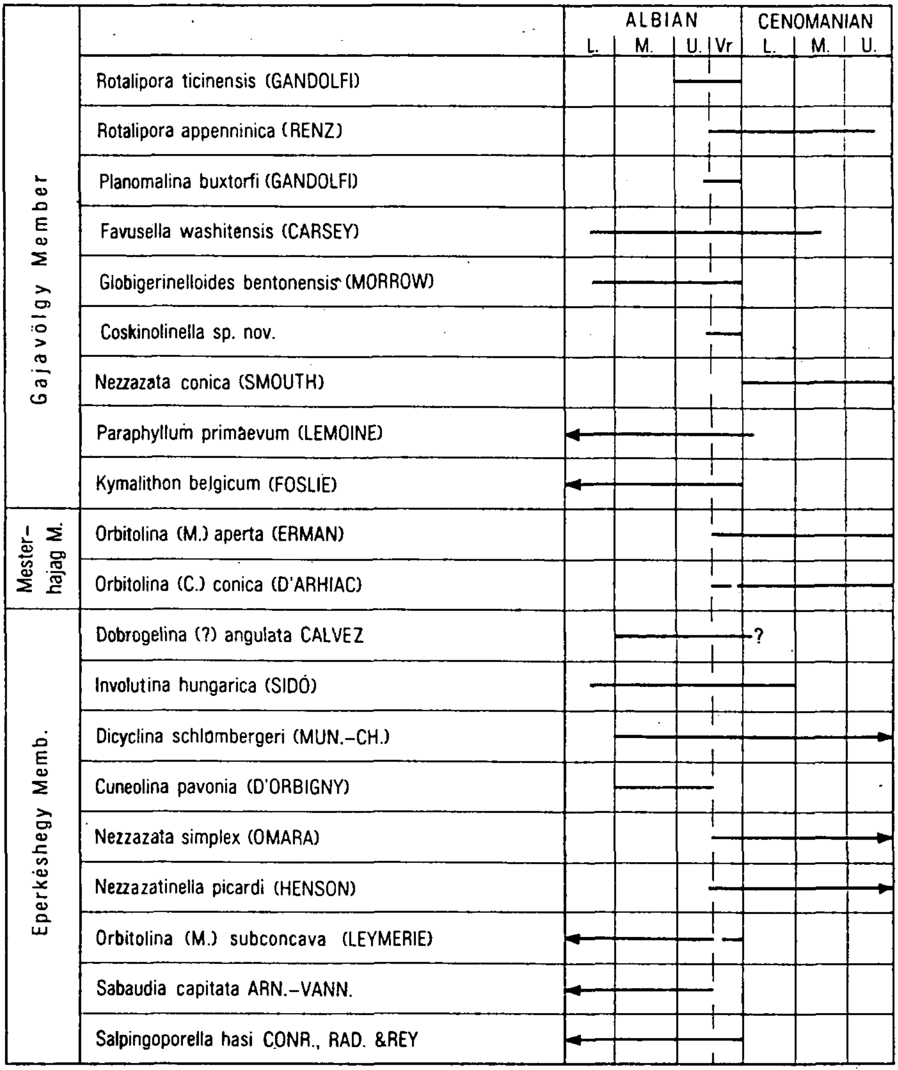


Fig. 5. The chronological distribution of the major foraminiferal and calcareous algal species of the Zirc Limestone Formation

5. ábra. A Zirci Mészkő Formáció fontosabb foraminifera és mészalga fajainak időbeni elterjedése

Profile Jásd J 2 (Mesterhajag Member)

The Mesterhajag Member, of the Zirc Limestone Formation is exposed in the quarry of Jásd (section marked J 2, Fig. 6).

The middle member of the Zirc Limestone Formation, referred to as Mesterhajag Member, includes Orbitolina-bearing limestone, the lower fossiliferous horizon and the upper part of the microfaunal limestone. The lower part of the upper member (Gajavölgy Member) of the formation in concern can be seen even today in the exposure. Rocks included in the Mesterhajag Member are rather difficult to separate, either macroscopically or microscopically, in the profile (Fig. 7, beds 0 through 10).

The light brown or grey, small-grained or, less frequently medium-grained limestone contains, in addition to small forams and Orbitolinae, only a few bivalves. The approx. 2-m-thick, so called lower fossiliferous level is a yellowish-brown or greyish-brown, bioclast-bearing limestone consisting of beds 20 to 50 cm thick. Rynchostreon occurs in mass in them. Worm tubes (*Serpula* sp.) and bivalves are also frequent. In addition, gastropods, enchinoids, corals and Orbitolinae can also be observed.

Benthonic foraminifers

Out of the 36 taxa shown in the microfauna table (Fig. 7), one-third of the taxa can be identified to the level of species. They are well preserved. The fauna features the dominance of arenaceous benthos (18 taxa, of which 8 can be determinded to the level of species). Included in them are Orbitolinae which are of greatest importance for stratigraphy. They are as follows:
Orbitolina (Conicorbitolina) conica (D'ARCHIAC)
Orbitolina (M.) aperta (ERMAN)
Orbitolina (M.) cf. *subconcava* (LEYMERIE)
Accessorial ones are as follows:
Nezzazata simplex OMARA
Vercosella cf. *scarsellai* ARNAUD-VANNEAU
Dobrogelina (?) angulata CALVEZ

Textulariidae have the greatest number of specimens which is, in the lower part of the sequence, parallel with the poorly-preserved, fragmental, rounded *Orbitolina* sp. and the maximum number of individuals of Miliolina.

Planktonic foraminifers

They are represented by transient-type *Hedbergella* div. sp., *Globigerinelloides* sp., and *Favusella washitensis* (CARSEY).

It is only the species of the Hedbergella genus that have a comparatively great number of specimens.

Calcareous algae

They are represented by *Corallinaceae of Vimport facies:*
Achaeolithothamnium rude (LEMOINE)
Kymalithon belgicum FOSLIE
Paraphyllum primaevum (LEMOINE)

The age of the Mesterhajag Member

B. PEYBERNES (1977, 1979) has assigned this member to the *Orbitolina (O.) concava Zone*, dating its age as Late Albian (Vraconian). However, according to M. NEUMANN and R. SCHROEDER (1981), and R. SCHROEDER and M. NEUMANN (1985) *Orbitolina (O.) concava* appeared not in the Late Albian but

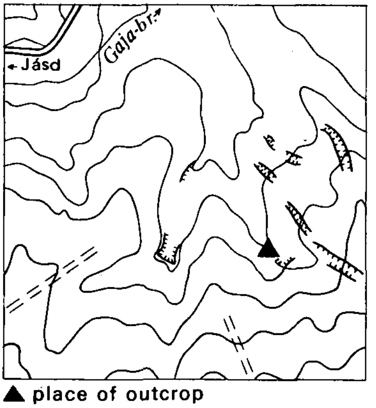


Fig. 6. The site of profile Jásd 2 of the middle Mesterhajag Member of Zirc Limestone Formation

6. ábra. A Zirci Mészkő Formáció középső, Mesterhajagi Tagozatának helye a Jásd 2 szelvényben

later in Early Cenomanian time. The combined occurrence of *Orbitolina (M.) aperta and Orbitolina (C.) conica* indicates a Vraconian age (BODROGI, I. 1989). This is also supported by the presence of *Rotalipora* sp. and *Praeglobotruncana* sp. in the Gajavölgy Member (in the lower part of the member) of the profile as well as by *Rotalipora appeninica* (RENZ) (BODROGI, I. 1989) identified in the upper part of the member, in the adjacent profile Bakonynána, which gives an Early Vraconian date to the member (Plate VII, Fig. 1).

K. MÉHES (1964) has described a new subspecies from an exposure of "Orbitolina-bearing Limestone" around Hárskút, referring to it as *Orbitolina texana lata* MÉHES, 1964. After studying the thin section Inv. No. K. 443 guarded in the Collection of the Hungarian Geological Survey, the holotype has been reassigned to *Orbitolina (M.) aperta* (ERMAN) species a photo of which is enclosed in this paper (Plate IV, Fig. 3). *Paraphyllum primaevum* (LEMOINE) red alga is frequently observed as an accompanying form.

The lower part of the Gajavölgy Member (Beds 11—1)

This rock overlies with unconformity the karstified surface of the Mesterhajag Member of the Zirc Limestone. Its lower, 20-cm-thick part contains limestone rich in glauconite, and glauconitic marl with slightly rounded pebbles of the older members of the Zirc Limestone, as well as chert nodules. This lower horizon consists of clayfilm- intersected, 20-to 60-cm-thick beds which are grey, greenish-grey, silty, fine-sandy and glauconitic, with a sand content decreasing upwards, and with carbonized plant fragments, and a large amount of Serpula and Echinoidea detritus. Intensive bioturbation and a great number of trace fossils are also observable therein.

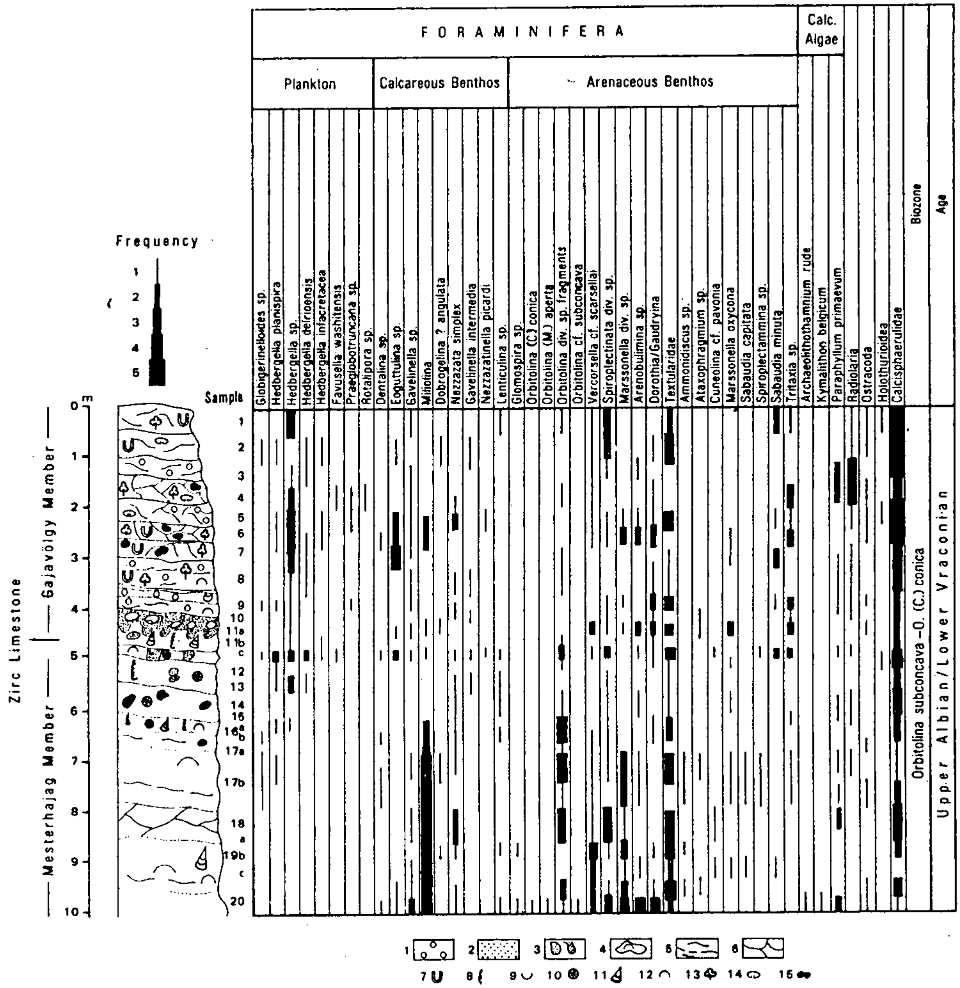


Fig. 7. The results of microfaunal study of profile Jásd 2, middle interval (Mesterhajag Member) of the Zirc Limestone Formation

Geological log: *1.* alien calcareous sand, *2.* glaukonite, *3.* glaukonitic cavity infilling, *4.* fossiliferous limestone clastics in glaukonitic limestone, *5.* clay intercalations, *6.* fractured and clay-filmed internal structure, *7.* worm-tracks, *8.* calcareous worm-tubes, *9.* Orbitolina, *10.* corals, *11.* gastropods, *12.* bivalves, *13.* carbonized plant remains, *14.* sea urchins, *15.* pyrite and limonite nodules, *1—20*: number of strata; frequency: *1.* sparse, *2.* few, *3.* mean, *4.* frequent, *5.* abundant

7. ábra. A Zirci Mészkő Formáció középső szakaszának (Mesterhajagi Tagozat) mikrofauna vizsgálati eredményei a Jásd 2 szelvényben

Rétegoszlop: *1.* idegen mészhomok, *2.* glaukonit, *3.* glaukonitos üregkitöltés, *4.* faunatartalmú mészkőtörmelék glaukonitos mészkőben, *5.* agyagközbetelepülés, *6.* repedezett agyagfilmes szerkezet, *7.* féregjárat, *8.* meszes féregcső, *9.* Orbitolina, *10.* korall, *11.* csiga, *12.* kagyló, *13.* szenesedett növénymaradvány, *14.* tengeri sün, *15.* pirit- és limonitgumók, *1—20:* rétegszám; gyakoriság: *1.* szórványos, *2.* kevés, *3.* közepes, *4.* gyakori, *5.* sok

Benthonic foraminifers

The benthonic foraminiferal assemblage is shown in Fig. 7. No remarkable difference from that of the Mesterhajag Member is experienced. *Sabaudia minuta* (HOFKER) has a somewhat greater number of specimens. Orbitolina can only be observed in fragments.

Planktonic foraminifers

They are represented mainly by Hedbergella species (planispira, infracretacea, delrioensis). Their number of specimens shows a tendency of increasing upwards in the profile. *Favusella washitensis*, *Praeglobotruncana* sp. and *Rotalipora* sp. (beds 4-5) are only encountered sporadically.

Calcareous algae

Paraplyllum primaevum LEMOINE

Incertae sedis

Calcisphaerula innominata BONET with its amount showing a rapid increase in sample to sample in the upper part of the sequence. In samples from the uppermost part it is frequent or abundant.

Metazoan

Ostrea, Serpula, Gastropoda, Ostracoda, Holothuroidea. The first three taxa are frequent.

The age of the lower part of the Gajavölgy Member

According to the occurrences of *Praeglobotruncana* sp. and *Rotalipora* sp., the age of the concerned horizon can be dated as Late Albian, and more closely, as Early Vraconian.

Profile Bakonynána 1 (The boundary stratotype between the Gajavölgy Member of the Zirc Limestone and the Pénzeskút Marl)

The site of the profile is shown in Fig. 8.

The section dealt with here constitutes the boundary stratotype between the Gajavölgy Member of the Zirc Limestone and the Pénzeskút Marl (Fig. 9).

An abandoned small quarry found in the valley of the brook Gaja-patak, in a cut of forest logging road is a protected exposure now. This profile represents tabular limestone beneath the Pénzeskút Marl, its thickness being appr. 5m down to the lower fossiliferous horizon. Each limestone bed has a thickness of 15 to 40 cm. They are light brown, light grey. Their texture is small- or medium-grained, with a glauconite content increasing upwards. Carbonized plant remains, sporadically chert nodules or some chert pebbles are also observed. In the upper part inclined bedding, intensive bioturbation, and a great number of trace fossils are observed together with a large amount of calcareous sand grains transported from the eroded older part of the Zirc Limestone (RAVASZ-BARANYI, L. in CSÁSZÁR et al. 1983). The Pénzeskút Marl grades out of it more or less continuously, with the limestone becoming nodular and with a rapid increase of glauconite content. The stratigraphy based on planktonic foraminifers of the Pénzeskút Marl has recently been discussed in a monograph by the author (BODROGI, I. 1989).

Fig. 8. The position of the Gajavölgy Member of the Zirc Limestone Formation in profile Bakonynána 1

8. ábra. A Zirci Mészkő Formáció felső, Gajavölgyi Tagozatának helye a Bakonynána 1 szelvényben

Foraminifers

An assemblage dominated by calcareous benthons and plankton (Plates VI and VII).

Calcareous algae

Archaeolithothamnium rude LEMOINE
Kymalithon belgicum (FOSLIE)
Paraphyllum primaevum LEMOINE

Incertae sedis

Calcisphaerula innominata BONET is dominant. It occurs even in mass in the Pénzeskút marl. *Pithonella ovalis* (KAUFMANN) is sporadically encountered. *Cadosina callosa* KNAUER (Plate VII, Fig. 10) and another *Cadosina* sp. nov. (det. KNAUER, J.) appears in the lower part of the Pénzeskút Marl.

Stratigraphy

The appearance of planktons as listed below is of great importance for stratigraphy:
Planomalia buxtorfi (GANDOLFI)

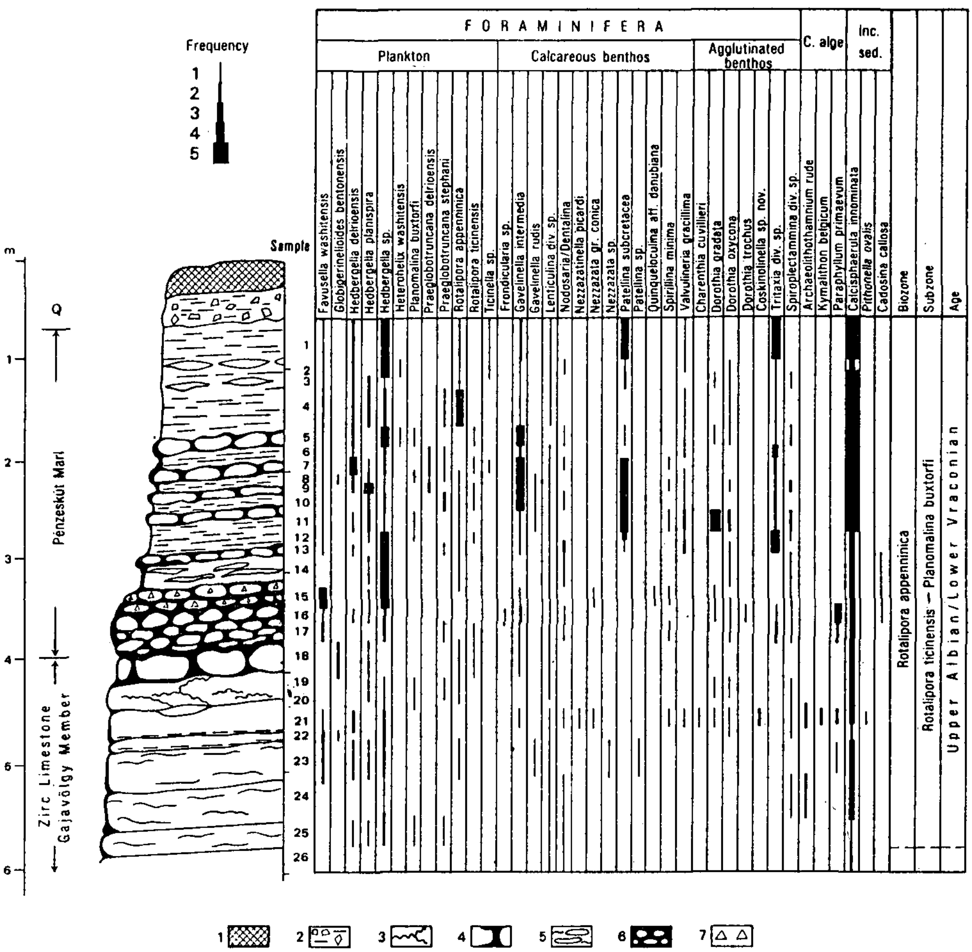


Fig. 9. The results of microfaunal study of profile Bakonynána 1, boundary stratotype of the Zirc Limestone Formation and the Pénzeskút Marl Formation

Geological log: *1.* soil, 2. talus, *3.* limestone with clay film, 4. nodular limestone, *5.* clay, claymarl and marl, *6.* calcareous marl and marl (nodular), *7.* intraclasts; 1—26: number of strata; frequency: *1.* sparse, *2.* a few, 3. mean, *4.* frequent, *5.* abudant

9. ábra. A Zirci Mészkő Formáció és a Pénzeskúti Márga Formáció Bakonynána 1 határsztratotípus szelvényének mikrofauna vizsgálati eredményei

Rétegsor: *1.* talaj, *2.* lejtőtörmelék, *3.* agyagfilmes mészkő, *4.* gumós mészkő, *5.* agyag, agyagmárga, *6.* mészmárga, gumós márga, *7.* intraklasztok; *1—26:* rétegszám; gyakoriság: *1.* szórványos, *2.* kevés, *3.* közepes, *4.* gyakori, *5.* tömeges

Rotalipora ticinensis (GANDOLFI)
Rotalipora appeninica (RENZ)
Praeglobotruncana stephani (GANDOLFI)

A new taxon enlisted in the group of calcareous benthos is represented by *Nezzazata gr. conica* (SMOUTH) (Plate I, Fig. 4). A new species in the group of arenaceous benthonic forms is *Coskinolinella* sp. nov., identified from the exposure for the first time (Plate VI, Figs. 1 through 3).

The age of the Gajavölgy Member in profile Bakonynána 1

Ammonites species identified by NOSZKY, J. (1966), later by SCHOLTZ, G. (1973, 1974, 1979) and HORVÁTH, A. (1985) in the immediate cover of the member, the upper fossiliferous horizon found at the base of the Pénzeskút Marl Formation are as follows:

Stoliczkaia dispar D'ORBIGNY

Stoliczkaia dispar blanchetti (PICT. et CAMP.)

Anisoceras (A.) armatum (SOW.)

On the basis of the above-listed species the age of the sequence has been dated to be as old as Early Vraconian and assigned to Stoliczkaia dispar blanchetti subzone of Stoliczkaia dispar zone.

The age of the sequence assigned to the *Rotalipora ticinensis — Planomalia buxtorfi* subzone, the lower subzone of the *Rotalipora appeninica* interval zone corresponding to the *Stoliczkaia dispar* zone is dated to be as old as Late Albian, more precisely, Early Vraconian. *Rotalipora appeninica* (RENZ) can be identified first in bed 23 of the sequence (Plate VII, Fig. 1).

In the Bakonynána profile the overlying bed of the Gajavölgy Member, the lower part of the Pénzeskút marl is also assigned to the Stoliczkaia dispar blanchetti subzone, or to the *R. ticinensis — Pl. buxtorfi* subzones of the corresponding *Rotalipora appeninica* zone and is also considered to be Early Vraconian in age.

Faunal relationship

There is a faunal relationship with the Urgonian of the Villány Mts (Nagyharsány Limestone Formation) and the Apátvarasd Limestone in the Mecsek Mts. This relationship is mainly indicated by the common Orbitolina species or Orbitolina-related species.

The Villány Mts and their SE Foreland

From the youngest middle and older Late Albian interval of borehole Lippó 2, which is in inverse position as proved by microfaunal data *Orbitolina (M.) texana* (ROEMER) and *O. (M.) subconcava* (LEYMERIE) species have been identified by the author BODROGI, I. (1987). The sequences of the Beremend quarry and the Urgonian Tenkes-hegy Limestone also contain O. (M.) texana. The red neptunian dykes found in the latter contains fragments of *Coskinolinella n.* sp. bearing Bakonynána crinoidal limestone, the Rotalipora appeninica- and *Favusella washitensis* bearing intraclasts of the Bisse Marl and the detritus of the *O. (M.) taxana* bearing Urgonian limestone.

In the two areas both the Urgonian limestone and the overlying marl are of similar age and facies and have similar microfaunal assemblage.

Mecsek Mts

In the Vékény valley-head, at the southern contact of the Turonian Vékény Marl, in the diabase- detrital crinoidal Apátvarasd Limestone pressed tectonically into the marl, sections of the new Coskinolinella species as well as of the *Coskinolinella navarroensis* RAMIREZ DEL POZO species described from the Late Albian Urgonian Limestone in the Spanish–French Pyrenean can be recognized. The Hedbergella bearing, *Favusella washitensis* containing pelagic Bisse marl accompanied by diabase detritus can also be recognized here as pressed into the Turonian marl.

A wider environment

B. PEYBERNES and M. A. CONRAD (1977, 1979) were the first to reveal the similarities of the Urgonian limestone sequences in Hungary with the similar rocks in the Pyrenean. My studies of foraminifers and calcareous algae in the 80's exhibited a close relationship with the Outer Dinarides (VELIC 1988) and the Gargano platform (LUPERTO-SINNI 1986). Similar relationships with the platform in Bulgaria and Greece can also be recognized (pers. comm. by S. MONOPOLIS, 1992). Besides faunal and floristic similarities, however, there is a significant difference: *Salpingoporella dinarica* RADOICIC does not occur in the Urgonian Limestones, neither of the Bakony, nor of the Villány and Mecsek Hills. However, the Schrattenkalk of Vorarlberg, in contrast with the opinion of G. STACHE (1881—82), only shows similarities in facial features. In regard to its age (Barremian—Early Aptian) it considerably differs from the facies of Bakony. A paper on a comparative foraminiferal calcareous algal examination of the Nagyharsány Limestone and the Rhomberg profiles of the Vorarlberg Schrattenkalk has gone to press (BODROGI—BÓNA—LOBITZER in press).

Acknowledgement

My thanks are due to Prof. A. ARNAUD-VANNEAU (Grenoble) and Prof. R. SCHROEDER (Frankfurt) for supervising the determination of the Orbitolina species and their advices, moreover to M. A. CONRAD (Geneve) for the great help provided at consultations, to G. CSÁSZÁR for allowing me to study in the field profiles and for allowing me to use his lithostratigraphic classification and a part of his collection of thin sections. I am also indebted to Mr. H. LOBITZER (Wien) for being an inspiration to me in doing the revision and preparing this paper. Z. BALLA—J. KNAUER, and I. NAGY my colleagues, were a great help to me by their professional assistance.

REFERENCES — IRODALOM

BODROGI, I. 1986: A Pénzeskúti Márga plankton foraminiferái. — Doktori disszertáció 1—145. ELTE AD, Budapest, Manuscript.

BODROGI, I. 1989: A Pénzeskúti Márga Formáció plankton Foraminifera sztratigráfiája. Planktonic Foraminifera Stratigraphy of the Pénzeskút Marl Formation. — Földt. Int. Évk. LVIII. 5., 1—127, Budapest.

CSÁSZÁR, G. 1986: A Dunántúli-Középhegységi középső-kréta formációk rétegtana és kapcsolata a bauxitképződéssel. — Geol. Hung. Ser. Geol. 23. 1—207. Budapest.

HAUER, F. 1862a: Petrefacten aus dem Bakonyerwald.—Jb. K. K. Geol. Reichsanst. B. 12. 67-68, Wien.

HAUER, F. 1862b: Über die Petrefacten der Kreideformation des Bakonyer Waldes. — Sitzungsber. K. Akad. Wiss. 44. 631—659. Wien.

HORVÁTH, A. 1985: Ammoniten-Stratigraphie der Pénzeskút Maergel-Formation. — Ergäbnisse der Mitteleuropäischen Gruppe in Project 73/I./58., Mid. Cretaceous Events. Österr. Akad. 1. Wiss. Schriften 1. Erdwiss. Komiss Bd. 7. 149—733. Taf. 4. Springer-Verlag, Wien, New York.

KNAUER, J.—KOPEK, G. 1982: Magyarázó a Bakony-hegység 20 000-es földtani térképsorozatához. Dudar. Földt. Int. 1—59., Budapest.

KNAUER, J. 1880: BOHN, P.—KAISER, M.—KOPEK, G.—VÉGH, S. közreműködésével: Magyarázó a Bakony-hegység 20 000-es földtani térképsorozatához. Lókút. — Földt. Int. 1—101. Budapest.

MÉHES, K. 1964: The foraminiferal genus Orbitolina from Hungary. — Acta Geol. 8. (1—4). 265—281. Budapest.

NOSZKY, J. 1964: A Bakony-hegység északi részének földtani vizsgálata. — Földt. Int. Évi Jel. 1961-ről, 1. 203—205. Budapest.

MONOSTORI, M.—BODROGI, I.—CSÁSZÁR, G. 1989: Olaszfalu, Eperkés Hill. — XXIst European Micropaleontological Colloquium, 4—13. IX. 1989. Hungary Guidebook, 252—253. Budapest.

MONOSTORI, M.—BODROGI, I.—CSÁSZÁR, G. 1989: Bakonynána, Zsidó Hill. — XXIst European micropaleontological Colloquium, 4—13. IX. 1989. Hungary. Guidebook, 244—248. Budapest.

NEUMANN, M.—SCHROEDER, R. et al. 1981: Tableau de répartition stratigraphique des Grand Foraminiféres caractéristiques du Crétacé moyen de la region méditerranéenne. — Cretaceous Res. 2. 383—393. London.

PEYBERNES, B. 1977: Découverte des Algues Floridées du “Facies de Vimport” dans l'Albien des Monts Bakony (Hongrie) et données biostratigraphiques nouvelles sur le Mesocrétacé hongrois.

PEYBERNES, B. 1979: L'Urgonien de Hongrie. The Urgonian limestones of Hungary. — Geobios, Memoire Special No. 3. 231—243. fig. 4. plat. 2. Lyon.

SCHOLTZ, G. 1979: Die Ammoniten des Vracon (Oberalb- Dispar-Zone) des Bakony-Gebirges (West. Ungarn) und eine Revision der Wichtigstein Vracon-Arten der Westmediterranen Faunen provinz. — Paleontographica A. 165. (1—2), 1—80, Stuttgart.

SCHROEDER, R.—NEUMANN, M. 1985: Les Grandes Foraminiferes du Cretacé Moyen de la Région Mediterranéenne. — Geobios, Menoire Special No. 7. 1—161., Ed. de Univ. Clode Bernard, Lyon.

SIDÓ M. 1980b: A Zirci Mészkő Formáció Foraminiferái. — Földt. Int. Adattár, Budapest.

A ZIRCI MÉSZKŐ FORMÁCIÓ FELSZÍNI SZTRATOTÍPUS SZELVÉNYEINEK FELÜLVIZSGÁLATA, RÉTEGTANI TAGOLÁSA FORAMINIFERÁK, MÉSZALGÁK ALAPJÁN (ÉSZAK-BAKONY, FELSŐ-ALBAI)

BODROGI ILONA

Magyar Állami Földtani Intézet
Budapest, Stefánia út 14.
H-1143

ETO: 561.26.026(234.371.1)
563.12(234.371.1)

T á r g y s z a v a k : Foraminifera, mészalga, Észak-Bakony, felső-albai, Zirci Mészkő Formáció

A Magyarhoni Földtani Társulat felkérésére végeztem el a Zirci Mészkő Formáció felszíni sztratotípus szelvényei (Olaszfalu Eperkéshegy, Jásd 2, Bakonynána 1) foraminifera és mészalga társulásainak revízióját és mutattam be a 1989-ben hazánkban megrendezett XXI. Európai Mikropaleontológiai Kollokviumon. A rendezvény során végzett további gyűjtéssel kiegészített vizsgálati eredményeket és konklúziókat az alábbiakban foglalom össze:

1. A Zirci Mészkő Fm. tagozatrangú felszíni sztratotípus szelvényei folyamatos szelvényben nem tanulmányozhatók. A Zirci Mészkő legidősebb tagozata (Eperkéshegyi T.) és a fekü Tési Agyagmárga felszíni határsztratotípusa nincs kijelölve és nincs megvizsgálva.

2. A legidősebb Eperkéshegyi Tagozat zátonyképzdőményt, a középső Mesterhajagi Tagozat háttéri lagunát és platform-homokot, a legfiatalabb Gajavölgyi Tagozat viszonylag gyorsan süllyedő külső platform peremet képvisel. Fedője a Pénzeskúti Márga, pedig már medenceperemi képződmény (lásd J. WILSON 1975).

3. Feküje a Tési Agyagmárga Fm. középső-albai korú (JUHÁSZ M. 1979), fedője a Pénzeskúti Márga Fm. Ammonitesek (SCHOLTZ G. 1974, 1979., HORVÁTH A. 1985) és plankton Foraminiferák alapján (BODROGI, I. 1986, 1989) felső-albai korú, azon belül is alsó-vrakóni.

A Zirci Mészkő felszíni határsztratotípus szelvényei rétegtani helyzetük és Foraminifera faunájuk alapján a felső-albaiba tartoznak, legfelső tagozataik (Gajavölgyi és Mesterhajagi) annak alsó-vrakóni alkorszakában képződtek a Bakonynánai szelvényből azonosított *Rotalipora appenica* alapján. (BODROGI, I. 1986, 1989), illetve az *Orbitolina (C.) conica* megjelenése alapján a Jásd 2 szelvényben.

4. A B. PEYBERNES (1977) által határozott *Orbitolina concava* (LEYMERIE) faj, — melynek pontos mintavételi helye ismeretlen —, anyagunkban nem fordult elő.

5. Azonosított Orbitolina fajok: *O. (M) subconcava, O. (M) aperta, O. (C.) conica*. Az első faj felső-apti—albai taxon, a két utóbbi a vracon alsó részén lép be.

6. Figyelmet érdemelnek a felső-albai kisbentosz Nezzazatidae fajok: *Nezzazata simplex, N. gr. convexa, Nezzazatinella picardi*, valamint *Dobrogelina ? angulata, Involutina hungarica, Gubaudia capitata*.

7. Átsoroltam az *Orbitolina texana lata* MÉHES, 1964 alfajt az *Orbitolina (M.) aperta* (ERMAN), 1884 fajhoz.

8. Új Coskinolinella fajt azonosítottunk a Gajavölgyi Tagozatból. Leírása folyamatban van.

9. Mészalgák: Dasycladaceae csak a formáció alsó tagozatának legidősebb mintáiban fordult elő, a *Salpingoporella hasi* faj képviseli. Fölötte csak Vimport-algákat (Corallinaceae) találtunk: *Archaeolithothamnium rude, Kymalithon belgicum, Paraphyllum primaevum* és *Acicularia* div.sp.

10. Kifejezett faunahasonlóság és mészalgaflóra rokonság mutatkozik a Spanyol—Francia Pireneusok, a Vercorsi platform és a Dinaridák felé, de fauna- és mészalgaflóra affinitás van a bulgáriai—görögországi középső-kréta platform felé is (szóbeli közlés, S. MONOPOLIS 1992).

11. Lényeges különbség viszont, hogy sem a bakonyi, sem a mecseki, sem a villányi urgon mészkőben nem fordult elő a *Salpingoporella dinarica* RADOIČIĆ faj.

PLATES — TÁBLÁK

Plate I — I. tábla

1. *Salpingoporella hasi* CONRAD, RADOIČIĆ et REY, inclined equatorial section and detritus, bed 2 Olaszfalu, Eperkés-hegy
40 x
2. *Dicyclina schlumbergeri* MUNIER—CHALMAS and *Salpingoporella hasi detritus,* bed 3, Olaszfalu, Eperkés-hegy
20 x
3. *Charentia cuvillieri* NEUMANN, bed 22/b, Olaszfalu, Eperkés-hegy
136 x
4. *Nezzazata gr. conica* (SMOUTH), axial section, bed 21, Bakonynána 1 profile
80 x

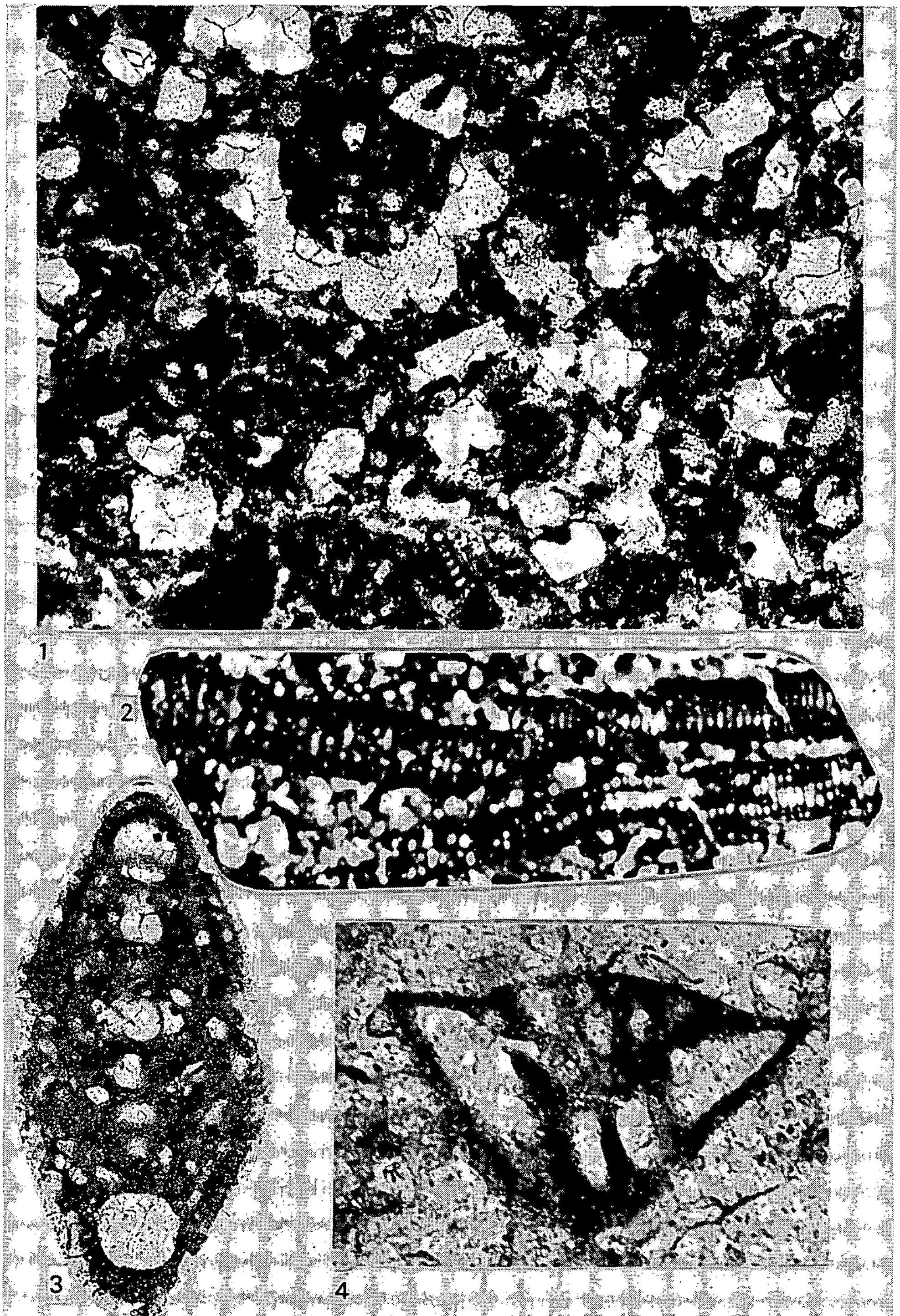

1
2
3
4

Plate II — II. tábla

1. Strongly corroded rudisted shell, Eperkés-hegy, sample 16
53 x

2. *Salpingoporella hasi* CONRAD, RADOICIC et REY, subequatorial section, Eperkés-hegy, bed 15
53 x

3. *Marinella lugeoni* PFENDER, Eperkés-hegy bed 25
136 x

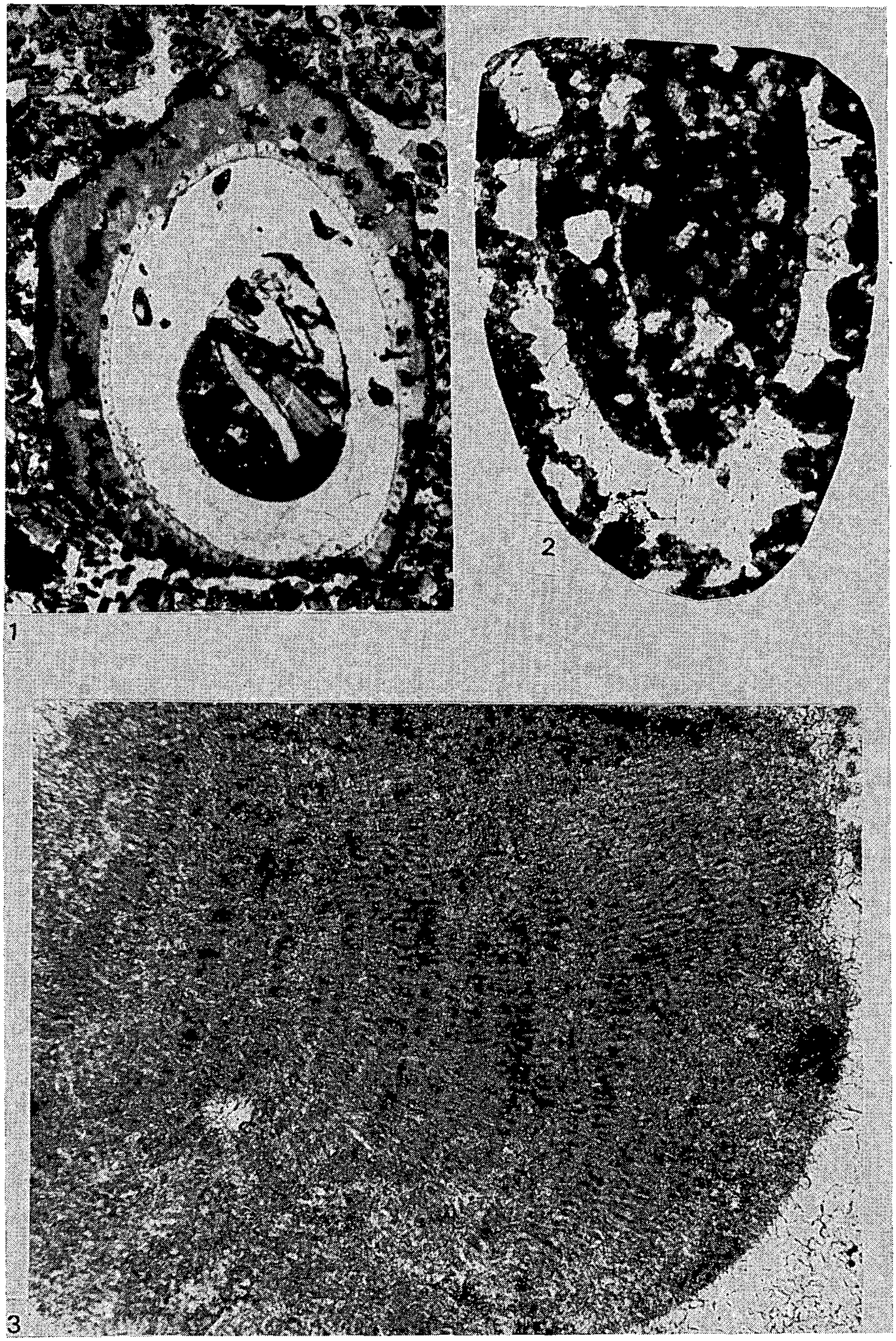

1
2
3

Plate III — III. tábla

1— 2. *Dobrogelina? angulata* CALVEZ, Eperkés-hegy
1. No. 25
136 x
2. No. 24/b
136 x
3— 5. *Nezzazatinella* cf. *simplex* OMARA, Eperkés-hegy
3—4. No. 19/c
136 x
5. No. 20
136 x
6. Miliolina, Eperkés-hegy No. 15
136 x
7— 9. *Nezzazatinella picardi* (HENSON), No. 11/b
136 x
10—11. *Involutina hungarica* (SIDÓ), Eperkés-hegy
10. No. 19/a
53 x
11. No. 11/a
53 x

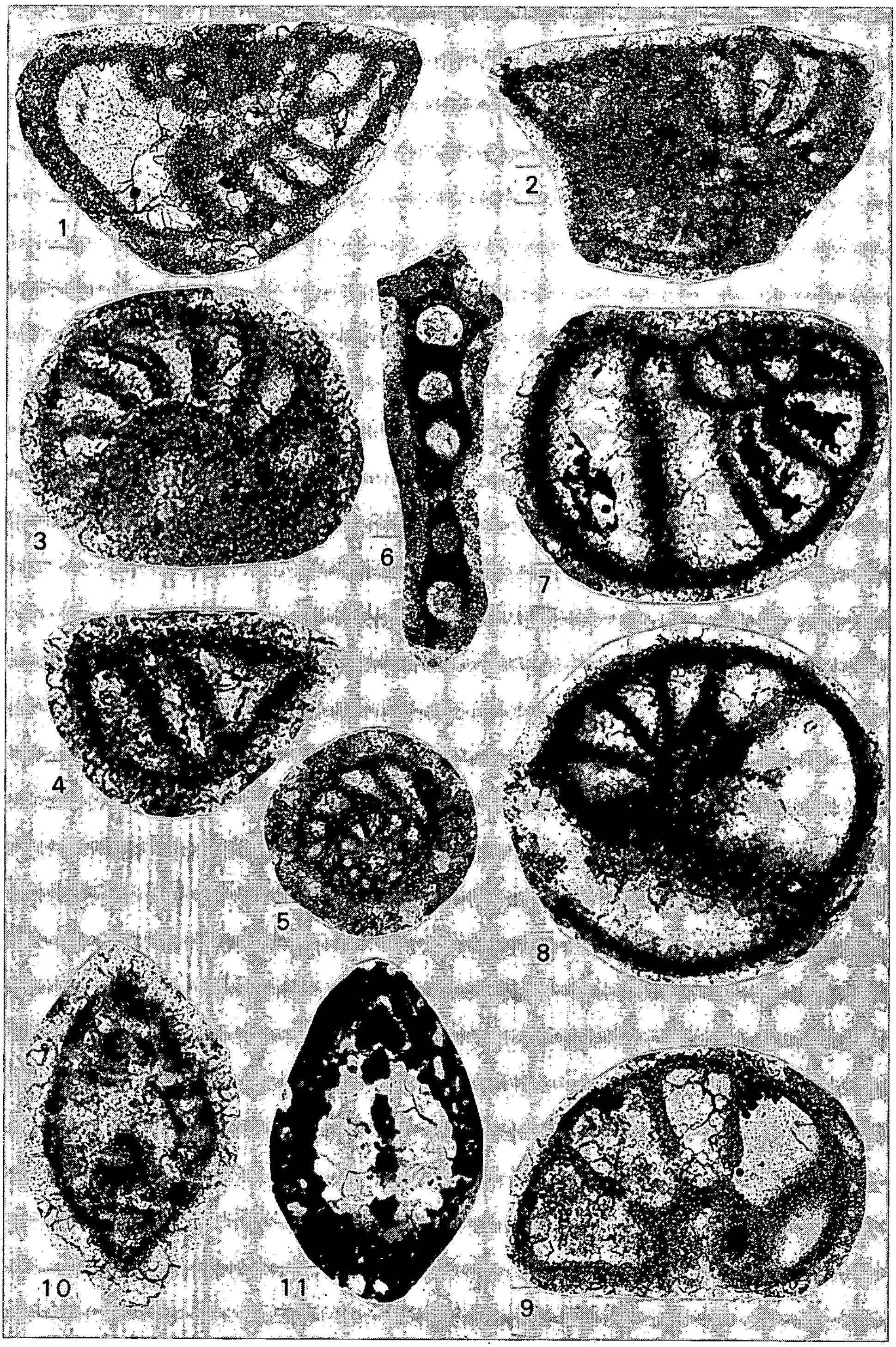

1
2
3
6
7
4
5
8
10
11
9

Plate IV — IV. tábla

1. *Conicorbitolina conica* (D'ARCHIAC),
   Jásd 2. No. 20
   60 x
2. *Orbitolina (M.) aperta* (ERMAN), Jásd 2. No. 20
   30 x
3. *Orbitolina (M.) aperta* (ERMAN), Hárskút, from the collection of K. MÉHES
   K 443
   60 x

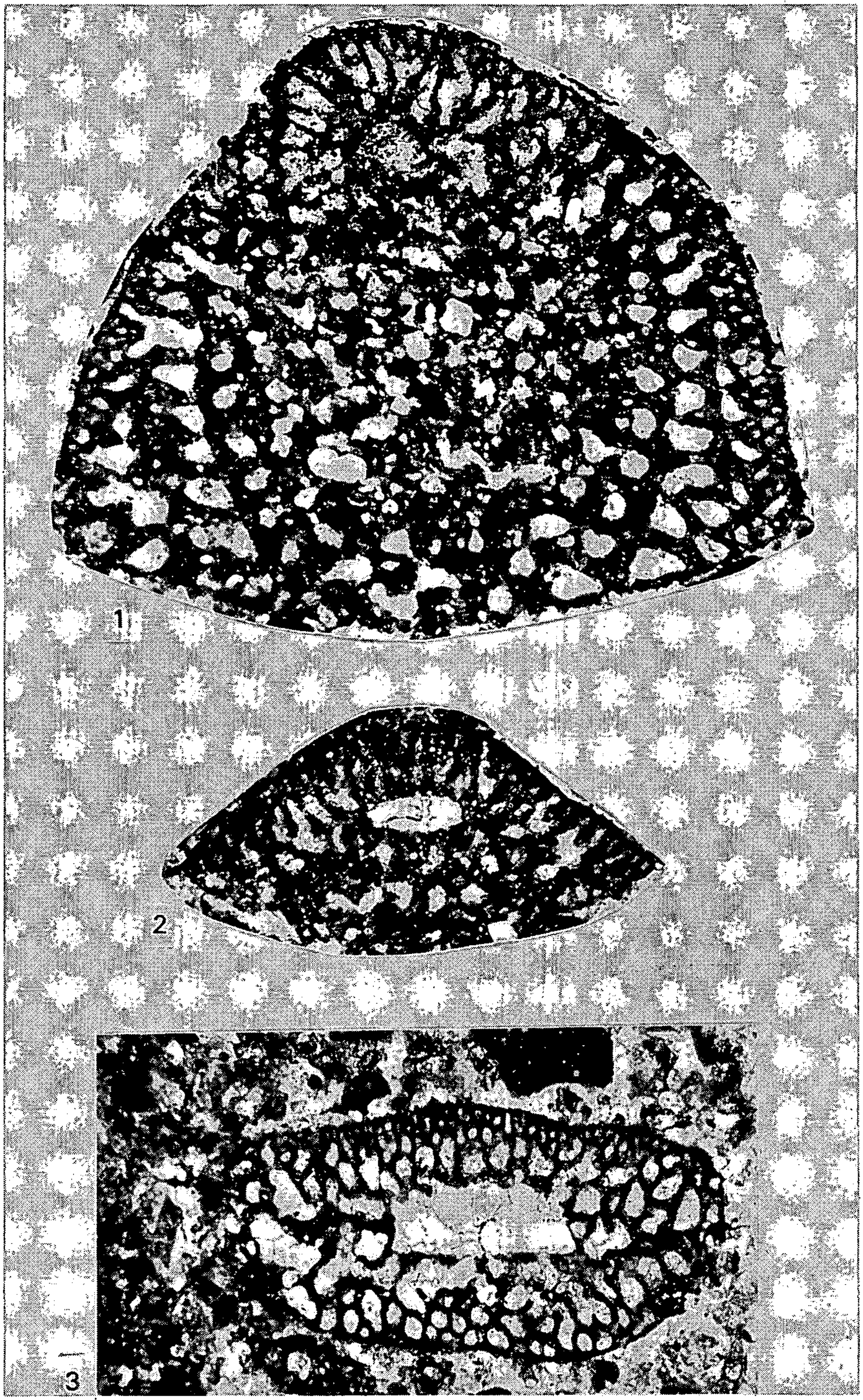

1
2
3

Plate V — V. tábla

1. *Paraphyllum primaevum* (LEMOINE), Jásd 2. No. 20
136 x
2. *Cuneolina pavonia* (D'ORBIGNY), Eperkés-hegy No. 3
53 x
3. *Spiroplectammina* sp., Eperkés-hegy No. 3
53 x
4. *Verneuilinidae*, Eperkés-hegy No. 19
53 x
5. *Arenobulimina* sp., Eperkés-hegy No. 17
136 x
6. *Miliolina*, Eperkés-hegy No. 19/b
136 x
7. *Praeglobotruncana* sp., Eperkés-hegy No. 20
136 x
8. *Dobrogelina* sp., Eperkés-hegy No. 19/b
136 x
9. *Cadosina* sp., Bakonynána No. 16
136 x
10. *Orbitolina (M.)* cf. *subconcava* (LEYMERIE), Eperkés-hegy No. 22/a
136 x
11. *Sabaudina minuta* (HOFNER), Eperkés-hegy No. 3
136 x

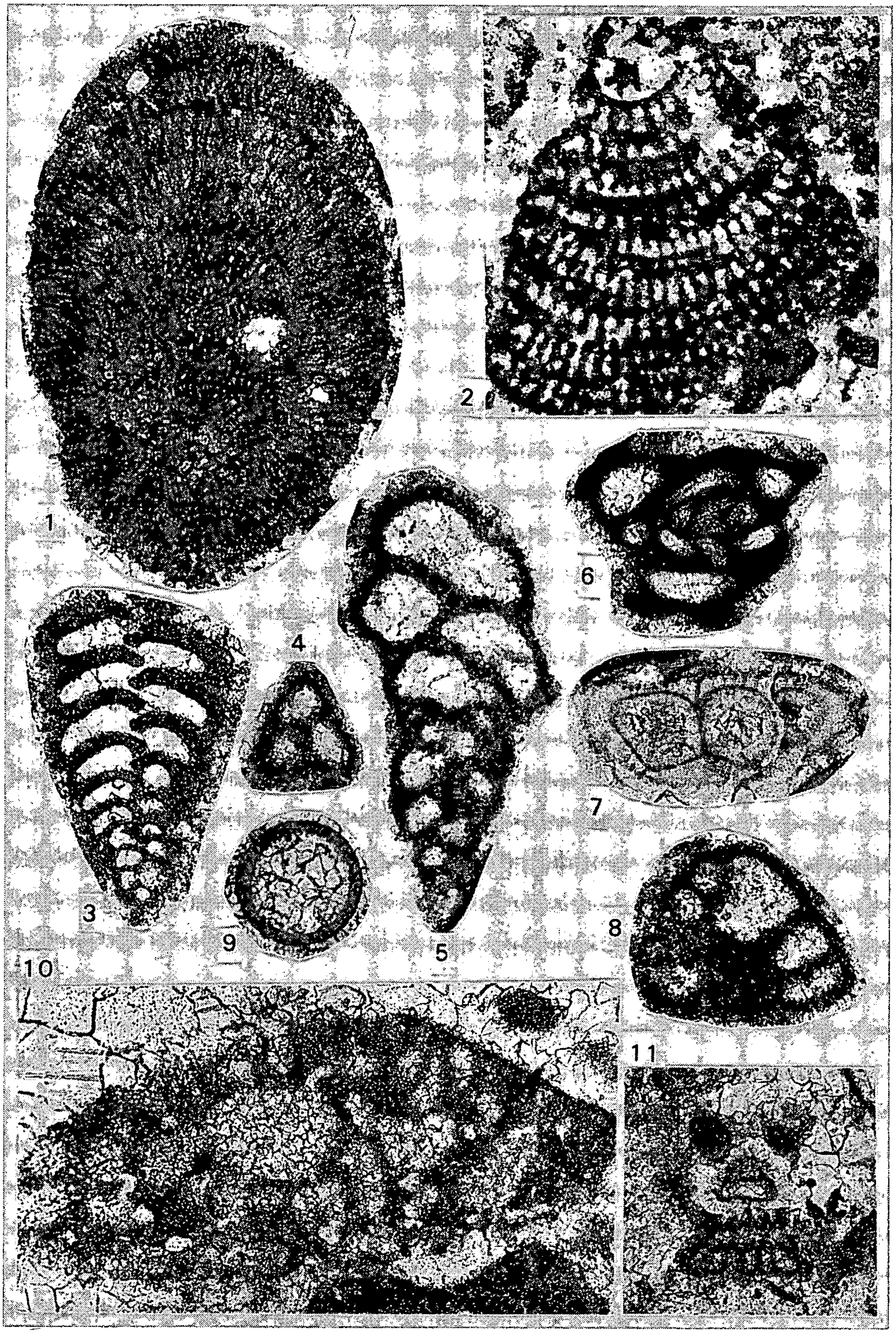

1
2
3
4
5
6
7
8
9
10
11

Plate VI — VI. tábla

1—3. *Coskinolinella n.* sp., Bakonynána 1. No. 21
136 x
4. *Marssonella oxycona* (REUSS), Bakonynána 1. No. 23
136 x
5. ? *Marssonella* sp., Bakonynána 1. No. 23
136 x
6. *Dorothia gradata* (BERTHELIN), Bakonynána 1. No. 21
136 x
7. *Tritaxia* sp., Bakonynána 1. No. 23
136 x
8. *Pithonella ovalis* (KAUFMANN), Bakonynána 1. No. 27
136 x

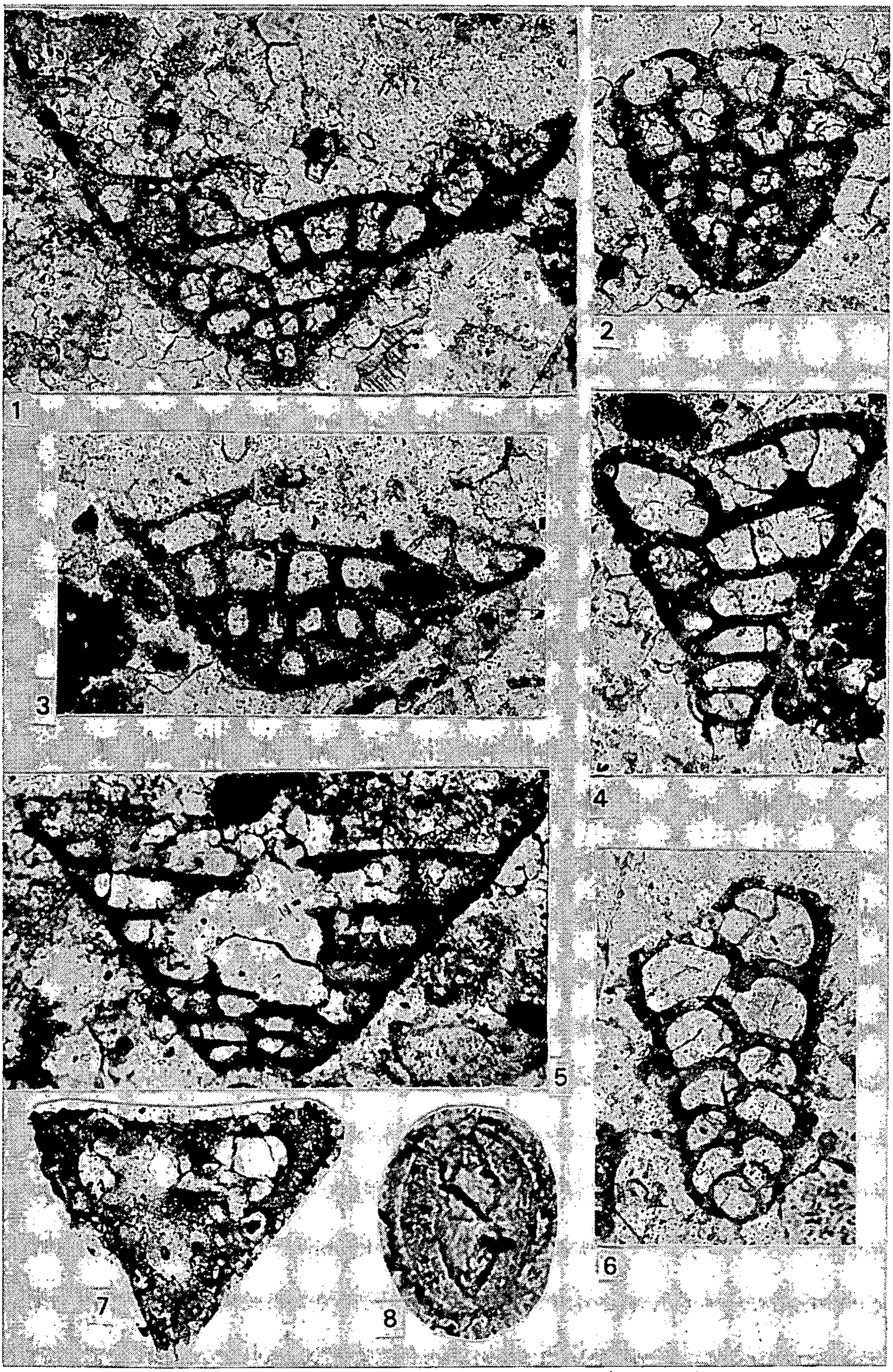
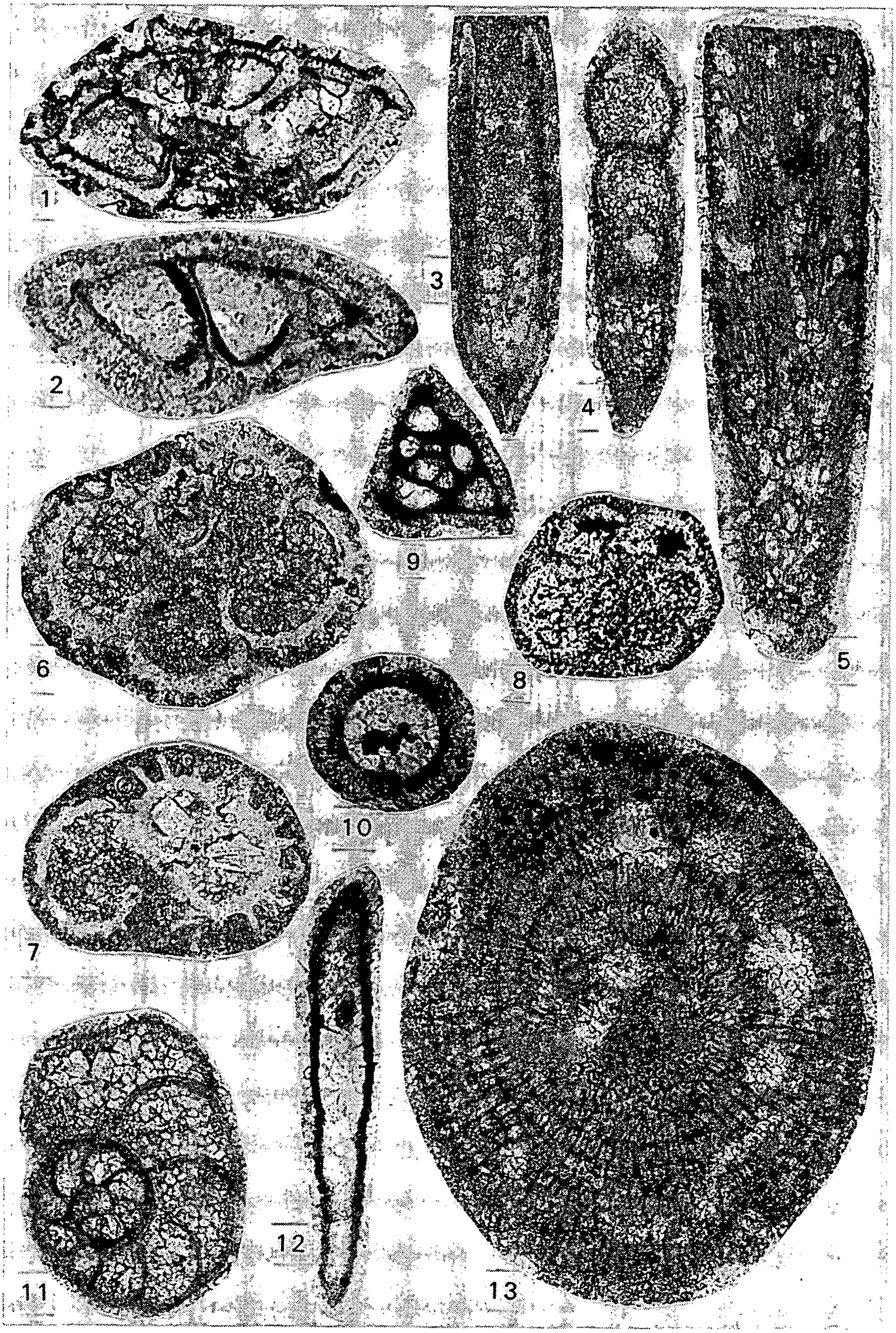

1
2
3
4
5
6
7
8

Plate VII — VII. tábla

1. *Rotalipora appeninica* (RENZ), Bakonynána 1. No. 23
136 x
2. *Rotalipora* sp., Bakonynána 1. No. 21
136 x
3. *Cercidina supracretacea* VOGLER, Bakonynána 1. No. 8
212 x
4. *Nodosaria* sp. micritized Bakonynána 1. No. 16
136 x
5. *Kymalithon belgicum* (FOSLIE), Bakonynána 1. No. 21
136 x
6—7. *Favusella washitensis* (CARSEY), Bakonynána 1.
6. No. 15
136 x
7. No. 16
136 x
8. *Hedbergella planispira* (TAPPAN), Bakonynána 1. bed 9
136 x
9. *Qinqueloculina* aff. *danubiana* NEAGU, Bakonynánana 1. No. 15
136 x
10. *Cadosina callosa* KNAUER, Bakonynána 1. No. 10
136 x
11. *Gavellinella intermedia* (BERTHELIN), Bakonynána 1. No. 16
136 x
12. *Erlandia* sp., Bakonynána 1. No. 21
136 x
13. *Paraphyllum primaevum* (LEMOINE), Bakonynána 1. No. 21
136 x
(The numbers mark the No. of the thin section)


1
2
3
4
5
6
7
8
9
10
11
12
13

PHYTOPLANKTONS FROM THE PALEOGENE FORMATIONS IN HUNGARY

by

LÁSZLÓ RÁKOSI

Hungarian Geological Survey
Budapest, Stefánia út 14.
H-1143

UDC: 561:581.526.325:551.781 (439)

Keywords: Phytoplankton, Paleogene, biostratigraphy, paleoecology, correlation, Hungary

For the first time, an attempt has been made to summarize the occurrences of organic-walled vegetable planktons in the marine Paleogene formations of Hungary. The comparison of the concerned froms, found during palynological studies, with nannoplanktonic zonation has also been attempted.

Palynological investigations related to the exploration of mineral resources in Hungary have produced a large number of organic-walled phytoplanktonic forms (Dinoflagellata, Prasinophyta, Chlorophyta, Acritarcha). To their stratigraphic classification in Hungary, a first approach has been offered here.

For the correlation of the borehole sections studied palynologically in details (spores and pollens) the well-elaborated nannoplankton zones were used (M. BÁLDI—BEKE 1974, A. NAGYMAROSY—M. BÁLDI—BEKE 1988, Table 1).

The studied boreholes of the main Hungarian Paleogene formations (Fig. 1), and their location (Fig. 2) are as follows:

I. Darvastó Formation (zone NP 14). There are only a few phytoplanktonic forms in the sequences. The analysed material comes from the bauxite exploratory boreholes of S Bakony Mts.

II. Szőc Limestone Formation (zones NP 14—16). The boreholes analysed in details: Gyepükaján Gykt 1, Gyepükaján Gy 5 and Gy 8, Halimba H 1, Padrag Pa 5, Somlóvásárhely Sv 1, Magyarpolány Mp 40.

III. Padrag Formation (zones NP 16—19). The borehole sections studied in details are Csabrendek Cs 12, Halimba H 1, Padrag Pa 5 and Somlóvásárhely Sv 1. The layers were classified into the *Pleurozonaria concinna-Pleuzonaria stellulata* Assemblage Zone (RÁKOSI, 1979). In N Transdanubia the layers belonging to the formation (Mór Formation) are parts of the *Retsisphaera microreticulata-Tytthodiscus* sp. A. Assemblage Zone (RÁKOSI, 1979).

Table I — I. táblázat

Stratigraphic range of the chief organic-walled phytoplanktonic remains in the Paleogene formations of Hungary (RÁKOSI, L. 1991)
A magyarországi paleogén képződményekben előforduló fontosabb szervesvázú növényi mikroplankton szervezetek rétegtani elterjedése (RÁKOSI L. 1991)

TAXON	NP ZONE										
	15	16	17	18	19	20	21	22	23	24	25
1. Tetraporina quadrata	+										
2. Geiselodinium hallense	+	+									
3. Noremia maior	+	+	+	+	+	+					
4. Tytthodiscus sp.	+	+	+	+	+	+					
5. Cyclopsiella elliptica	+	+	+	+	+	+	+	+	+	+	
6. Cymatiosphaera eupeplos	+	+	+	+	+	+	+	+	+	+	
7. Thlassiphora pelagica	+	+	+	+	+	+	+	+	+	+	+
8. Deflandrea oebisfeldensis	+	+				+				+	+
9. Apectodinium homomorphum	+	+								+	+
10. Ovoidites ligneolus	+						+				
11. Ovoidites microligneolus	+						+				
12. Pilospora parvus	+						+				
13. Achilleodinium biformoides		+									
14. Achomosphaera alcicornu		+									
15. Apectodinium quinquelatum		+									
16. Areoligera undulata		+									
17. Araeosphaeridium arcatum		+									
18. Araeosphaeridium multicornutum		+									
19. Cleistosphaeridium diversispinosum		+									
20. Deflandrea nucula		+									
21. Diphyes colligerum		+									
22. Distatodinium craterum		+									
23. Distatodinium solidum		+									
24. Glaphyrocysta undulata		+									
25. Gochtodinium simplex		+									
26. Gochtodinium spinulum		+									
27. Hemicystodinium zoharyi		+									
28. Homotryblium oceanicum		+									
29. Homotryblium tenuispinosum		+									
30. Hystrichosphaeridium asterum		+									
31. Hystrichosphaeridium tubiferum		+									
32. Hystrichostrogylon membraniphorum		+									
33. Impagidinium aspidatum		+									
34. Impletosphaeridium rugosum		+									
35. Melitasphaeridium pseudorecurvatum		+									
36. Millioudinium tenuitabulatum		+									
37. Phthanopteridinium crenulatum		+									
38. Phthanopteridinium tritonium		+									
39. Pyxidinopsis bakonyensis		+									
40. Samlandia chlamydophora		+									
41. Selenopemphix nephroides		+									
42. Spiniferites cornutus		+									
43. Spiniferites mirabilis		+									
44. Thalassiphora velata		+									
45. Tityrosphaeridium exilimurum		+									
46. Tityrosphaeridium gracile		+									
47. Turbiosphaera filosa		+									
48. Wetzeliella symmetrica		+									

TAXON			N	P		Z	O	N	E		
	15	16	17	18	19	20	21	22	23	24	25
49. *Pterospermella microptera*		+									
50. *Rhombodinium porosum*		+	+								
51. *Pterospermella helios*		+	+	+	+						
52. *Cleistosphaeridium insolitum*		+	+	+	+	+					
53. *Distatodinium ellipticum*		+	+	+	+	+					
54. *Homotryblium floripites*		+	+	+	+	+					
55. *Hystrichokolpoma cinctum*		+	+	+	+	+					
56. *Lingulodinium machaerophorum*		+	+	+	+	+					
57. *Mycrystridium stellatum*		+	+	+	+	+					
58. *Pleurozonaria concinna*		+	+	+	+	+					
59. *Palaeocystodinium golzowense*		+	+	+	+	+	+	+	+		
60. *Pentadinium laticinctum*		+	+	+	+	+	+	+	+		
61. *Cordosphaeridium inodes*		+	+	+	+	+	+	+	+	+	
62. *Lejeunecysta hyalina*		+	+	+	+	+	+	+	+	+	
63. *Paralecaniella indentata*		+	+	+	+	+	+	+	+	+	+
64. *Achomosphaera ramulifera*		+	+	+	+	+	+	+	+	+	+
65. *Deflandrea phosphoritica*		+	+	+	+	+	+	+	+	+	+
66. *Impletosphaeridium multispinosum*		+	+	+	+	+	+	+	+	+	+
67. *Spiniferites ramosus*		+	+	+	+	+	+	+	+	+	+
68. *Wetzeliella articulata*		+	+	+	+	+	+	+	+	+	+
69. *Cordosphaeridium funiculatum*		+	+	+	+	+	+	+		+	
70. *Systematophora placacantha*		+	+	+	+					+	+
71. *Kisselovia clathrata*		+		+	+						
72. *Operculodinium centrocarpum*		+			+	+	+	+	+	+	+
73. *Araneosphaera arenosa*		+				+					
74. *Glaphyrocysta reticulosa*		+				+					
75. *Spiniferites pseudofurcatus*		+				+					
76. *Homotriblium pallidum*		+								+	+
77. *Micrhystridium costatum*			+	+	+	+					
78. *Michrystridium spinuliferum*			+	+	+	+					
79. *Achomosphaera sagena*				+	+	+	+				
80. *Areosphaeridium diktyoplokus*				+	+	+	+	+	+	+	
81. *Pleurozonaria stellulata*				+	+	+		+	+	+	
82. *Botryococcus luteus*				+	+			+			
83. *Distatodinium tenerum*					+	+	+				
84. *Glaphyrocysta laciniiforme*					+	+	+				
85. *Glaphyrocysta pastielsii*					+	+	+				
86. *Hystrichokolpoma rigaudiae*					+	+	+				
87. *Impletosphaeridium implicatum*					+	+	+				
88. *Polysphaeridium simplex*					+	+	+				
89. *Tectatodinium pellitium*					+	+	+				
90. *Thalassiphora delicata*					+	+	+				
91. *Wetzeliella gochtii*					+	+	+				
92. *Glaphyrocysta inculata*					+	+	+				
93. *Pleurozonaria minor*					+	+		+	+	+	+
94. *Rhombodinium perforatum*						+					
95. *Corrudium incompositum*						+	+	+	+		
96. *Rhombodinium draco*						+	+	+	+	+	
97. *Campenia circellata*						+		+	+		
98. *Deflandrea heterophlycta*						+		+	+		
99. *Deflandrea leptodermata*						+		+	+		
100. *Deflandrea spinulosa*						+		+	+		
101. *Dictyotidium pachydermum*						+		+	+		
102. *Homotryblium plectilum*						+		+	+		
103. *Hystrichosphaeridium mineralosum*						+		+	+		

TAXON	NP 15	16	17	18	19	ZONE 20	21	22	23	24	25
104. *Kisselovia coleothrypta*						+		+	+		
105. *Phthanopteridinium resitente*						+		+	+		
106. *Retisphaera microreticulata*						+		+	+	+	
107. *Retisphaera perforata*						+		+	+	+	
108. *Cordosphaeridium cantharellum*						+		+	+	+	+
109. *Cordosphaeridium fibrospinulosum*						+		+	+	+	+
110. *Impletosphaeridium pycnospinosum*						+		+	+	+	+
111. *Operculodinium hirsutum*						+		+	+	+	+
112. *Operculodinium pseudorecurvatum*						+		+	+	+	+
113. *Phthanopteridinium amoenum*						+		+	+	+	+
114. *Spiniferites membranaceus*						+		+	+	+	+
115. *Nematosphaeropsis reticulensis*						+				+	+
116. *Plankton A*							+				
117. *Pseudokomewuia laevigata*								+			
118. *Batiacasphaera compta*								+	+		
119. *Deflandrea speciosa*								+	+		
120. *Hystrichokolpoma granulatum*								+	+		
121. *Pleurozonaria manumi*								+	+		
122. *Acomosphaera grallaeforme*								+	+	+	+
123. *Cleistosphaeridium polytrichum*								+	+	+	+
124. *Operculodinium xanthium*								+	+	+	+
125. *Pleurozonaria cooksoni*								+	+	+	+

IV. Dorog Formation (zone NP 15). Only the underlying beds of the browncoal complex, the seams of limnic-swampy and the eutrophic, palm-bearing swampy forest origin are included in this Formation. The transgressive beds above this and the parallic browncoal deposits already contain organic-walled vegetable microplanktons of marine origin and foraminiferal remains. The further overlying marine sequences belong to the Csolnok Formation. The limnic beds include only fershwater phytoplanktons. The studied areas are the browncoal basins of Dorog, Csolnok, Nagysáp, Tarján, Héreg, Mány, Zsámbék, Nagyegyháza, Csordakút, Tatabánya, Pusztavám, Oroszlány, Balinka and Dudar, drilled by hundreds of boreholes.

V. Csolnok Formation (zone NP 16). The paralic browncoal deposits of the above basins and the brackish-water and marine argillaceous and argillaceous-beds belong to this Formation. They are extremely rich in phytoplanktons. The areas investigated by boreholes are Dorog, Nagysáp, Héreg, Mány, Zsámbék, Csordakút, Nagyegyháza, Tatabánya, Pusztavám and Oroszlány.

VI. Tokod Formation (zones NP 16—17). The Tokod Formation includes additional calcareous, sandstone-bearing and partially regressive beds of the above-mentioned browncoal basins containing in certain places also browncoal seams. Its upper section is described by the presence of *Plourozonaria concinna-Pleurozonaria stellulata* Assemblage Zone (RÁKOSI, 1979).

VII. Szépvölgy Limestone Formation (zones NP 18—19). The concerned formation was localized in certain parts of the browncoal basins, moreover in the bed sequence of borehole Tóalmás To 4. The rocks are assignable to the *Retisphaera microreticulata-Tytthodiscus* sp. A. Assemblage Zone (RÁKOSI, 1979).

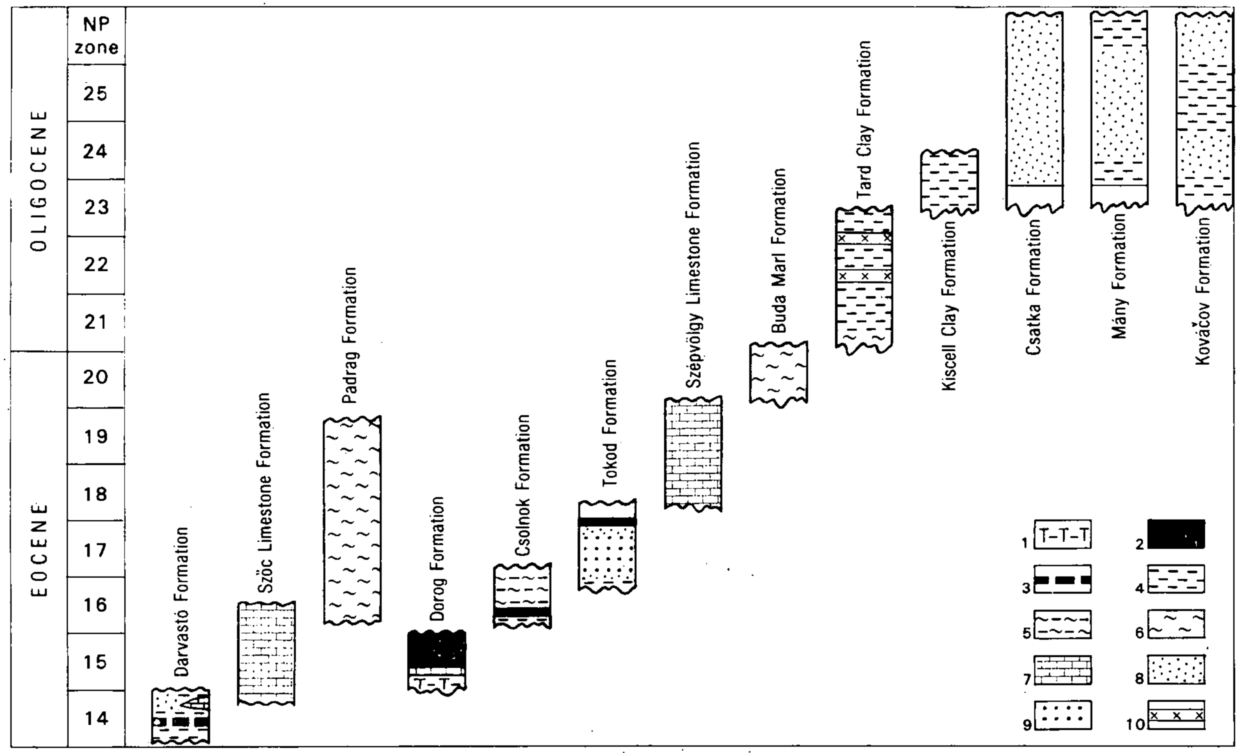


Fig. 1. The position of the model geological sections of the Paleogene formations concerned in this study as compared to the nannofloral zonation
1. Variegated clay, *2.* browncoal, *3.* carbonaceous clay, *4.* clay, *5.* claymarl, *6.* marl, *7.* limestone, *8.* sand, *9.* sandstone, *10.* tuff bands

1. ábra. A jelen dolgozatban említett fontosabb paleogén formációk elvi szelvényeinek helyzete a nannoflóra zonációhoz viszonyítva
1. Tarka agyag, *2.* barnakőszén, *3.* szerves agyag, *4.* agyag, *5.* agyagmárga, *6.* márga, *7.* mészkő, *8.* homok, *9.* homokkő, *10.* tufa csíkok

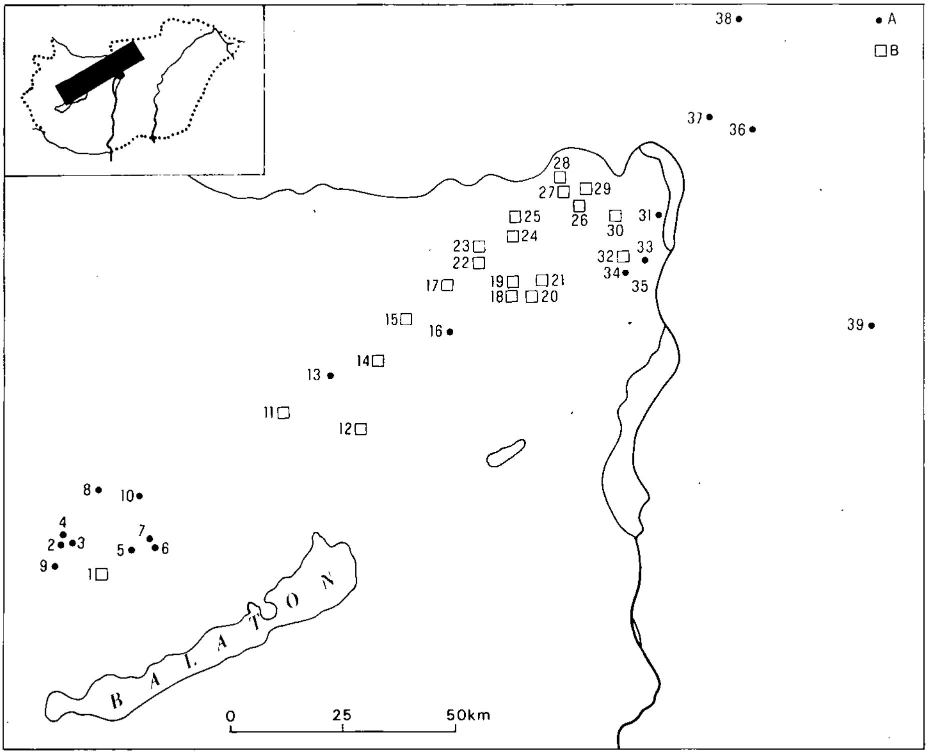


Fig. 2. Location map showing the more important browncoal basins and boreholes

1. Bauxite exploratory boreholes, *2.* Gyepükaján Gytk 1 borehole, *3.* Gyepükaján Gy 5 borehole, *4.* Gyepükaján Gy 8 borehole, *5.* Halimba H 1 borehole, *6.* Padragkut Pa 1 borehole, *7.* Padragkut Pa 5 borehole, *8.* Somlóvásárhely Sv 1 borehole, *9.* Csabrendek Cs 12 borehole, *10.* Magyarpolány Mp 40 borehole, *11.* Dudar area, *12.* Balinka area, *13.* Csatka Cs 1 borehole, *14.* Pusztavám area, *15.* Oroszlány area, *16.* Alcsútdoboz Ad 3 borehole, *17.* Tatabánya area, *18.* Nagyegyháza area, *19.* Csordakút area, *20.* Mány area, *21.* Zsámbék area, *22.* Tarján area, *23.* Héreg area, *24.* Bajna area, *25.* Nagysáp area, *26.* Csolnok area, *27.* Dorog area, *28.* Esztergom area, *29.* Keszölc area, *30.* Piliscsaba area, *31.* Szentendre Sz 2 borehole, *32.* Solymár area, *33.* Kiscell K 1 borehole, *34.* Városmajor Vm 1 borehole, *35.* Mátyáshegy exposure, *36.* Nézsa Nb 5 borehole, *37.* Felsőpetény exposure, *38.* Balasagyarmat Bgy 5 borehole, *39.* Tóalmás To 4 borehole, A: borehole, B: basin

2. ábra. A fontosabb barnakőszén medencék és fúrások térképvázlata

1. Bauxitkutató fúrások, *2.* Gyepükaján Gytk. 1. sz. fúrás, *3.* Gyepükaján Gy. 5. sz. fúrás, *4.* Gyepükaján Gy. 8. sz. fúrás, *5.* Halimba H. 1. sz. fúrás, *6.* Padragkút Pa. 1. sz. fúrás, *7.* Padragkút Pa. 5. sz. fúrás, *8.* Somlóvásárhely Sv. 1. sz. fúrás, *9.* Csabrendek Cs. 12. sz. fúrás, *10.* Magyarpolány Mp. 40. sz. fúrás, *11.* dudari terület, *12.* balinkai terület, *13.* Csatka Cs. 1. sz. fúrás, *14.* pusztavámi terület, *15.* oroszlányi terület, *16.* Alcsútdoboz Ad. 3. sz. fúrás, *17.* tatabányai terület, *18.* nagyegyházai terület, *19.* csordakúti terület, *20.* mányi terület, *21.* zsámbéki terület, *22.* tarjáni terület, *23.* héregi terület, *24.* bajnai terület, *25.* nagysápi terület, *25.* csolnoki terület, *27.* dorogi terület, *28.* esztergomi terület, *29.* kesztölci terület, *30.* piliscsabai terület, *31.* Szentendre Sz. 2. sz. fúrás, *32.* solymári terület, *33.* Kiscell K. 1. sz. fúrás, Városmajor Vm. 1. sz. fúrás, *35.* mátyáshegyi feltárás, *36.* Nézsa Nb. 5. sz. fúrás, *37.* felsőpetényi feltárás, *38.* Balassagyarmat Bgy. 5. sz. fúrás, *39.* Tóalmás To. 4. sz. fúrás, A: fúrás, B: medence

VIII. Buda Marl Formation (zone NP 20). The pertaining rocks are extremely rich in phytoplanktons. The studied boreholes are the following: Kiscell 1, Városmajor Vm 1, Alcsútdoboz Ad 3, Nézsa Nb 5 with the Mátyáshegy (bryozoan marl) and Felsőpetény exposures added.

IX. Tard Clay Formation (zones NP 21—23). Beds of marine and brackish-water facies are present. The contained a phytoplankton assemblage can well serve the correlation of freshwater strata. The studied boreholes are Városmajor Vm 1, Kiscell 1, Alcsutdoboz 3, Szentendre Sz 2, Nézsa Nb 5, with the Felsőpetény exposure.

X. Kiscell Clay Formation (zone NP 24). Only few phytoplanktons has been found. It was studied in boreholes at Esztergom, Kesztölc, Piliscsaba, Solymár, Szentendre and Balassagyarmat.

XI. Csatka Formation (zones NP 24—25). The drilled sequence of borehole Csatka Cs 1 was examined. In the sequence only a few planktonic forms of limnic origin were found.

XII. Mány Formation (zones NP 24—25). Brackish-water and sometimes freshwater rocks are present. Borehole sections were examinated in the Mány, Nagysáp, Szomor, Héreg, Tarján and Zsámbék areas.

XIII. Kovacov Formation (zones NP 24—25). Mainly beds of brackish-water origin with few phytoplanktons to be found. Boreholes deepened in Esztergom, Kesztölc and Szentendre were studied.

The next step of the evaluation of the phytoplanktonic vegetation in Hungary should be the elaboration of the zonation and the remote correlation. The Hungarian zonation does not fully agree with the already known western model. The IGCP-216 project wishes to establish this correlation. The results may be expected by the end of 1992.

Paleoecology

From a paleoecological point of view, first of all Dinoflagellates and the freshwater Chlorophytae should be considered. Based on the literature, the following evaluation can be given.

Species of the Ovoidites, Pillospora, Tetraporina, Pseudokomewuia and the Plankton sp. A. genera refer to freshwater environment. The Areosphaeridium and Homotriblium species are of brackish-water type but indicate increasing salinity. The Thalassiphora is characteristic of the coastline and near-shore layers of anoxic facies. The Wetzeliella, Deflandrea, Kesselovia and Rhombodinium species dwelled in estuaries, lagoons and brackish-waters. The majority of the genera Spiniferites and Achomosphaera live in deep, open and warm seas. Glaphyrocista, Areoligera and Systematophora can be definitely found in typical warm seas. The Cordosphaeridium species favour the moderately warm open sea environment. Tytthodiscus is insensitive to salinity.

The list of taxa

Numerals after the taxa indicate the serial number the stratigraphic Table.
Achilleodinium biformoides (EISENACK 1954) EATON 1976 — 13
Achomosphaera alcicornu (EISENACK 1954) DAVEY & WILLIAMS 1966 — 14
Achomosphaera grallaeforme (BROSIUS 1963) DAVEY & WILLIAMS 1969 — 122

Achomosphaera ramulifera (DEFLANDRE 1937) EVITT 1963 — 64
Achomosphaera sagena DAVEY & WILLIAMS 1966 — 79
Apectodinium homomorphum (DEFLANDRE & COOKSON 1955) LENTIN & WILLIAMS 1977 — 9
Apectodinium quinquelatum (WILLIAMS & DOWNIE 1966) COSTA & DOWNIE 1979 — 15
Araneosphaera arenosa EATON 1976 — 73
Areoligera undulata EATON 1976 — 16
Areosphaeridium arcatum EATON 1971 — 17
Areosphaeridium dikyoplokus (KLUMPP 1953) EATON 1971 — 80
Areosphaeridium multicornutum EATON 1971 — 18
Batiacasphaera compta DRUG 1970 — 118
Botryococcus luteus TRAVERSE 1955 — 82
Campenia circellata JIABO 1978 — 97
Cleistosphaeridium diversispinosum DAVEY & al. 1966 — 19
Cleistosphareidium insolitum (EATON 1976) STOVER & EVITT 1978 — 52
Cleistosphaeridium polytrichum (VALENSI 1947) DAVEY & al. 1969 — 123
Cordosphaeridium cantharellum (BROSIUS 1963) GOCHT 1969 — 108
Cordosphaeridium fibrospinulosum DAVEY & WILLIAMS 1966 — 109
Cordosphaeridium funiculatum MORGENROTH 1966 — 69
Cordosphaeridium inodes (KLUMPP 1953) EISENACK 1963 — 61
Corrudium incompositum (DRUGG 1970) STOVER & EVITT 1978 — 95
Cyclopsiella elliptica DRUGG & LOEBLICH 1967 — 5
Cymatiosphaera eupeplos (VALENSI 1948) DEFLANDRE 1954 — 6
Deflandrea heterophlycta DEFLANDRE & COOKSON 1955 — 98
Deflandrea leptodermata COOKSON & EISENACK 1965 — 99
Deflandrea nucula COOKSON & EISENACK 1962 — 20
Deflandrea oebisfeldensis ALBERTI 1959 — 8
Deflandrea phosphoritica EISENACK 1938 — 65
Deflandrea speciosa ALBERTI 1959 — 119
Deflandrea spinulosa ALBERTI 1959 — 100
Dictyotidium pachydermum JIABO 1978 — 101
Diphyes colligerum (DEFLANDRE & COOKSON 1955) COOKSON 1965 — 21
Distatodinium craterum EATON 1976 — 22
Distatodinium ellipticum (COOKSON 1965) EATON 1976 — 53
Distatodinium solidum CHATEAUEAUF 1980 — 23
Distatodinium tenerum (BENEDEK 1972) EATON 1976 — 83
Geiselodinium hallense KRUTZSCH 1962 — 2
Glaphyrocysta inculata (MORGENROTH 1966) STOVER & EVITT 1978 — 92
Glaphyrocysta laciniiforme (GERLACH 1961) STOVER & EVITT 1978 — 84
Glaphyrocysta pastielsii (DEFLANDRE & COOKSON 1955) STOVER & EVITT 1978 — 85
Glaphyrocysta reticulosa (GERLACH 1961) STOVER & EVITT 1978 — 74
Glaphyrocysta undulata (EATON 1976) STOVER & EVITT 1978 — 24
Gochtodinium simplex BUJAK 1979 — 25

Goctodinium spinulum BUJAK 1979 — 26
Hemicystodinium zoharyi (ROSSINGOL 1962) WALL 1967 — 27
Homotryblium floripites (COOKSON & EISENACK 1961) LENTIN & WILLIAMS 1977 — 54
Homotryblium oceanicum EATON 1976 — 28
Homotryblium pallidum DAVEY & WILLIAMS 1966 — 76
Homotryblium plectilum DRUGG & LOEBLICH 1967 — 102
Homotryblium tenuispinosum DAVEY & WILLIAMS 1966 — 29
Hystrichokolpoma cinctum KLUMPP 1953 — 55
Hystrichokolpoma granulatum EATON 1976 — 120
Hystrichokolpoma rigaudiae DEFLANDRE & COOKSON 1955 — 86
Hystrichosphaeridium asterum EATON 1976 — 30
Hystrichosphaeridium mineralosum VARMA & DANGWAL 1964 — 103
Hystrichosphaeridium tubiferum (EHRENBERG 1838) DEFLANDRE 1937 — 31
Hystrichostrogylon membraniphorum AGELOPOLUS 1964 — 32
Impagidinium aspidatum (COOKSON & EISENACK 1974) DAMASSA 1979 — 33
Impletosphaeridium implicatum MORGENROTH 1966 — 87
Impletosphaeridium multispinosum BENEDEK 1972 — 66
Impletosphaeridium pycnospinosum BENEDEK 1972 — 110
Impletosphaeridium rugosum MORGENROTH 1966 — 34
Kisselovia coleothrypta (WILLIAMS & DOWNIE 1966) LENTIN & WILLIAMS 1976 — 104
Kisselovia clathrata (EISENACK 1938) LENTIN & WILLIAMS 1976 — 71
Lejeunecysta hyalina (GERLACH 1961) LENTIN & WILLIAMS 1978 — 62
Lingulodinium machaerophorum (DEFLANDRE & COOKSON 1955) WALL 1967 — 56
Melitasphaeridium pseudorecurvatum (MORGENROTH 1966) BUJAK & al. 1980 — 35
Millioudinium tenuitabulatum (GERLACH 1961) STOVER & EVITT 1978 —3 6
Micrhystridium costatum VALENSI 1958 — 77
Micrhystridium spinuliferum TAKAHASI 1964 — 78
Micrhystridium stellatum DEFLANDRE 1942 — 57
Nematosphaeropsis reticulensis (PASTIELS 1948) SARJEANT 1986 — 115
Noremia maior KEDVES 1962 — 3
Operculodinium centrocarpum (DEFLANDRE & COOKSON 1955) WALL 1967 — 72
Operculodinium hirsutum (EHRENBERG 1838) LENTIN & WILLIAMS 1973 — 111
Operculodinium pseudorecurvatum (MORGENROTH 1966) STOVETR & EVITT 1978 — 112
Operculodinium xanthium (BENEDEK 1972) STOVER & EVITT 1978 — 124
Ovoidites ligneolus (R. POTONIE 1931) R. POTONIE 1951 — 10
Ovoidites microligneolus KRUTZSCH 1959 — 11
Palaeocystodinium golzowense ALBERTI 1961 — 59
Paralecaniella indentata (DEFLANDRE & COOKSON 1955) — 63
Pentadinium laticinctum GERLACH 1961 — 60

REFERENCES — IRODALOM

BÁLDINÉ BEKE, M. 1974: A dunántúli paleogén képződmények nannoplanktonjai. — Geol. Hung. Ser. Pal. Fasc. 43. 1—307.

KÖTHE, A. 1990: Paleogene Dinoflagellates from Northwest Germany — Biostratigraphy and Paleoenvironment. — Geol. Jhb. A. Heft 118. 3—111.

LENTIN, J. K.—WILLIAMS, G. L. 1985: Fossil Dinoflagellates: Index to Genera and Species. — Canadian Tech. Rep. Hydrogr. Ocean Sci. 60. 1—451.

NAGYMAROSY, A.—BÁLDI-BEKE, M. 1988: The position of the Paleogene formations of Hungary in the standard nannoplankton zonation. — Annal. Univ. Sci. Budapestiensis Eötvös Nom. 28. 3—25.

RÁKOSI, L. 1979: A Dunántúli-középhegység eocén képződményeinek biozónái palinologiai vizsgálatok alapján. — Földt. Int. Évi Jel. 1977-ről.: 241—256.

SNOPKOVÁ, P.—SAMUEL, O. 1981: Mikroplankton z paleogénu Západnych Karpat. — Zap. Karp. ser. paleont. 6. 101—151.

PHYTOPLANKTON SZERVEZETEK A MAGYARORSZÁGI PALEOGÉN KÉPZŐDMÉNYEKBŐL

RÁKOSI LÁSZLÓ

Magyar Állami Földtani Intézet
Budapest, Stefánia út 14.
H-1143

ETO: 561:581.526.325:551.781(439)

T á r g y s z a v a k : Phytoplankton, paleogén, biosztratigráfia, korreláció, paleoökológia, Magyarország

A magyarországi paleogén barnakőszén és bauxit kutatás során, 1961-től sok száz mélyfúrás részletes palynológiai vizsgálatát végeztem el. A spóra és a pollen vizsgálatok során a tengeri eredetű képződményekből számos szervesvázú növényi plankton szervezet került elő. Ezek felsorolását a taxon lista tartalmazza.

A rétegtani korreláció alapjául a már jól kidolgozott nannoplankton zonációt alkalmaztam (1. sz. táblázat).

A fontosabb magyarországi paleogén litosztratigráfia egységek elvi szelvényei az 1. sz. ábrán láthatók.

A 2. sz. ábrán a fontosabb vizsgált fúrásokat és területegységeket jelöltem.

Az irodalmi adatok alapján a növényi plankton szervezetek ökológiája a következőkben adható: Az Ovoidites, Pillospora, Tetraporina, Pseudokomewuia és a Plankton sp. A. genuszok fajai édesvízi eredetre utalnak.

Az Areosphaeridium és Homotriblium fajai csökkentsósvíziek, de a növekvő sótartalmat jelzik. A Thalassiphora tengerparti, partközeli euxin fáciesű rétegekre jellemző. A Wetzeliella, Deflandrea, Kesselovia és Rhombodinium fajok lagunák, estuáriumok és brakkvizek lakói. A Spiniferites és Achomosphaera genuszok jórésze a mély, nyílt meleg tengerekben élnek. A Glaphyrocysta, Areoligera és a Systematophora kimondottan trópusi, meleg tengerek lakói. A Cordosphaeridium fajok a mérsékelten meleg nyílt tengert kedvelik. A Tytthodiscus a sótartalomra érzéketlen.

A PALEOENVIRONMENTAL RECONSTRUCTION OF THE HUNGARIAN NEOGENE

by

ESZTER NAGY

Hungarian Geological Survey
Budapest, Stefánia út 14.
H-1143

UDC: 551.782 (439): 56:581

K e y w o r d s : paleoenvironment, Neogene, Hungary, palynology

The Neogene paleoenvironment of the present-day Hungarian territory has been sketched up upon palynology. In the lower part of the holostratotype of the Egerian we can find a tropical fernery near the seashore. The subtropical forest with dry subsoil includes a great number of tropical elements. For the Late Egerian, coastline changes have been reconstructed by the alternating presence and absence of swamp forest controlling also the appearance of riparian forest. The uppermost part of the section features the predominance of hillside forest. In the Eggenburgian, in the south terrestrial environment and in the north an open water coast with swamp forest came into existence. Ottnangian time, in the S a rich riparian forest and, in N Hungary, brown-coal-forming swamp forest prevailed. In the Karpatian, in South and Middle Hungary there were very rich riparian and hillside forest, in with poorer vegetation in the N, indicating transgression. The Badenian geographical picture resembled largely the present-day conditions, with a very rich vegetation, and in the Late Badenian the vegetation was poorer and a hillside forest became characteristic. In Sarmatian time the components of the flora were changed and a contact with the East European sea came into being. In the Pannonian and Pontian the hilly land were surrounded by brackish-water inland sea and by a lake, respectively. The mixed deciduous and hillside forests were composed of warm-temperate and temperate floral elements.

Introduction

The paleoenvironmental reconstruction can be carried out through the study of paleogeography and paleovegetation. The evaluation is based on the knowledge of the botanical relationships of sporomorphs. The paleoecological and paleoclimatological conclusions can be drawn from the study of the available components of the one-time vegetation and the pertinent lithologies.

The majority of the samples I have studied from the Neogene of Hungary are of coastal facies and, therefore, the fundamental paleoenvironmental conditions were likewise similar. The presence of sea, inland sea or lake can usually be recognized everywhere. This is also a precondition of the embedding of the palynological material. Plant associations indicative of coastal or more humid ecological conditions can be observed nearly in every case. Besides, owing to the transportability by water or air of the spores and pollen grains the sporomorphs of plant associations pre-existing farther away from the coast were also embedded and, selectively, fossilized together with those pointing to the mountain range.

Evaluation

As for the Neogene in Hungary, the following conclusions can be drawn for the Oligocene-Miocene time interval ranging from the Egerian to the Pontian.

The *lower* part of the *Egerian*, the holostratotype, was of a sandy nearshore facies with a little extended Cyrilla swamp. Its pollen spectrum proves the presence of a tropical fernery found more distantly from the shore. The mixed subtropical forest with a drier subsoil embraces a great number of tropical elements. The upper part of the Lower Egerian is dominated by forest covering mountains of midding height, with a few tropical and many subtropical species (Fig. 1).

In the *Upper Egerian* the coastline changes are attested to by the presence or absence of the swamp forest which also controls the appearance of riparian forests. In the Upper Egerian the lower part is dominated by warm, subtropical, mixed subtropical forest with palms, whereas the upper part reflects cooler temperature conditions as described by the predominance of hillside forests.

In the *Eggenburgian*, in the Mecsek Mts (S Hungary) the terrestrial beds contain no sporomorphs. In Central and North Hungary the changes in the quantity of planktonic organisms indicate a fluctuating level of seawater, shown by the changing presence and areal extent of swamp and marsh forests, as well as by the changes in the pollen spectra of mixed subtropical and hillside forests. Spectra of hillside forests make it possible to detect the proximity of hills, in the Buda Mts. In the lower Eggenburgian the vegetation contains more tropical ferns, but among gymnosperms und angiosperms less tropical and more subtropical elements are present. Species requiring temperate climatic conditions also occur in a considerable number. This suggests a uniform subtropical climate (Fig. 2).

In *Ottnangian time*, South Hungary was dominated by rich, ferny riparian forests. In the areae of embedding, the pollen spectra of mixed subtropical and hillside forests can hardly be detected, owing to the thick coastal vegetation. In Central and North Hungary, the coast was throughout accompanied by swamp forests which is indicated, from the Bakony Mts to the Cserehát Mts, by coalification. The mixed subtropical forest consists of thermophylous and temperate vegetation which had given, along with the hillside forest covering medium-level mountainous range, peculiar feature to the region (Fig. 3).

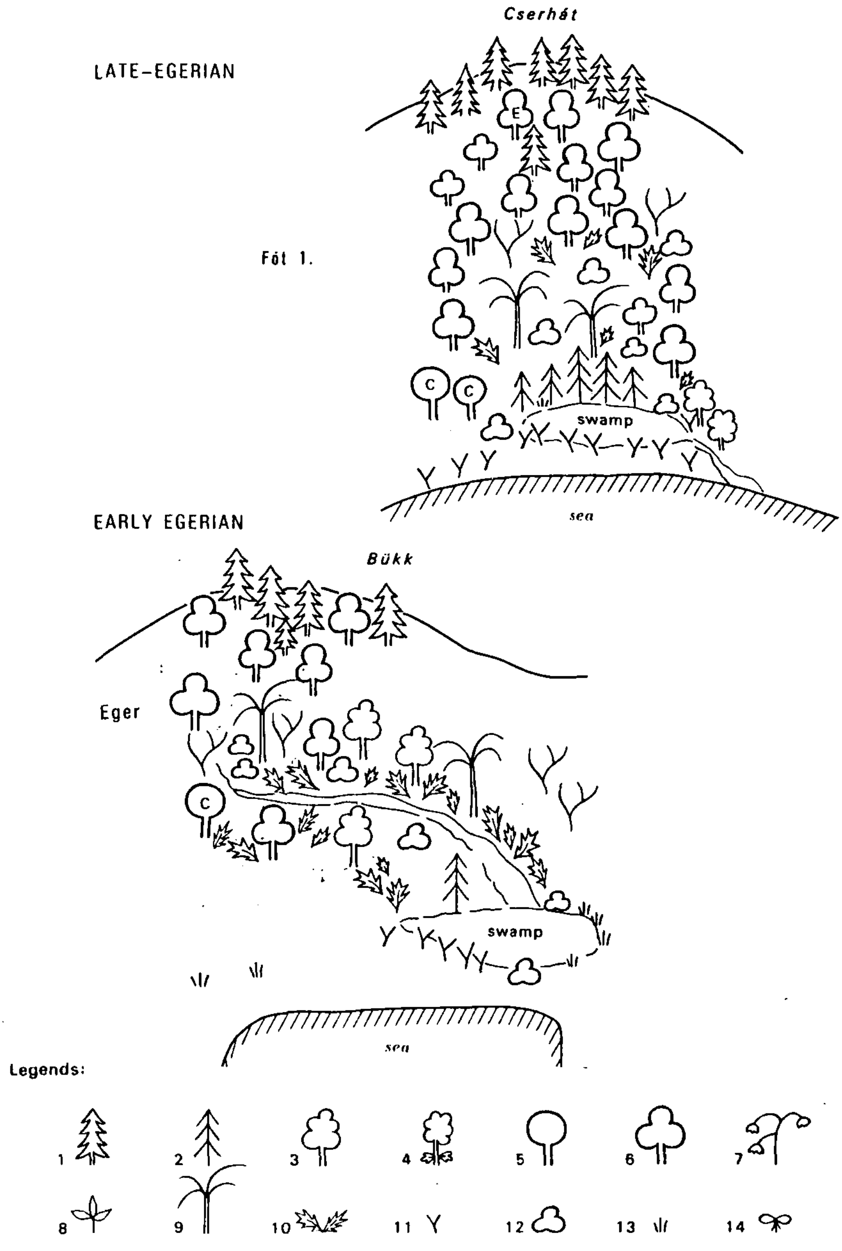


Fig. 1. — *1. ábra*

List of symbols (*Fig. 1—10*)—Jelmagyarázat (*1—10 ábra*): *1.* Coniferae, *2.* Taxodiaceae, *3.* Alnus, *4.* Nyssa, *5.* Carya, Pterocarya, *6.* Tilia, Ulmus, Quercus, Fagus, *7.* Salix, *8.* Spotaceae, *9.* palm trees, *10.* ferns, *11.* Cyrilla, *12.* bush, *13.* Graminaea, *14.* limnic peants, *A*= Alnus, *B*= Betula, *C*= Carya, *Ch*= Chenopodiaceae, *E*= Ephedra, *F*= Fagus, *G*= Gramineae, *IL*= Ilex, *My*= Myrica, *Pt*= Pterocarya, *Q*= Quercus, *T*= Tilia, *U*= Ulmus, Z= Zelkova

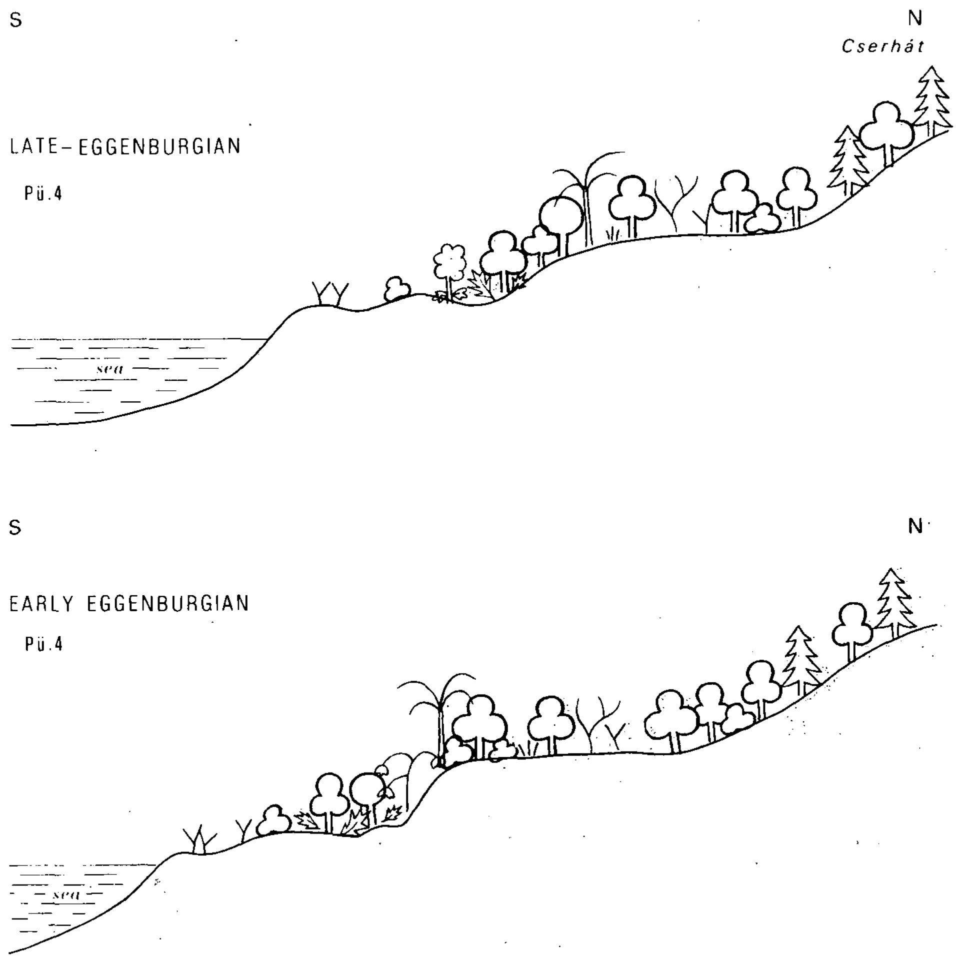


Fig. 2. — 2. ábra

In *Karpatian time* a rich vegetation in South Hungary refers to a coastal and limnic environment. In some places, the mountainous region is indicated by a great number of Coniferae (for example, in the Komló area). In the Hidas area (the NE part of the Mecsek Mts) and in the Bakony Mts swamp forests appeared, and the mixed subtropical forests became less significant. The nearby mountains were represented by rich warmtemperate hillside — piedmont forests. In the northern areas of the country the poorer pollen spectra point to a transgression of the sea, therefore in many cases a vegetation of mountain zone with warmtemperate climatic requirement and living in more distant areas of the terrestrial area can be identified (Fig. 4).

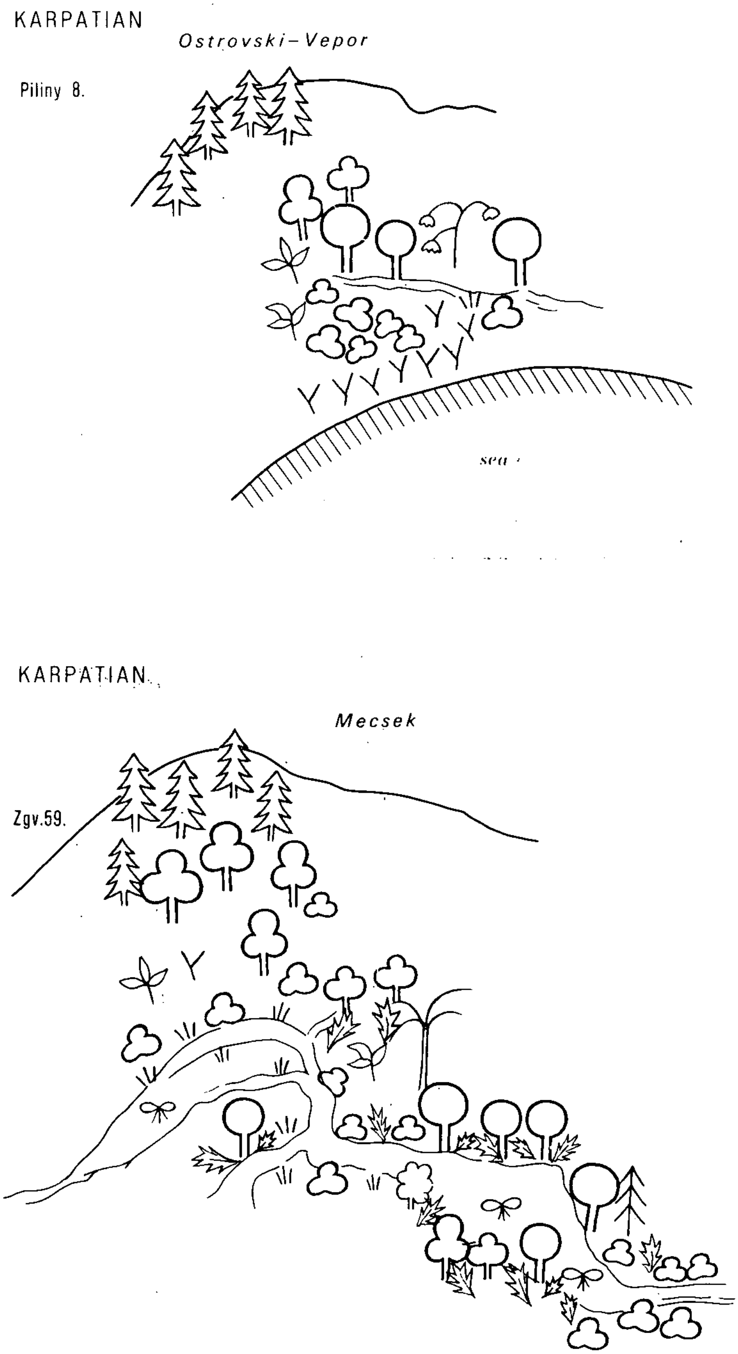

KARPATIAN
Ostrovski–Vepor
Piliny 8.
sea
KARPATIAN
Mecsek
Zgv.59.

Fig. 4. — 4. ábra

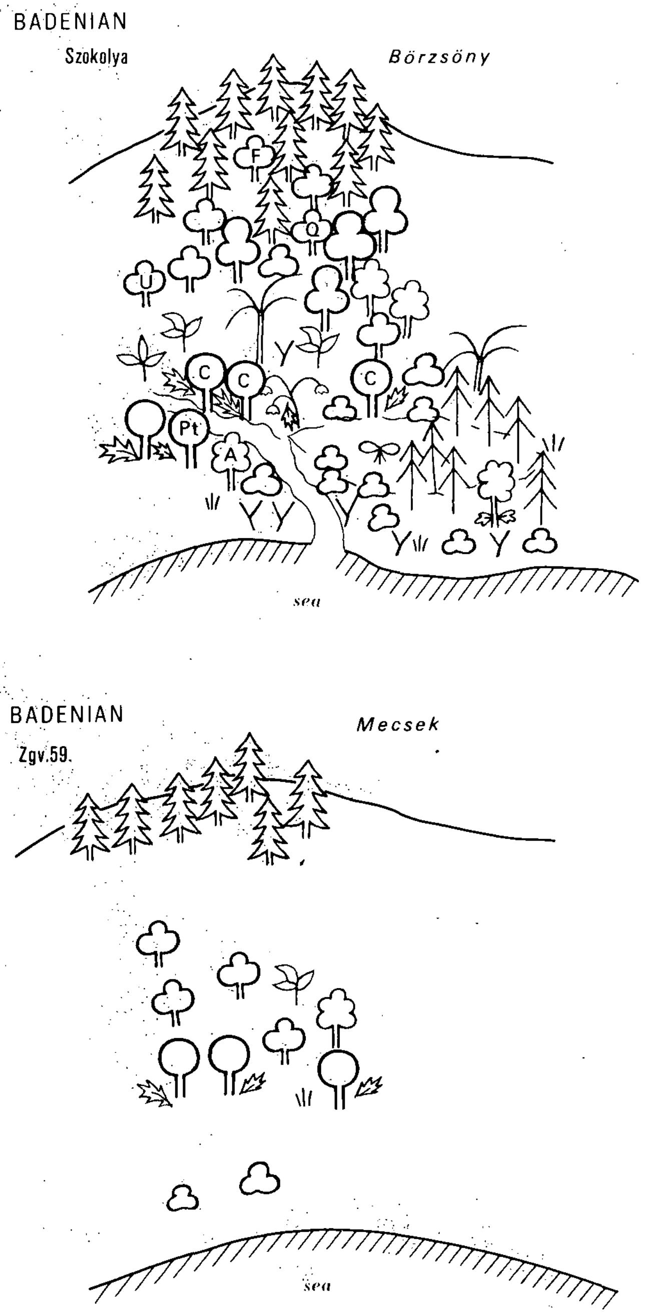

BADENIAN
Szokolya
Börzsöny
F
Q
U
C
C
C
Pt
A
sea
BADENIAN
Zgv.59.
Mecsek
sea

Fig. 5. — 5. ábra

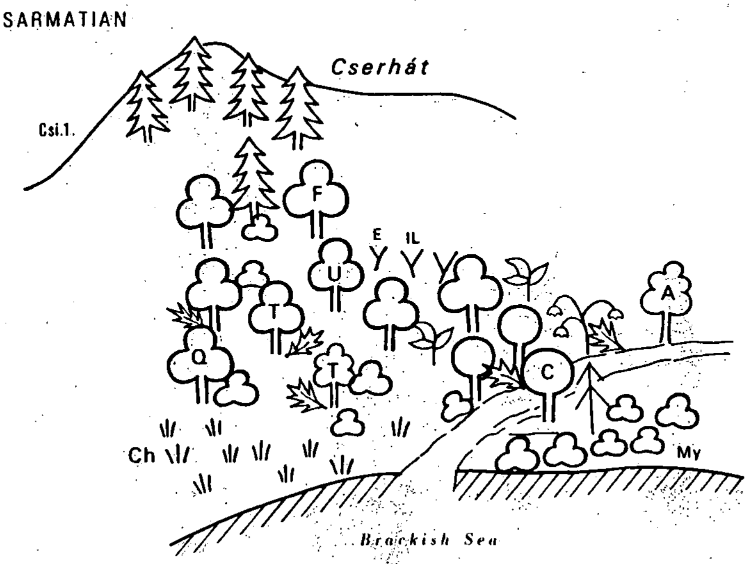


Fig. 6. — 6. ábra

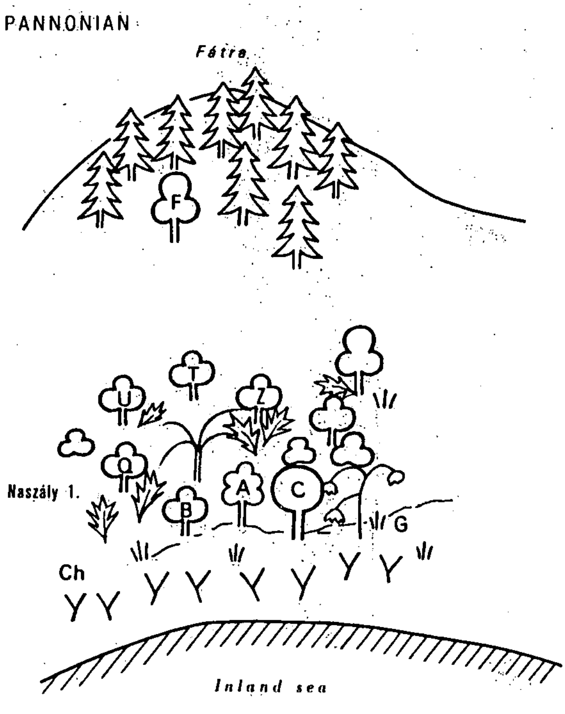


Fig. 7. — 7. ábra

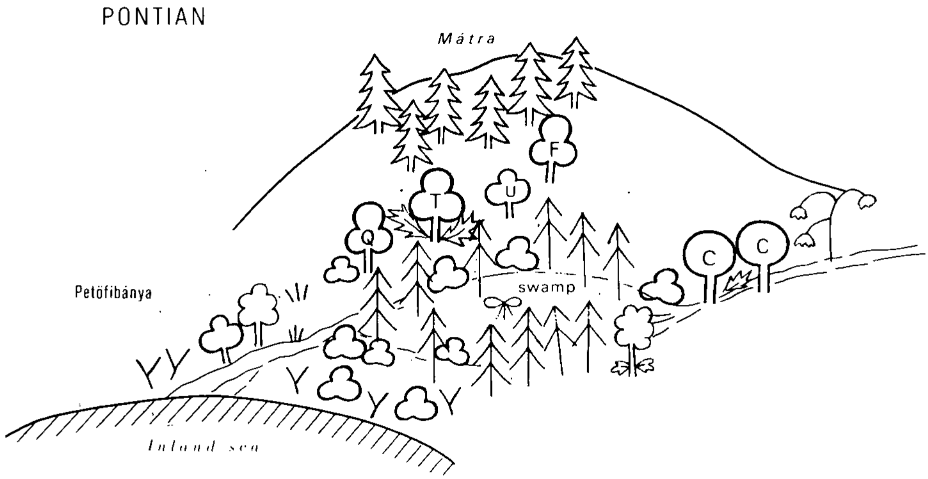


Fig. 8. — 8. ábra

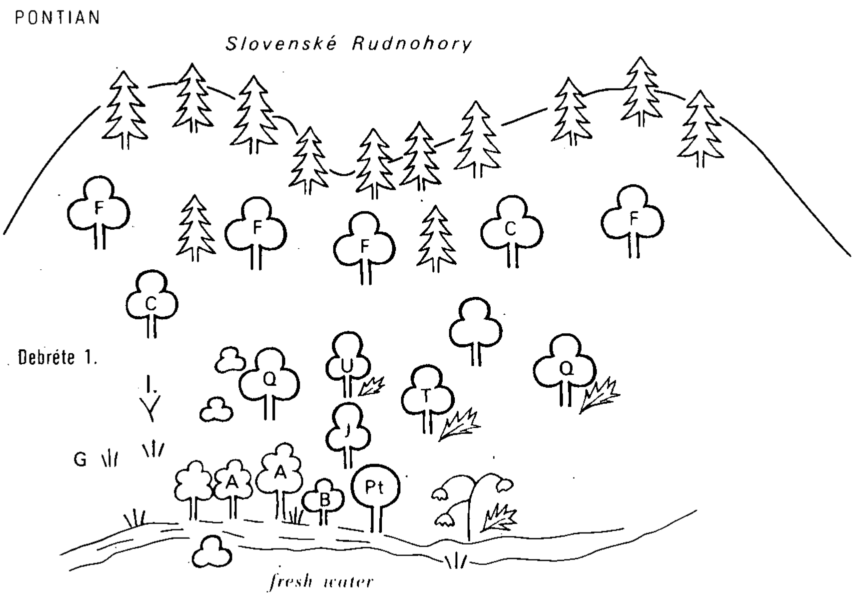


Fig. 9. — 9. ábra

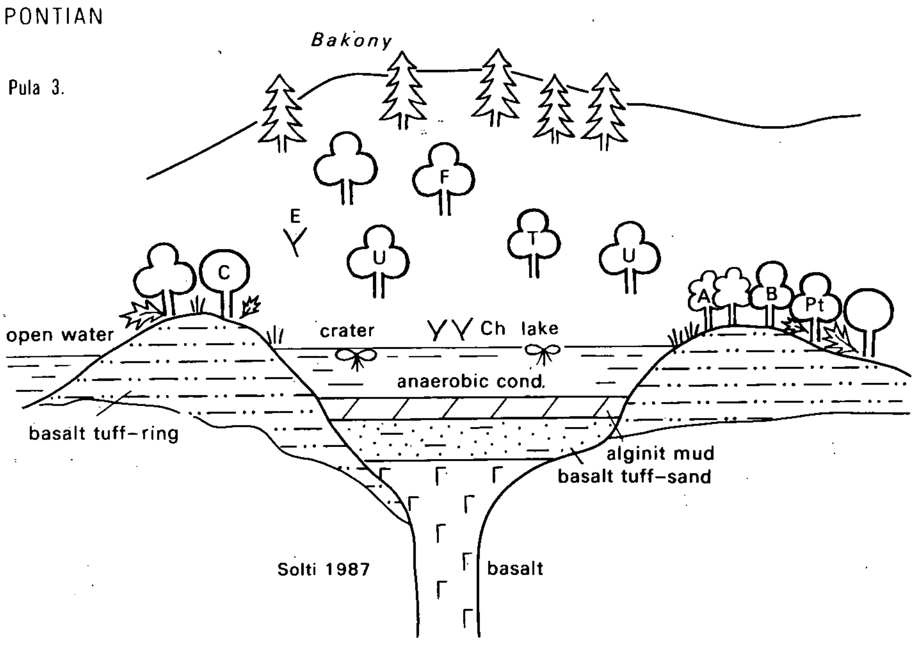


Fig. 10. — 10. ábra

REFERENCES — IRODALOM

NAGY, E.: The evaluation of sporomorphs of the Hungarian Neogene. — Geol. Hung. Ser. Pal. (in press).

A MAGYARORSZÁGI NEOGÉN ŐSKÖRNYEZETI REKONSTRUKCIÓJA PALYNOLÓGIAI VIZSGÁLATOK ALAPJÁN

NAGY ESZTER

Magyar Állami Földtani Intézet
Budapest, Stefánia út 14.
H-1143

ETO: 551.782_(439)_56:581

T á r g y s z a v a k : őskörnyezet, neogén, Magyarország, palynologia

A magyarországi neogén őskörnyezeti viszonyaira palynológiai vizsgálatok alapján következtettünk. Az egri sztratotípus alsó részére egy gazdag trópusi páfrányos a jellemző. A felső-egriben a mocsárerdő váltakozó előfordulásából tengeri parteltolódásra következtethetünk. Az eggenburgi emeletben a Mecsekben terresztrikus rétegek vannak. Az ország északabbi területein nyíltvízi tengeri rétegekről tanúskodnak a palynológiai vizsgálatok. Az ottnangi emelet jellemzői Dél-Magyarországon a gazdag ligeterdők, Észak-Magyarországon a kőszénképző láperdők. A kárpáti emelet rétegeinek pollenspektrumai gazdag növényvilágra utalnak a Mecsekben és a Dunántúli-középhegységben. Észak-Magyarországon a transzgresszió hatására szegényebb a vegetáció. Az alsó-bádeni rétegek gazdag vegetációja már a mai geográfiai viszonyokat tükrözi. A felső-bádeni kiemelkedettebb középhegységein megnövekedett a fenyőerdők területe. A szarmata őskörnyezetét a tenger sótartalmának csökkenése és a klíma szárazabbá válása jellemzi. A pannonban a csökkenő kiterjedésű beltenger körüli vegetáció meleg—mérsékelt és mérsékeltégövi klímaigényű. A pontusi emeletben kiédesedő beltó mentén lignitképző láperdők éltek. Észak-Magyarországon, azokon a területeken ahová már nem terjedt ki a beltó, az édesvízi üledékekre igen gazdag elegyes lomberdő, Fagus dominanciával, a jellemző.

A PETROGRAPHIC CLASSIFICATION OF CENOZOIC SANDS AND SANDSTONES IN HUNGARY

by

E. THAMÓ-BOZSÓ

Hungarian Geological Survey
Budapest, Stefánia út 14.
H-1143

UDC: 551.77 (439)
552.513 (439)

Keywords: Cenozoic, sand, sandstone, micromineralogy, maturity index, pleogeographical conclusions

The result of approximately 4800 micromineralogical examinations of the 0.1—0.2 mm grain-size fraction of Cenozoic sands and sandstones in Hungary have been studied and evaluated upon data published in the geological literature. The petrographic type of each sample was determined using the quartz+silica—feldspar—rock fragments ternary plot worked out by McBride, R.S. (1963). The knowledge of the dominant rock type and the maturity of samples of different age from various areas, in addition to facilitating the comparison of various areas, also reflects differences in their evolution history. Samples from the Neogene and Quaternary beds in S Transdanubia are least mature and feature the dominance of lithic arkoses and subarkoses. The most mature ones are represented by the samples from the Északi-középhegység (Northern Central Range of Hungary) and its foreland, consisting mainly of quartz-sandstone and subarkose. The maturity index determined on the basis of the heavy mineral composition, namely, the ZTR-index seems to point to the mineralogical composition of rocks subject to denudation rather than to reflect the maturity of sedimentary rocks, in some areas.

Introduction

The mineral composition of sedimentary rocks, particularly sands and sandstones, contains geological information of great importance. This paper is devoted to a petrographical classification method which is based on the determination of light minerals of psammites and has so far been hardly applied in practice in Hungary, and allows us to get denominations with genetic content, as well as to the maturity that can be determined using the ratio of these minerals, the feldspar-to-rock fragments ratio pointing to the origin, and to the study of maturity according to heavy mineral composition. Using this method it makes possible to draw geological, mainly paleogeographical conclusions concerning the Cenozoic in Hungary. A total of approx. 8800, out of the results of micromineralogical examinations published not later than 1983 or stored in the Database of the Hungarian

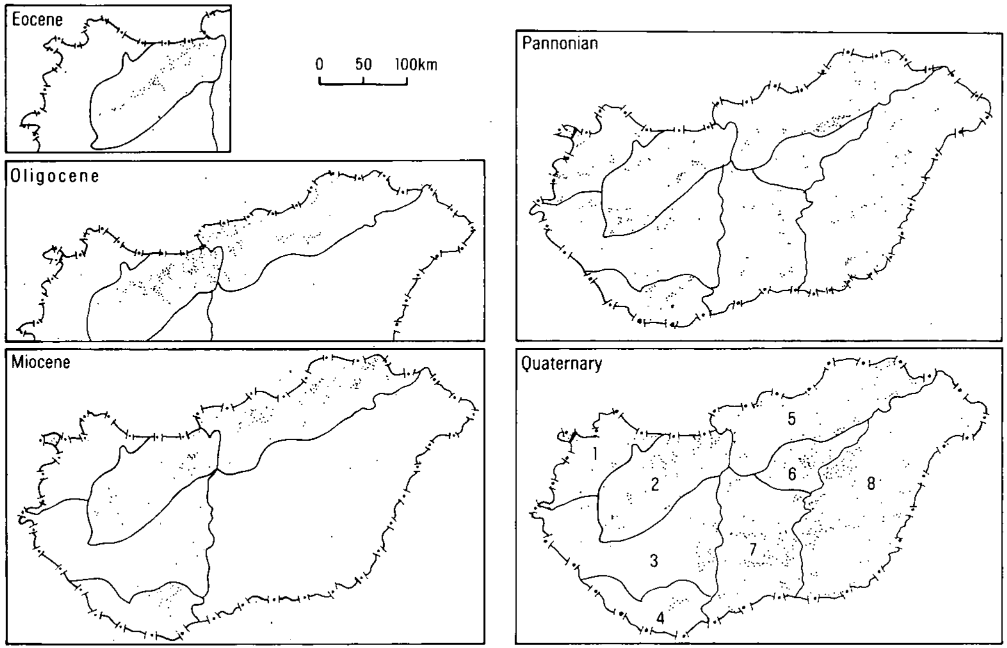


Fig. 1. Location map showing the sites where the data of micromineralogical analyses of Cenozoic sands and sandstones were gained from and published not later than 1983, with the boundary of each reagion:

1. Little Hungarian Plain, *2.* the Transdanubian Central Range and its foreland, *3.* Transdanubian Hilly region, *4.* S Transdanubia, *5.* Northern Central Range and its foreland, *6.* N Great Hungarian Plain, *7.* the Danube-Tisza Interfluve, *8.* the Trans-Tisza Region

1. ábra. Az 1983-ig publikált kainozóos homokokra és homokkövekre vonatkozó mikromineralógiai vizsgálati adatok származási helye a tájegységek határaival:

1. Kisalföld, *2.* Dunántúli-khg. és előtere, *3.* Dunántúli dombság, *4.* Dél-Dunántúl, *5.* Északi-khg. és előtere, *6.* Észak-Alföld, *7.* Duna–Tisza köze, *8.* Tiszántúl

Geological Survey and collected by M. SALLAI are related to Cenozoic sands and sandstones of molasse facies in Hungary (Fig. 1).

Of them, a total of approx. 4800 results relating to the 0.1 to 0.2 mm light mineral fraction of the samples were involved in the evaluation.

The method applied

In accordance with the feature of data available, the triangle diagram of quartz+silica—feldspar—rock fragments worked out by MCBRIDE, R. S. (1963) has been used as a basis for the petrographical classification (Fig. 2). The proportions of quartz+silica, feldspar and rock fragments in the samples related to 100% using a plotting program package called Grapher were represented in triangle diagram, with a help from my colleague Z. PARTÉNYI. The total amount

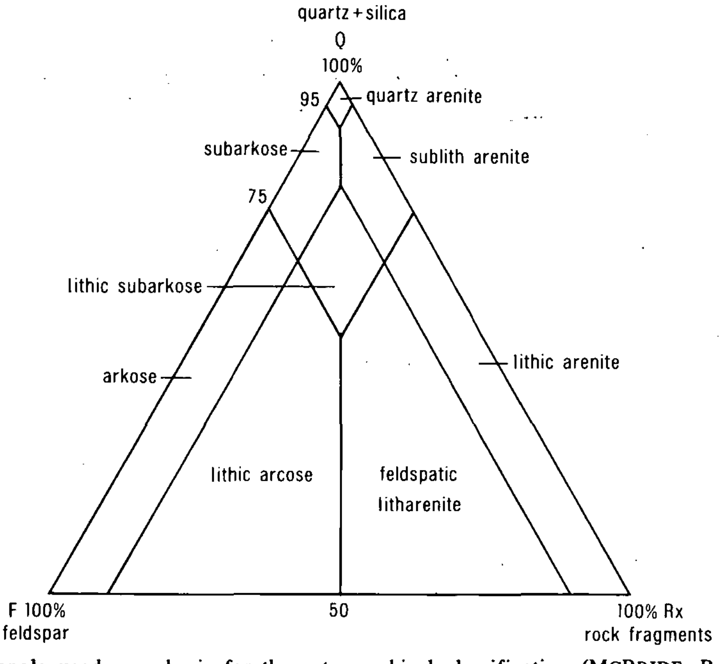


Fig. 2. A triangle used as a basis for the petrographical classification (MCBRIDE, R. S. 1963)

2. ábra. A petrográfiai osztályozás alapjául szolgáló diagram (MCBRIDE, R. S. 1963)

of these light minerals regarded in the classification exceeds 75% for four-fifth of the samples and was less than 50% for only 6% of the samples.

The knowledge of position of samples from various areas in the quartz+silica – feldspar – rock fragments triangle diagram not only renders possible the description and classification of sands and sandstones but it also has a genetic content (PETTIJOHN, F. J. 1975). The feldspar-to-rock fragments ratio, the so-called provenance index reflects the geological setting of the denudation area, since during the weathering process of coarse-grained deep-seated plutonic rocks mainly feldspar grains with size of sand were produced whereas the weathering of supracrustal (igneous, metamorphic and sedimentary) rocks caused sandgrain-sized pieces to form. The (quartz+silica)-to-(feldspar+rock fragments) ratio roughly expresses the mineralogical maturity which is implied by the sedimentary and diagenetic impacts owing to the different resistivity of quartz, feldspar and rock fragments.

The distribution of the types of rock samples of different age from superficial beds and mainly from boreholes is shown in Fig. 3 and Table 1. The position of samples of different age from each area in the triangle diagram is indicated by the areas confined by dots in Fig. 4.

Table 1 — 1. táblázat

The distribution of the evaluated Cenozoic sands and sandstones in Hungary according to petrographical types

A kiértékelt magyarországi kainozóos homokok és homokkövek petrográfiai típus szerinti megoszlása

Epoch	sample No	quartz-arenite %	subarkose %	sublitharenite %	lithic subarkose %	arkose %	lithic arenite %	lithic arkose %	feldspathic litharenite %
Quaternary	1009	6.2	57.0	12.3	6.9	11.0	2.4	2.1	2.1
Pannonian	1633	13.3	47.9	7.6	8.0	13.3	2.1	3.5	4.3
Miocene	661	10.7	14.5	5.4	12.5	11.5	7.6	25.6	12.2
Oligocene	1177	13.6	26.3	13.0	5.4	24.4	8.7	6.6	2.1
Eocene	336	36.9	32.4	8.9	4.8	5.4	9.2	1.5	0.9

The samples from each region were compared using the summarized data in Table 2. Included in this table are the amounts of samples, their dominant rock type, the average quartz+silica, feldspar and rock fragments contents, the maturity index determined using a computer program called Histo and worked out by L. Ó. KOVÁCS, and based on the light mineral composition, moreover another maturity index called ZTR index (zircon+tourmaline+rutile) total heavy mineral content) for the samples. Theoretically the values for both indices are higher for the more mature sedimentary units than for the less mature ones. On account of the kind of distribution of the data, medians are the best to express the maturity of each group of samples.

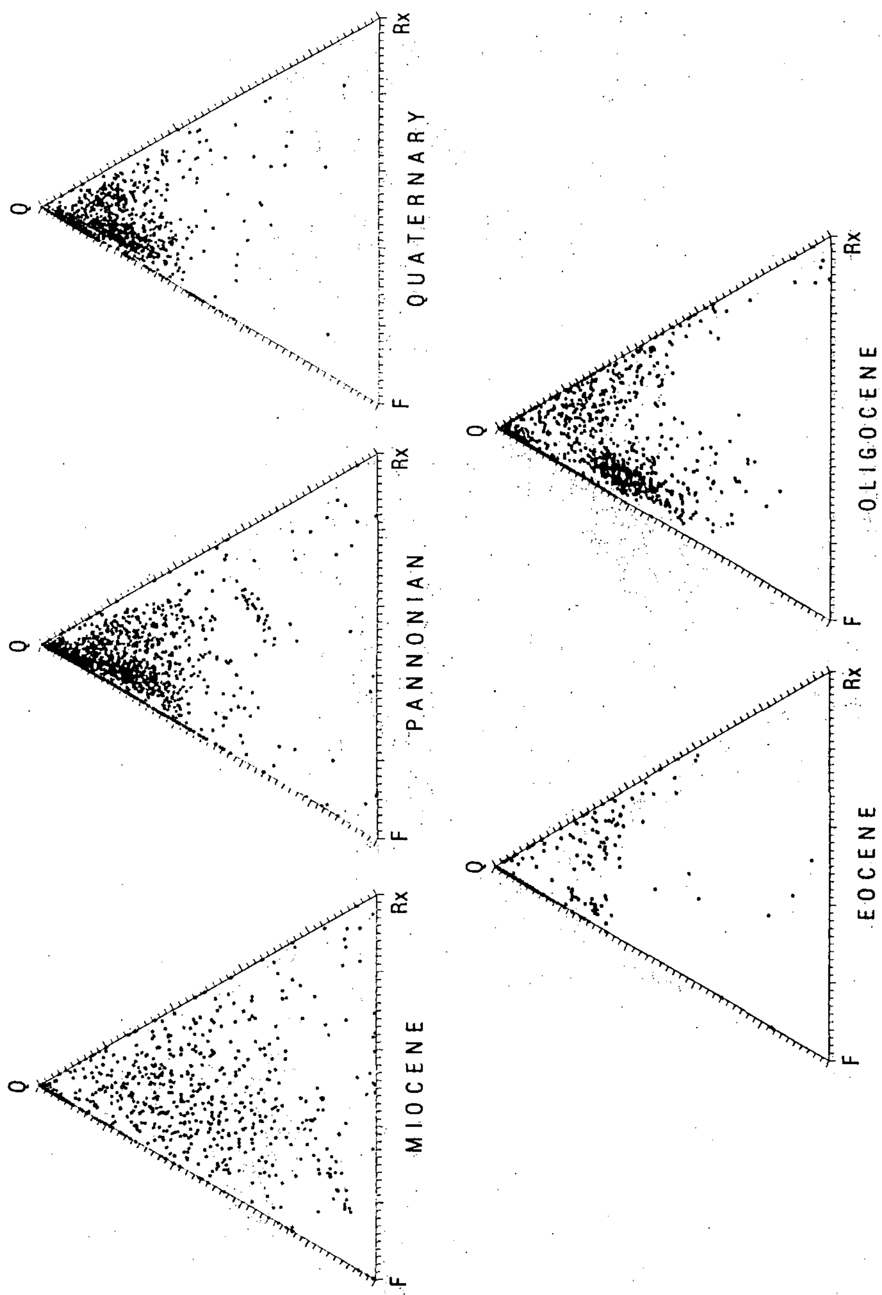


Fig. 3. The position of samples in the triangle of quartz+silica – feldspar – rock fragments
3. ábra. A minta elhelyezkedése a kvarc+kova – földpát – kőzettöredék háromszög diagramban

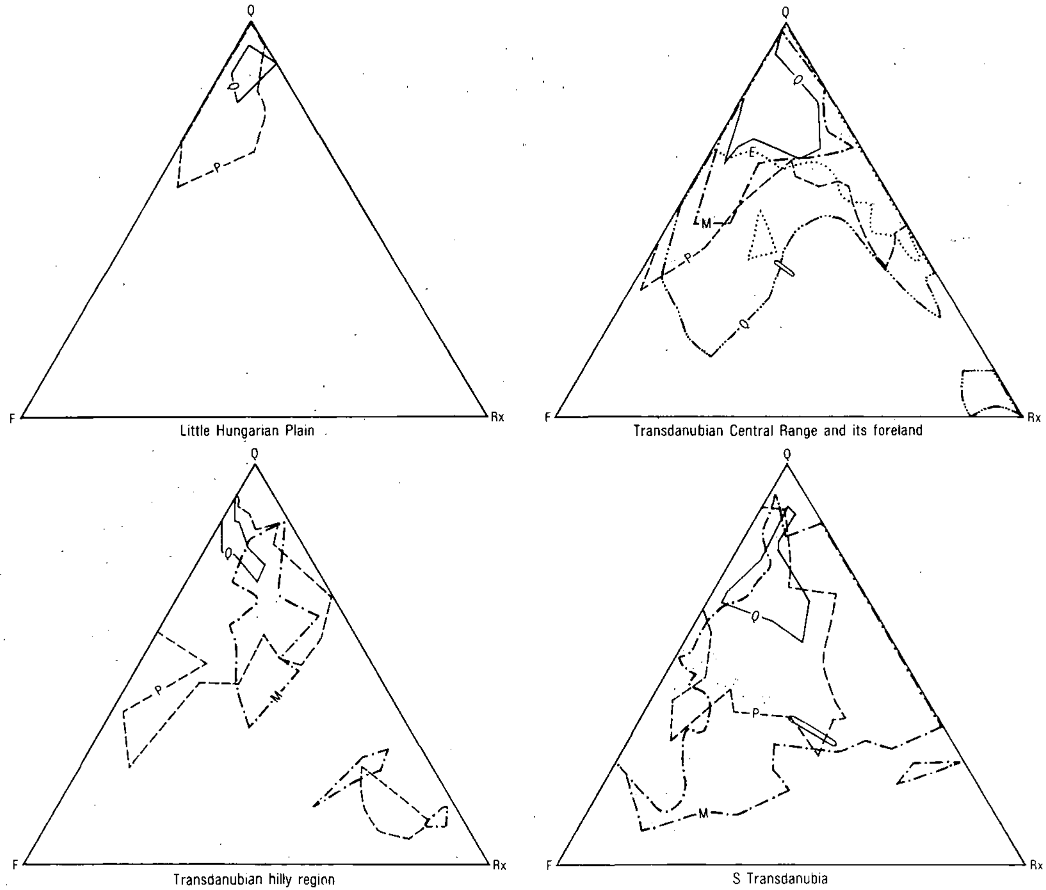


Fig. 4a. Location of the samples taken from the individual regions in the triangle of quartz+silica – feldspar – rock fragments
E: Eocene, *O:* Oligocene, *M:* Miocene, *P:* Pannonian, *Q:* Quaternary

4a. ábra. Az egyes tájegységek területéről származó minták elhelyezkedése a kvarc+kova – földpát – kőzettörmelék háromszög diagramban
E: Eocén, O: Oligocén, M: Miocén, P: Pannóniai, Q: Kvarter

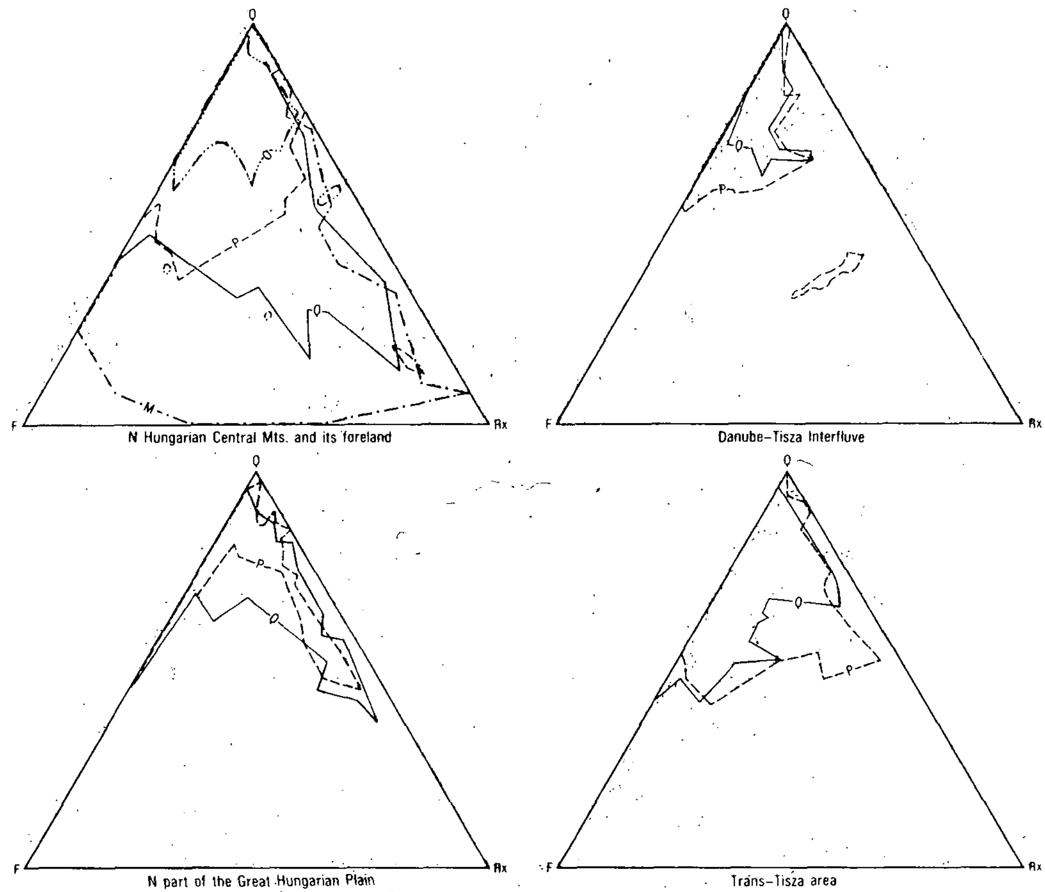


Fig. 4b. Location of the samples taken from the individual regions in the triangle of quartz+silica – feldspar – rock fragments
4b. ábra. Az egyes tájegységek területéről származó minták elhelyezkedése a kvarc+kova – földpát – kőzettöredék háromszög diagramban

Table 2 — 2. táblázat

Typical features of samples of different age from various areas
A különböző területekről származó, különböző korú minták jellemző adatai

Region / Epoch		Little Hungarian Plain	Transdanubian Central Range and its foreland	Transdanubian Hilly Region	S Transdanubia	Northern Central Range and its foreland	N Great Hungarian Plain	Duna-Tisza Interfluve	The Trans-Tisza Region
Quaternary	1.	4	41	15	20	206	111	179	432
	2.	sublitharenite	subarkose	subarkose	subarkose	subarkose	sublitharenite and arkose	subarkose	subarkose
	3.	88 : 6 : 7	81 : 11 : 8	79 : 16 : 5	67 : 20 : 13	82 : 11 : 8	69 : 17 : 14	85 : 12 : 3	77 : 17 : 6
	4.	8.9 5.6 7.3	14.9 23.5 4.4	5.8 3.4 4.4	2.8 2.0 2.1	13.9 21.6 8.1	2.9 2.6 2.3	8.6 6.1 8.6	4.2 2.7 3.4
	5.	3.0 0.5 3.3	5.4 5.9 4.0	3.7 3.1 3.4	9.3 4.7 10.0	3.9 4.1 3.0	7.3 5.6 7.0	2.3 1.9 2.0	2.7 2.5 2.0
Pannonian	1.	61	158	77	89	526	87	366	269
	2.	subarkose	subarkose and quartz-sandstone	subarkose	lithic arkose and subarkose	subarkose and quartz-sandstone	sublitharenite and subarkose	subarkose	subarkose
	3.	81 : 17 : 2	81 : 13 : 7	68 : 17 : 15	61 : 23 : 15	82 : 12 : 6	77 : 13 : 10	78 : 16 : 6	74 : 18 : 8
	4.	8.8 15.1 4.3	19.7 31.4 5.6	4.5 6.9 2.5	6.4 20.5 1.7	17.4 26.1 7.1	5.4 6.7 4.2	5.9 5.0 4.0	5.1 9.9 2.7
	5.	3.6 3.2 3.0	6.6 7.4 5.0	2.5 3.2 1.1	7.8 8.1 6.3	5.3 6.6 3.4	8.3 9.2 4.5	2.6 2.7 2.0	3.3 3.8 2.1
Miocene	1.		82	36	313	250			
	2.		subarkose	lithic subarkose	clastic arkose	quartz-sandstone and subarkose			
	3.		72 : 20 : 8	57 : 14 : 29	45 : 31 : 24	70 : 17 : 12			
	4.		7.3 16.7 2.5	2.1 2.4 1.6	2.1 9.8 0.9	17.7 30.5 3.4			
	5.		9.6 6.9 8.0	4.0 3.3 3.3	10.1 9.7 8.0	4.5 6.4 2.0			
Oligocene	1.		1111			66			
	2.		subarkose and arkose			subarkose and quartz-sandstone			
	3.		73 : 17 : 10			82 : 12 : 6			
	4.		10.5 21.5 2.6			13.6 27.3 8.1			
	5.		5.8 7.6 4.0			6.0 5.2 4.5			
Eocene	1.								
	2.		quartz-sandstone and subarkose						
	3.		85 : 8 : 7						
	4.		30.7 38.2 9.9						
	5.		11.6 19.1 5.0						

Legend:
1. sample No.
2. dominant rock type
3. average (quartz+silica):(feldspar):rock fragments ratio
4. maturity index: $\left(\frac{\text{quartz+silica}}{\text{feldspar+rock fragments}}\right)$ mean, standard, deviation
5. ZTR index: $\left(\frac{\text{zircon+tourmaline+rutile}}{\text{total heavy minerals}}\right)$ mean value, standard deviation, median

The petrographic types, maturity and feldspar/rock fragments content of the examined Cenozoic sand and sandstone samples from Hungary

Based on Tables 1 and 2 and Figures 3 and 4 as well as on the maturity hereinafter referred only to as maturity determined according to the light mineral composition the following features have been stated:

The Eocene sandstone samples — that only are from the Transdanubian Central Range and its region — are mainly quartz-sandstones and subarkoses and are the most mature ones among the samples studied. They have low rock fragments contents that is hardly exceeded by the amount of feldspars. Their ZTR index is higher than that of any other unit of the Cenozoic.

The major part of Oligocene samples are subarkoses and arkoses less mature than the Eocene ones. In the Északi—középhegység (The Northern Central Range of Hungary) more mature subarkoses and quartz-sandstones, whereas in the Transdanubian Central Range less mature subarkoses and arkoses are dominant. In the latter area the feldspar and rock fragments contents of samples are higher than in the Northern Central Range of Hungary. The Oligocene psammites have a medium ZTR index that is somewhat higher in the Nothern Central Range of Hungary than elsewhere.

The Miocene sands and sandstones are mainly lithic arkoses, but also include all other types. Of the Cenozoic samples, they have the highest rock fragments and feldspar contents and are less mature than the older ones. The least mature ones are the lithic arkoses in S Transdanubia which have, however, a rather high ZTR index. They are more mature in the Northern Central Range of Hungary and the Transdanubian Central Range than at other sites and are dominated by quartz-sandstone or subarkose. In general, the Miocene samples contain more feldspar than for rock fragments, particularly in the Transdanubian Central Range. An exeption to this is only represented by samples from the Transdanubian Hilly Region, since their rock fragments content is twice the amount of feldspar. The ZTR index is high in S Transdanubia and the Transdanubian Central Range and is low elsewhere.

The Pannonian sand and sandstone samples are dominated by subarkoses, but the presence of arkoses and quartz-sandstones is also characteristic. As with the Miocene ones, they are most mature in the Northern Central Range and the Transdanubian Central Range. Their feldspar-to-rock fragments ratio is higher in the Little Hungarian Plain and the Danube-Tisza Interfluve than at any other site. The ZTR index is the highest in S Transdanubia, the Transdanubian Central Range and the northern Great Hungarian Plain.

The Quaternary sands are largely subarkoses. The samples from S Transdanubia and the N Great Hungarian Plain are the least mature ones and have higher feldspar and rock fragments contents as well as a higher ZTR index than anywhere else. The Quaternary sand samples, except for those from the Little Hungarian Plain, generally have a higher feldspar content than rock fragments content.Comparing the regions referred to most striking is the fact that data concerning S Transdanubia differ from those of the rest of the areas. Of the Neogene and Quaternary samples they are the least mature with the highest ZTR index. The Miocene samples from the Transdanubian Hilly Region excel in their rock fragments content exceeding twice their feldspar content. Here and in S Transdanubia the Pannonian and Quaternary units are more mature than the Miocene ones. The Cenozoic psammite samples from the Transdanubian Central Range and its foreland are more mature than those from any other part of Transdanubia towards the south. Here the Eocene sandstones are most mature and the Quaternary and particularly Pannonian samples are more mature than the Oligocene and Miocene samples. Sands and sandstones in the Northern Central Range of Hungary and its foreland are, with a single exception, generally more mature than any unit of the same age in the other regions. In the Great Hungarian Plain the least mature ones are represented by the Pannonian and Quaternary sands in Tiszántúl (The Trans-Tisza Region) and the Quaternary sands in the northern part of the Great Hungarian Plain. Except the samples from the N Great Hungarian Plain, the Quaternary beds are more mature than the Pannonian ones in the Little Hungarian Plain and the Great Hungarian Plain alike. As for the ZTR index, it is generally low in the plain areas, reaching a minimum in samples from the Danube-Tisza Interfluve and a maximum in the N Great Hungarian Plain.

Conclusions

As for sands and sandstones, their petrographical type and maturity are pre-determined by factors influencing their composition. Of them, conclusions can be made, by comparing data relating to psammites of each epoch, on changes in climate and relief energy that had prevailed in various periods as well as on the different degrees of diagenesis (for details see THAMÓ-BOZSÓ, E. 1990). Comparing the data relating to each region and regarding the paleogeographical reconstructions (HÁMOR, G. et al 1988), additional information on the proximity or distant position of the erosional area, the degree of redeposition, and possibly on the lithology of the area of erosion or the one-time volcanism and the various facies of deposition can be obtained.

Within each stratigraphic interval the less mature rocks point to a nearer area of primary denudation or volcanism, whereas the more mature rocks indicate a more distant erosional area or the presence of a greater amount of reworked material, or a facies producing a more mature deposit. A higher feldspar-to-rock fragments ratio indicates a larger amount of plutonic material, whereas its low ration indicates more supracrustal material.

The fact that as far as the Oligocene subarkoses and arkoses are concerned, those from the Northern Central Range of Hungary are more mature than those from the Transdanubian Central Range, points to a more distant area of erosion or, possibly, to a facies situated farther off the shores. In addition, they contain a larger amount of plutonic material, according to their higher feldspar-to-rock fragments ratio. The fact that the Miocene, mostly lithic arkoses are less mature than the

Paleogene rocks, mainly indicates a volcanism becoming more and more intensive.

The fact that the Miocene, Pannonian and Quaternary subarkoses and quartz-sandstones in the Transdanubian Central Range and the Northern Central Range of Hungary are more mature than those encountered in other regions of Hungary indicates that here the amount of reworked material is larger than in the other areas and, in the case of the Northern Central Range of Hungary, they may have also originated from a more distant denudation area. Samples from the Pannonian and Quaternary rocks in the Transdanubian Central Range and from the Miocene and Pannonian rocks in the Northern Central Range of Hungary are more mature. This indicates a larger amount of reworked material, as compared to the units of different age of the specific areas.

The Neogene and Quaternary clastic arkoses and subarkoses from S Transdanubia that are less mature than the samples from any other region may indicate an intensive erosion of the local rocks (particularly in Miocene time) or, possibly, to a different lithology of the erosional area. The fact that in S Transdanubia and the Transdanubian Hilly Region the Pannonian and Quaternary samples are more mature than the Miocene ones indicates the presence of more reworked material in the younger rocks.

The lower degree of maturity of the Pannonian and Quaternary subarkoses, sublitharenites in the regions of plains, as compared to the degree of maturity of the pertaining rocks in the Central Ranges mainly indicates that they are originated from a primary erosion or they contain a smaller amount of reworked material. The higher maturity of samples from the Little Hungarian Plain, as compared to the samples from the Great Hungarian Plain may also have resulted from the different lithology of the pre-existing rocks eroded off later. As for the Great Hungarian Plain the higher degree of maturity of samples from the Danube-Tisza Interfluve, as compared to those from the N Great Hungarian Plain and the Trans-Tisza Region are mainly indicative of a greater distance from the area of erosion of the concerned rocks.

Based on the feldspar-to-rock fragments ratios, that is, the provenance indices, the amount of supracrustal material is larger, as compared to other regions, in the Transdanubia Hilly Region, S Transdanubia and the Northern Central Range of Hungary for the Miocene samples, in the Transdanubian Hilly Region, S Transdanubia and the N Great Hungarian Plain for the Pannonian samples, whereas in the Little Hungarian Plain, the N Great Hungarian Plain the Transdanubian and Northern central Ranges and S Transdanubia for the Quaternary sands. However, this needs an additional back-up by other mineralogical data.

The comparison of the maturity degrees determined on the basis of the light mineral composition with the ZTR indices has shown that a more mature rock not always implies a higher ZTR index and vice versa. Thus, the Neogene and Quaternary immature rocks in S Transdanubia and the Pannonian and Quaternary immature psammites in the N Great Hungarian Plain have the highest ZTR index. That is why, in my opinion, the ZTR index, in regard to the entire territory of Hungary, is decreasing as the sands and sandstones are younger and younger, thus proving their increasing immaturity, whereas in smaller areas the ZTR index must be indicative of the zircon, tourmaline and rutile contents of the pre-existent rocks instead of maturity.

REFERENCES — IRODALOM

BLATT, H. 1982: Sedimentary petrology, 564.

MCBRIDE, R. S. 1963 in:WALLACHER, L. 1989: Üledékes kőzetek és kőzetalkotó ásványaik I—II. — NME, Egyetemi jegyzet, Tankönyvkiadó, Budapest, 816.

HÁMOR, G. et al. 1988: Közép és Kelet-Európa neogén ősföldrajzi atlasz, M=1:300 000 — Földt. Int. kiadv.

PETTIJOHN, F. j. 1975: Sedimentary Rocks. — New York, HARPER&ROW. 628.

SALLAY, M. 1984: A magyarországi harmad- és negyed-időszaki üledékes képződmények mikromineralógiai adatai. I—VI. — Földt. Int. Adattára.

SALLAY, M.—E. THAMÓ-BOZSÓ 1988: A magyarországi harmad- és negyed-időszaki üledékes képződmények mikromineralógiai vizsgálati helyzete. — Földt. Int. Évi Jel. 1986-ról, 435—439.

E. THAMÓ-BOZSÓ 1990:The heavy mineral content and mineralogical maturity of the Cenozoic *psammites in Hungary — Abstract of posters, 13th International Sedimentological Congress* Nottingham 214—215.

WALLACHER, L. 1989: Üledékes kőzetek és kőzetalkotó ásványaik. I—II. — NME, Egyetemi jegyzet, Tankönyvkiadó, Budapest, 816.

MAGYARORSZÁGI KAINOZÓOS HOMOKOK ÉS HOMOKKÖVEK PETROGRÁFIAI OSZTÁLYOZÁSA

THAMÓNÉ BOZSÓ E.

Magyar Állami Földtani Intézet
Budapest, Stefánia út 14.
H-1143

ETO: 551.77 (439)
552.513 (439)

Tárgyszavak: kainozóikum, homok-homokkő, mikromineralógia, érettségi index, ősföldrajzi következtetések

A magyarországi kainozóos homokok és homokkövek 0,1—0,2 mm-es frakciójára vonatkozó, a földtani irodalomban fellelhető kb. 4800 db mikromineralógiai vizsgálati eredmény került kiértékelésre. A minták petrográfiai típusának meghatározása MCBRIDE, R. S. (1963) kvarc+kova – földpát – kőzettöredék háromszög diagramja alapján történt. A különböző területekről származó, különböző korú képződmények domináns kőzettípusának és érettségének ismerete segítséget nyújt a területek összehasonlításához és a fejlődéstörténeti különbségeket is tükrözi. A Dél-Dunántúl neogén és kvarter képződményei bizonyultak a legéretlenebbnek, melyek között a kőzettöredékes arkózák és szubarkózák dominálnak. Az Északi-khg. és előtere zömmel kavarchomokkő és szubarkóza mintái a legérettebbek. Úgy tűnik, hogy a nehézásványi összetétel alapján meghatározott érettségi mutató, a ZTR-index az egyes területeken nem az üledékes kőzetek érettségét tükrözi, hanem a lepusztuló kőzetek összetételére utal.

CONTRIBUTIONS TO THE MINERALOGY OF THE LAHÓCA HYDROTHERMAL ORE DEPOSITS OF RECSK, NORTH HUNGARY

by

**GÁBOR DOBOSI—BÉLA NAGY*

*Hungarian Geological Survey
Budapest, Stefánia út 14.
H-1143

**Hungarian Academy of Sciences, Laboratory for Geochemical Research.
Budapest, Budaörsi út 45.
H-1112

UDC: 553.439: 552.13: 553.21/24 (234.373.3)

Keywords: paragenesis, Recsk-Lahóca mineralization, enargite, luzonite, fahlores: tetrahedrite, tennantite, goldfieldite, annivite, Mn-fahlore, chalcostibite, Au-Ag-tellurides, Bi-telluride, native bismuth, native gold, bismutite, guanajuatite, Se-bearing galena, stannite, kesterite

Qualitative and quantitative electron-microprobe investigations were made on samples formerly collected from the enargitic-luzonitic ore stocks in the Lahóca-hegy area of Recsk, and stored in the Museum of the Hungarian Geological Survey, as well as on samples taken from an inclined shaft opening up the enargitic-luzonitic mineralization also penetrated by borehole Rm 48. The authors have determined the chemical composition of enargite, luzonite and fahlores, also identifying the presence of famatinite, goldfieldite, annivite, Mn-fahlore, chalcostibite, Ag-telluride, Au-Ag-telluride, Bi-telluride, native bismuth and bismutite, with the verification of the occurrence of guanajuatite in the mineral paragenesis. In addition, it was the first time that kesterites were found in Hungary.

Introduction

In recent decades the ore explorations around Recsk have greatly contributed to the understanding of the genetics of the Lahóca-type mineralization exploited for more than 125 years (CSEH-NÉMETH 1991).

PANTÓ (1951, 1952) made a two-fold division of the ore stocks of Lahóca-hegy (Mount Lahóca) with the following groups (Fig. 1):

The southern ore stocks (stocks I, II, IV, V, VII, IX and XII) with blueschist envelope — reworked andesite tuffite or detritus-bearing volcanic mud representing the final stage of mineralization — with disseminated to veined ore distribution, including a mostly continuous silicification.

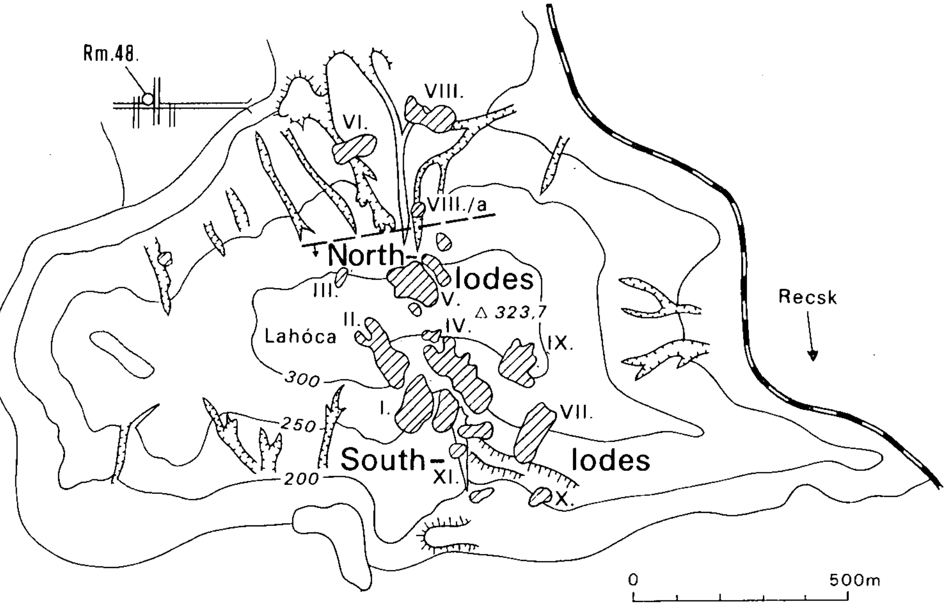


Fig. 1. A layout of ore-bearing stocks in the area of Recsk-Lahóca

1. ábra. Az érces tömzsök elhelyezkedése a recski Lahóca-hegy környékén

In the northern stocks no blueshist is present, and the ore appears in the form of nests and concretions (stocks III, VI and VIII).

The stocks of the Lahóca mineralization cannot be regarded as true stocks in an ore-geological sense, since they are rather stock-like ore impregnations in the Eocene andesite. The size of stocks varies in a wide range. Stock III has a basic area of 3960 sq.m., whereas the basic area for stock V is as large as 22,920 sq.m. Their height ranges from 30 to 92 m.

The exploitation of this ore type was stopped in 1975. The idea of mining to be re-opened is now under consideration. A science-historically interesting significance relative to this mineralization is given by the fact that enargite was first identified here in Europe (PETTKO 1863, 1867).

In a book titled Magyarország ásványai (Minerals of Hungary) by KOCH (1985) the paragenesis of the Lahóca mineralization, based on examinations by PAPP (1932, 1933) PETTKÓ (1863, 1867), SZABÓ (1875), SZTRÓKAY (1940, 1944, 1952), VAVRINECZ (1929, 1931), ZEPHAROVICZ (1867), and ZSIVNY (1923, 1925), is summarized as follows:

Dominant ore minerals: pyrite, enargite, luzonite.

Accessory minerals: tennantite, galena, sphalerite, tenorite, seligmanite, lautite, bournonite, boulangerite, chalcopyrite, bornite, gold, klaprothite, wittichenite, emplectite, galenobismuthite, guanajuatite.

The aim of this paper is to describe more precisely the Recsk—Lahóca-type ore mineralization through electron microprobe investigations, and to obtain quantitative data bearing on the Cu-A-Sb-sulfides of complicated and varying composition, such as enargite, luzonite or fahlores.

Table 1—1. táblázat

List of samples — A gyűjtött minták jegyzéke

Sample	*Locality*	*Collected by*	*MÁFI Inv. No.*
R1	Recsk-Lahóca, Stock II Old-middle György breaking 41	Pantó, G.	3909
R2	Recsk-Lahóca, Stock II Old-middle György breaking 41 by point 708	Pantó, G.	3908
R3, R4	Recsk-Lahóca, Stock II Old-middle György breaking 38	Pantó, G.	3907
R5	Recsk-Lahóca, Stock II Old-middle György breaking 79	Pantó, G.	3910
R6	Recsk-Lahóca, Stock III	Rozlozsnik, P.	2917
R7	Recsk-Lahóca, Stock III Ore breaking 110	Pantó, G.	—
R8	Recsk-Lahóca, Stock IV	Pantó, G.	3923
R9	Recsk-Lahóca, Stock IV Inclined adit 4	Pantó, G.	4664
R10	Recsk-Lahóca, Stock V Top, point 93	Vidacs, A.—Marczis, J.	3936
R11	Recsk-Lahóca, Stock V Point 53	Vidacs, A.—Marczis, J. 1962. VIII.	—
R12	Recsk-Lahóca, Stock V Incl. adit IV. level II, point 2143	Kákay Szabó, O. 1970. XII. 9.	—
R13	Recsk-Lahóca, Stock V Lower half, ore breaking 1083	Tasnádi Kubacska, A.	3942
R14	Recsk-Lahóca, Stock VI Breaking 1025 over "Katalin", tract 1		3949
R15	Recsk-Lahóca, Stock VIII	Pantó, G.	—
R16	Recsk-Lahóca, Stock VIII	Pantó, G.	3955
R17	Recsk-Lahóca, Stock VIII	Pantó, G.	—
R18	Recsk-Lahóca, Stock IX NE III, level 1	Pantó, G.	3985
R19	Recsk-Lahóca, Stock IX NE III, level 1	Pantó, G.	3958
R20	RM-48 Inclined shaft	Szebényi, G.	—
RL1,RL2& and RL3	RM-48 Inclined shaft	Nagy, B.	—
RD3	RM-48 Inclined shaft	Baksa, Cs.	92—227—1
RD4	RM-48 Inclined shaft RM-48 112,8 m	Baksa, Cs.	—

A list of the samples investigated is given in Table 1.

The greater part of samples were collected by G. PANTÓ to be stored in the Collections of the Hungarian Geological Survey (thus, when possible, the numbers of inventory of the Hungarian Geological Survey also are presented in the aforesaid Table).

Each test and measurement was carried out using an electron microprobe Model JEOL Superprobe 733. For the quantitative analyses an accelerating vol-

Table 2—2. táblázat

Representative analyses of some minerals of the Cu-As-Sb-S system from the hydrothermal ore of Recsk, Lahóca. Chemical formulae of the minerals were calculated for 32, 29 and 4 atoms for enargite-luzonite, fahlores and chalcostibnite, respectively

A Cu-As-Sb-S rendszer reprezentatív elemzése egyes ásványoknál a recski és lahócai hidrotermális ércesedésnél. Az ásványok kémiai képletét 32, 29 és 4 atomra állapították meg az enargitra és luzinitre, illetve a fahlclorokra és chalcostibinitre

	1	2	3	4	5	6	7	8	9	10	11
Cu	47.56	48.06	45.36	44.15	46.02	46.01	39.33	45.17	39.54	43.27	25.74
Ag	—	—	0.10	0.11	0.86	0.28	1.38	0.23	0.52	0.36	0.10
Zn	—	—	—	—	—	—	6.64	—	3.07	0.09	—
Fe	0.17	0.08	—	—	0.25	4.27	0.05	0.10	0.69	0.25	—
Mn	0.13	—	—	0.34	1.57	—	0.42	—	—	6.13	—
Sn	—	—	—	—	—	—	—	—	—	—	—
Sb	0.31	3.16	13.24	22.51	3.60	1.38	21.36	3.52	12.37	2.38	47.51
As	18.88	17.02	10.15	4.08	15.03	19.18	5.37	3.89	8.17	18.73	1.79
Te	—	—	—	—	—	—	—	21.37	—	—	—
Bi	—	—	—	—	—	—	—	—	9.81	—	—
S	33.53	32.62	30.92	29.78	32.07	29.25	26.18	25.37	25.37	28.30	25.05
sum	100.45	100.94	99.90	100.97	99.40	100.73	100.37	99.65	99.54	99.51	100.19
Chemical formulae											
Cu	11.672	11.931	11.869	11.909	11.702	10.589	9.940	11.749	10.398	10.106	1.012
Ag	—	—	0.015	0.017	0.129	0.038	0.205	0.035	0.081	0.050	0.002
Zn	—	—	—	—	—	—	1.632	—	0.785	0.020	—
Fe	0.047	0.023	—	—	0.072	1.118	0.014	0.030	0.206	0.066	—
Mn	—	—	—	—	—	—	0.123	—	—	1.656	—
Sn	—	—	0.018	0.049	0.214	—	—	—	—	—	—
Sb	0.040	0.409	1.808	3.169	0.478	0.166	2.818	0.478	1.698	0.290	0.975
As	3.930	3.584	2.253	0.933	3.242	3.744	1.151	0.858	1.822	3.710	0.060
Te	—	—	—	—	—	—	—	2.768	—	—	—
Bi	—	—	—	—	—	—	—	—	0.785	—	—
S	16.311	16.052	16.037	15.922	16.164	13.344	13.116	13.081	13.225	13.101	1.952

1. Enargite, sample R3, Stock II
2. Luzonite, sample R16, Stock VIII
3. Luzonite, sample RD4, Shaft Rm 48.
4. Famatinite, sample R8, Stock IV.
5. Sn-bearing luzonite, sample R16, Stock VIII
6. Tennantite, sample R10, Stock. V.
7. Tetrahedrite, sample R8, Stock. IV.
8. Goldfieldite, sample R2, Stock. II.
9. Annivite, sample R4, Stock. II.
10. Mn-fahlore, sample RD3, Shaft. Rm48.
11. Chalcostibite, sample R8, Stock IV.

tage of 25 kV, and a beam current of approx. 36 nA were used. The standards used are pure Cu, Sn, Te, Ag, Bi, Sb, Zn and pyrite (for the Fe and S measurements), or GaAs (for the As measurements). The set of raw data was subjected to a ZAF correction calculation. The results of each representative analysis are shown in Tables 2 and 3.

Table 3—3. táblázat

The composition of kesterite from the stock of Rm-48 shaft. Chemical formulae were calculated on the basis of 8 atoms.

Az Rm 48-as aknából származó keszterit összetétele. A kémiai összetételt és képletet 8 atom alapján számítottuk ki

	1.	2.	3.
Cu	29.76	29.89	30.12
Zn	13.27	13.10	12.84
Fe	0.14	0.23	0.32
Sn	27.24	26.79	26.70
S	29.95	29.91	30.04
sum	100.36	99.92	100.02
Chemical formulae			
Cu	2.039	2.054	2.064
Zn	0.885	0.874	0.853
Fe	0.008	0.015	0.023
Sn	0.997	0.985	0.981
S	4.070	4.071	4.078

1. Kesterite, Plate VIII
2—3. Kesterite, Plate IX

Results

Enargite and luzonite

Both minerals are the ones being most typical of the Recsk/Lahóca-type mineralization and occurring in the largest amount, beside pyrite. In the samples studied, a great number of quantitative analyses of luzonite and enargite were made. The grains to be studied were selected under ore microscope, since the two minerals cannot be distinguished by microprobe, owing to their nearly identical chemical composition. In consequence, the identification may be uncertain in some cases, particularly, when the two minerals show an intergrowth.

Enargite Experiments by LUCE et al. (1977) in the Cu-A-Sb-S system have shown that the incorporation of Sb into enargite is restricted. According to their experiments, enargite with highest antimony content bore 12.5 mole% of stibioenargite (Cu_3SbS_4) at a temperature of 500°C, and the amount of Sb showed a decreasing tendency as temperature was reduced. According to measurements by SPRINGER (1969) and TANELLI (1970), the maximum solubility of the stibioenargite end-member component was given by 20 mole%. The enargite included in the examined samples from Recsk is generally homogeneous and its composition stands close to the theoretical Cu_3AsS_4 composition. In addition, the proportion of the stibioenargite end-member component does not exceed 20 mole% in accordance with data from the relevant literature (see Fig. 2).

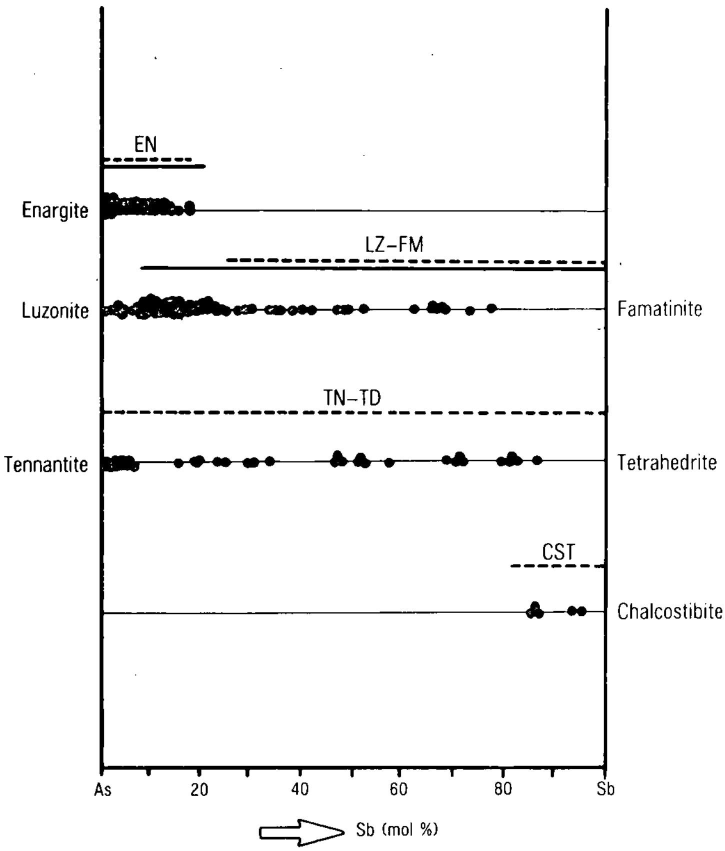


Fig. 2. The variation of As and Sb in the enargite, luzonite-famatinite, fahlore and chalcostibite minerals of the Lahóca mineralization. Black dots indicate measured mineral composition. The thick line confines the region of solid solutions encountered in the nature, whereas the dotted lines indicate the boundary of occurrence of solid solutions, marked upon experiments by LUCE et al. (1977). Abbreviations: EN — enargite, LZ — luzonite, FM — famatinite, TN — tennantite, TD — tetrahedrite, CST — chalcostibite

2. ábra. Az As és Sb változása a lahócai ércek enargit, luzonit–famatinit, fakóérc és kalkostibit ásványaiban. A fekete pontok a mért ásványösszetételeket jelzik, folyamatos vastag összekötő vonal a természetben előforduló elegykristály tartományt jelzi, míg a szaggatott vonal LUCE et al. (1977) kísérletei során kapott elegykristály határokat mutatják. Rövidítések: EN — enargit, LZ — luzonit, FM — famatinit, TN — tennantit, TD —tetraedrit és CST — kalkostibit

Famatinite-luzonite After SKINNER et al. (1972) and LUCE et al. (1977), the Cu_3AsS_4 end-member component is referred to as luzonite, whereas the Cu_3SbS_4 component is called famatinite, avoiding the use of the term "stibio-luzonite". Regarding the transitional members (solid solution), the so-called fifty-percent-rule was applied to.

Contrary to enargite, luzonite is strongly zoned and its Sb and As contents vary in a wide range. Examples of zoning are shown by back-scattered or, otherwise called, compositional electron images in Plate I. The light zones within the zoned luzonite grains indicate an Sb enrichment at the expense of As.

In some grains (see Plate I, Photo 1) the zoning reflects the periodical variation of As and Sb contents during mineral growth, whereas in other cases luzonite with a different compositon was segregated later in the cracks of a slashed luzonite grain (Plate I, Photo 2). Zoning can be of checker-like or parquet pattern (Plate I, Photos 3 and 4). A segregation of Sb-rich luzonite or famatinite is frequently observed at the edge of luzonite (Plate I, Photo 4).

As far as we know, the mixing between luzonite (Cu_3AsS_4) and famatinite (Cu_3SbS_4) is continuous. However, luzonite with Cu_3SbS_4 content less than 10 mole% is unstable under the conditions encountered in nature (LUCE et al. 1977; BERNARDINI et al. 1973). This is also supported by measurements on natural luzonite (SPRINGER 1969, TANELLI 1970) Fig. 2. shows the distribution of Sb and As in the measured luzonites. Accordingly, although a greater part of the measurement points correspond to a zone with an Sb content higher than 10 mole%, there are also luzonite samples with Sb content lower than the aforesaid value. In this case this classification might be inaccurate, since the enargite that cannot be distinguished using microprobe test is also included in the luzonite grain identified under microscope. The Sb content is higher and more varied for luzonite than for enargite. In a number of cases the occurrence of famatinite is also observed, not only in the mineralization of the inclined shaft near borehole Rm 48 but in the Lahóca stocks, too.

According to the relevant literature, in addition to the four main elements (Cu, As, Sb and S), also Fe (PALACHE et al. 1974), Sn (MOH and OTTEMAN 1962) and Ag (KARUP-MOLLER 1974) may be included in luzonite in a large amount. As shown by the present investigations and measurements, Ag and Fe are present in luzonite only by some tenth parts of weight% (for Ag — maximum 0.9 %, for Fe — maximum 0.4 %). However, Sn content may attain even 1.5 weight %. An interesting appearance of the latter can be seen in the luzonite of the zone around inclined shaft near borehole Rm 48, in which the oscillatory zoning is due to an alternating change of Sn content (Plate II, Photos 1 and 2). As shown by the photos, Sn represents an essential element of the hydrothermal system, which is also reflected by the fact that in addition to its being incorporated in luzonite, it is also observed as an independent mineral (see later).

No significant difference was revealed between the composition of enargite and luzonite of the individual ore stocks.

Chalcostibite

Chalcostibite ($CuSbS_2$) was found and analysed in samples from stocks II, IV and VIII, and from an inclined shaft situated near borehole Rm 48. Chalcostibite usually appears as an inclusion in enargite or luzonite, or at the edge of these minerals (plate II, Photos 3 and 4). As for its composition, in addition to its main elements (Cu, Sb, S), a little As can also be found (Fig. 2). Its representative analysis is shown in Table 2. As shown by the analyses, chalcostibite is likely to be the same as a mineral described as wolfsbergite by BAKSA (1975). However, the term "wolfsbergite" is not used any longer and is even not mentioned in most manuals dealing with ore minerals (for instance, UYTEN-BOGAARDT and BURKE 1971).

An experimental investigation of Cu-As-Sb-S system by LUCE et al. (1977) has found that chalcostibite, in addition to enargite or luzonite, is nearly always present in each experimental system, therefore its comparatively rare occurrence under natural conditions seems to be somewhat enigmatical.

Fahlores

Since a very detailed study of the complex chemical features of fahlores encountered in Hungary is just before completion (DOBOSI and NAGY, a paper under preparation for printing), so the Recsk fahlores will be treated here as only touched upon.

As shown in Fig. 2, the Sb and As contents of the Lahóca fahl-ores include nearly the entire tennantite-tetrahedrite range. As or Sb might be substituted by Te and Bi in a larger amount. Moreover, at places in the ores of stocks II and IV, the Te-fahlore, *goldfieldite* (Plate IV, Photos 1 through 3) is observed, whereas *annivite*, a Bi-fahlore is included in the ore of stock II. For their representative analysis, see Table 2. It is of great importance to lay stress on them, since this publication is the first to report on the occurrence of these two minerals in Hungary. The occurrence of another interesting fahl-ore should also be mentioned: fahlore grains with a rather high Mn content (more than 6 weight %) can be detected in the enargite-luzonite-bearing ore in an inclined shaft near borehole Rm 48. However, in details it will be discribed in the paper mentioned above (DOBOSI and NAGY). The picture of Mn-fahlore is shown in Plate III, whereas its representative analysis is given in Table 2.

Miscellaneous ore minerals

Minerals listed so far are generally included in large amounts in the Lahóca ores and can be identified under microscope. Now a few minerals that are considerably less frequent, as compared to those described previously, and are difficult to identify or cannot be identified at all under microscope, due to their small size (a few 10 μm as a maximum), will be discussed. Quantitative analyses have only been made in some cases; their identification is based on their elements.

Ag-telluride. Ag-telluride is rather frequent: by our microprobe tests it was determined in enargite, luzonite and fahlore included in stocks II, V and VIII. Its size is usually smaller than 20 μm (Plate V, Photos 1 and 2). Its combined occurrence with goldfieldite can be seen in Plate IV, Photos 1 through 3, in the ore of stock II. Here the Ag-telluride is represented by 3-to-5-μ-wide plates in goldfieldite.

Considering that no analysis of Ag-telluride was made, we cannot decide whether it is present in the form of hessite, empressite or stuetzite. No Ag-telluride has so far been described from the Lahóca ores; the Ag-telluride inclusion found by microprobe examination of a sample from an inclined shaft near borehole Rm 48 was mistaken for montbrayite (BAKSA 1975).

Au-Ag-telluride. A grain with size of approx. 10 μ, containing Au, Ag and Te elements has been identified as an inclusion in goldfieldite of the ore of stock II (Plate IV, Photo 4). Since it was impossible to make a quantitative analysis of the grain, it cannot be described more precisely. This is likely to be a very rare mineral in the paragenesis, since the grain concerned is the only one that has been encountered. No Ag-Au-telluride has so far been identified in samples from the Lahóca ores.

Native gold. Native gold was found in enargite and luzonite of stocks II and V, and in the goldfieldite of stock II in the form of inclusions smaller than 10 μ. Its typical occurrence is shown in Plate VII. In addition to Au, a few Ag can always be detected in them. In line with microscopic examinations, native gold from Recsk has been known for a long time.

Ag-Bi-Se-bearing phase. In goldfieldite of the ore of stock II a grain with size of approx 10 by 20 μ and containing Bi, Ag and Se elements has been identified. The picture of this grain, with the distribution of the listed elements are shown in Plate VI. More grains like this have not been encountered. Solely its composition of element did not enable us to come to a proper identification.

Bi-Se-bearing phase, probably guanajuatite. Enargite from stock II contains, at several places, Bi-and-Se-bearing inclusion with a size smaller than 10 μ. Inclusions like this are shown in Photos 3 and 4 of Plate V. Since guanajuatite has already been identified in the area concerned on the basis of microscopic examination, the presence of the Bi-and-Se-bearing phase we have encountered here has corroborated the results of earlier studies.

Bi-(and S?)-containing phase. Minor, Bi-bearing inclusions with a size smaller than 10 μ were also found in the enargite and luzonite of stock II. Due to the small size and the S-bearing environment it was not possible to surely decide the question whether S was included in the grain concerned. Bismuthite or native bismuth may be taken into account. Also these minerals have not yet been identified in this area.

Bi-telluride. Bi-telluride has been identified in the luzonite of stock IX and the enargite in the inclined shaft situated near borehole Rm-48, in the form of inclusions with size of around 10 μ. For its occurences in the latter area, see Plate III. Apart from its Bi and Te contents, the mineral cannot be more closely determined on the basis of its elements. Up to the day no Bi-telluride minerals have been described from this area.

Pb-Bi and Pb-Bi-Ag sulfosalts. In enargite and luzonite in the ore of an inclined shaft near borehole Rm 48 tiny rods a few μ wide and 10 to 20 μ long with Pb and Bi, or Pb, Bi and Ag elements have been found. According to their elements, they are likely to be a kind of sulfosalt, however, they cannot be described more precisely. Probably this phase hasen described by BAKSA (1975) questionably as galenobismutite. Galenobismutite has also been identified in the Lahóca area.

Galena. Galena is observable in grains about 10 μ large or smaller, here and there in the Lahóca ores, in enargite, luzonite and pyrite.

Se-bearing galena. Its grains with a size smaller than 10 μ were identified in luzonite of the ore in an inclined shaft near borehole Rm 48. Although no quantitative analysis was made, the selenium content is estimated to be as high as several weight %. Its occurrence here (and not in the Lahóca ores) is very interesting, since the Se-bearing galena is not rare in the Parádfürdő ores.

Stannine. A mineral containing Cu, Sn, Fe and S and having a size of several 100 μ is encountered, in conjunction with enargite, tennantite and goldfieldite, in the ore of stock VI. Based on its elements it would be classified as stannine, however, according to quantitative analyses, the proportion of each element is different, as compared with stannine. As shown by the analysis, its composition is roughly as follows: Cu 41.8 %, Zn O.2 %, Fe 9.4 %, Sn 16.9 % and S 3O.6 %. This composition ocrresponds to a mineral with a composition of $Cu_{2.7}Fe_{0.7}Sn_{0.6}S_4$. This mineral requires further investigations.

Kesterite. A mineral occurring together with luzonite and fahlore in the form of grains with a size of 20 to 50 μ is rather frequently encountered in some samples from an inclined shaft near borehole Rm 48. It is noteworthy that in luzonite from the same samples Sn is present very frequently. Its appearance is shown in Plates VIII and IX, whereas its composition is included in Table 3. The formula calculated on the basis of a quantitative analysis corresponds to the formula a Cu_2ZnSnS_4, that is, to that of custerite. Kesterite differs from stannine by Zn which is contained instead of Fe. ORLOVE (1956) was the first to describe kesterite. The name of this mineral comes from a geographic name Kester in Yakutia, therefore there are some difficulties as far as its mode of writing in Latin is concerned. It is also written as kösterite, Köstérite, kjusterite and custerite. We use the name recommended by FLEISCHER (1966).

Summary

Samples taken from the Recsk-Lahóca enargite-luzonite-bearing ore stocks and from the likewise enargite-luzonite-bearing mineralization of the N foreground of Lahóca — from an inclined shaft made near the site of borehole Rm 48, were examined qualitatively and quantitatively using the electron mi-

croprobe method. Thereby the composition of enargite, luzonite and fahlores was determined, the presence of famatinite was also proved in the Lahóca stocks, and some varieties of fahlores that had not been identified in Hungary before, (e.g. goldfieldite, annivite, and Mn-fahlore), were found in the Lahóca ores.

Based on qualitative examinations, the knowledge of the paragenesis of the Recsk-Lahóca mineralization has been complemented with the verification of the following phases: a kind of Ag-telluride. Au-Ag-telluride, Bi-telluride, native bismuth or bismuthite and an Ag-Bi-Se-bearing mineral phase. It is difficult to give a more precise description of the above phases. The presence of guanajuatite at Lahóca and the occurrence of Se-bearing galena inclusions in the ores in an inclined shaft near borehole Rm 48 have been verified. A variety of stannine of unusual composition has been encountered in the samples from stock VII of Lahóca. We are the first to verify, upon measurements, the presence of kesterite in Hungary.

The additional information on the paragenesis of the Recsk—Lahóca mineralization and a clarification of the chemical composition of fahlores would offer an opportunity to presume a relationship or joint post-magmatic (postvolcanic) origin of the precious metal-telluride-fahlore mineralization of Parádfürdő (NAGY, B. 1985).

As shown by our examinations, the stock-type Recsk-Lahóca mineralization and the vein-type Parádfürdő mineralization can be considered as products of hydrothermal solutions reaching subsurface level from the deep-level porphyritic, skarn-type and metasomatic mineralization of Recsk.

REFERENCES — IRODALOM

BAKSA, Cs. 1975: Új enargitos-luzonitus-pirites ércesedés a recski Lahóca-hegy É-i előterében. — Földt. Közl. 105, 58—74.

BERNARDINI, KG. P.—TANELLI, G.—TROSTI, R. 1973: Relazioni di fase nel sistema Cu_3AsS_4-Cu_3SbS_4. — Soc. Italiana Mineralogia Petrologia — Milano, 29: 281—296.

CSEH-NÉMETH, J. 1991: Kontakt-metaszomatikus szkarnos réz- és polimetallikus érclelőhely (Recsk). — A Földt. Int. Évi Jel. 1989-ről: 113—176

FLEISCHER, M. 1966: Index of new mineral names, discredited minerals, and changes of mineralogical nomenclature in Volumes 1—50 of The American Mineralogist. — Amer. Mineral., 51, 1248—1357.

KARUP-MOLLER, S. 1974: Mineralogy of two copper-antimony-sulphide-oxide occurrences from the Ilimaussaq alkaline intrusion in South Greeenland. — N. Jb. Mineral. Abh. 122, 291—313.

KOCH, S. 1985: Magyarország ásványai. — Akadémiai Kiadó Budapest.

LUCE, F. D.—TUTTLE, C. L.—SKINNER, B. J. 1977): Studies of sulfosalts of copper: V. Phases and phase relations in the system Cu-Sb-As-S between 350 and 500 C. — Econ. Geol., 72, 271—289.

MOH, G. H.—OTTEMANN, J. 1962: Neue Untersuchungen an Zinnkiesen und Zinnkiesverwandten. — N. Jb. Mineral. Abh., 99, 1—27.

NAGY, B. 1985: Arany-, ezüst-, és bizmuttelluridok a parádfürdői ércesedés ásványparagenezisében. — A Földt. Int. Évi Jel. 1983-ról: 321—357.

ORLOVA, Z. V. 1956: Trudy Vses. Magadansk Nauch. — Issled. Inst. Min. Tsvet. Met. SSSR, 2, 76. Ref. in: Amer. Mineral., 43, 1222—1223.

PALACHE, C.—BERMAN, H.—FRONDEl, C. 1944: The system of mineralogy, vol. I. Elements, sulfides, sulfosalts and oxides. — New York, John Wiley and Sons. 834.

PANTÓ, G. 1951: A recski Lahóca felépíítése és érce. — Földt. Közl. 81., 146—152.

PANTÓ, G. 1952: Bányaföldtani felvétel Recsk és Parád környékén. — Földt. Int. Évi Jel. 1949-ről: 67—80.

PAPP, F. 1932: Examen microscopique des minerals métalliques de Hongrie. — Bull. du Soc. Franc. Min. 55., 93.

PAPP, F. 1933: Ércvizsgálatok hazai előfordulásokon. — Földt. Közl. 63. 8—11.

PETTKÓ, J. 1863: A parádi enargit. — M. Tud. Akad. Ért. IV. 141.

PETTKÓ, J. 1867: Enargit von Parád. XX. Lotos.

SKINNER, B. J.—LUCE, F. D.—MAKOVICKY, E. 1972: Studies of the sulfosalts of copper III. Phases and Phase relations in the system Cu-Sb-S. — Econ. Geol. 67, 924—938.

SPRINGER, G. 1969: Compositional variations in enargite and luzonite. — Mineral. Deposita, 4, 72—74.

SZABÓ J. 1875: Enargit ujabb előjövetele Parádon. — Földt. Közl. 5., 160.

SZTRÓKAY, K. 1940: A recski ércek ásványos összetétele és genetikai vizsgálata. — Math. Term. tud. Ért. 59., 722—746.

SZTRÓKAY, K. 1944: Ercmikroskopische Beobachtungen an Erzen von Recsk in Ungarn. — N. Jahrb. f. Min. Abt. A. 79., 104—128.

SZTRÓKAY, K. 1952: Ujabb vizsgálatok hazai ércásványokon. — Földt. Közl. 82., 37—50.

TANELLI, G. 1970: Ricerche sui minerali del gruppo dell'- enargite. — Peri adico di Mineralogia, 39, 561—588.

UYTENBOGAARDT, W.—BURKE, E. A. J. 1971: Tables for microscopic identification of ore minerals. — Elsevier Publ. Co. Amsterdam, London, New York.

VAVRINECZ, G. 1929: Recski ásványok elemzése. — M. Chem. Folyóirat.

VAVRINECZ, G. 1931: Antimondus enargitféleség Recskről. — Bány. Koh. Lapok. 80.

ZEPHAROVICZ, V. 1867: Über enargit von Parád. — Lotos CVII.: 20—23.

ZSIVNY, V. 1923: Ásványtani megfigyelések Recskről. — Ann. Mus. Nat. Hung. XIX., 147—149..

ZSIVNY, V. 1925: A recski Lahóca néhány ásványáról. — Math. Term. tud. Ért. 42., 128—148.

ÚJ ADATOK A RECSKI LAHÓCAI ÉRCESEDÉS ÁSVÁNY PARAGENEZISÉHEZ

**DOBOSI GÁBOR—NAGY BÉLA*

*Magyar Állami Földtani Intézet
Budapest, Stefánia út 14.
H-1143

**MTA Geokémiai Kutató Laboratórium
Budapest, Budaörsi út 45.
H-1112

ETO: 553.439: 552.13: 553.21/24 (234.373.3)

Tárgyszavak: paragenezis, Recsk-Lahóca, ércesedés, enargit, luzonit, fakóércek: tetraedrit, tennantit, goldfieldit, annivit, Mn-fakóérc, kalkoztibit, arany–ezüst-telluridok, bizmuttellurid, termésbizmut, termésarany, bizmutin, guanajuatit, Se-tartalmú galenit, stannin, kesterit

Az elmúlt évtizedek recski érckutatásai nagyban elősegítették a több mint 125 éven keresztül művelt lahócai ércesedés genetikai kérdéseinek a tisztázását (CSEH—NÉMET 1991.)

A felszínközeli bányászat beszüntetése után még mindig kérdéses maradt az ércesedés viszonylag jelentős nemesfémtartalmának ásványokhoz való kötődésének az ismerete. Ezért szerzők célul tűzték ki, hogy a Magyar Állami Földtani Intézet Múzeumában őrzött anyagokból, az MTA Geokémiai Kutatólaboratóriumában, elektron mikroszondás vizsgálatokkal új ismereteket szereznek.

Vizsgálataik során kvantitatív adatokat nyertek a bonyolult és változó összetételű Cu-As-Sb-szulfidokról, mint amilyenek az enargit, a luzonit és a fakóércek.

Kimutatták az ásványparagenezis új tagjaként a kalkostibitet, a fakóércek közül az annivitet, goldfielditet és a Mn-fakóércet, ezüst telluridot (hessitet?), arany-ezüst-telluridot (petzitet?), bizmuttelluridot, termésbizmutot, egy Ag-Bi-Se fázist, Pb-Bi és Pb-Bi-Ag szulfosókat, stannint, és a kesteritet.

Igazolták az ásványparagenezisben a guanajuatit, a termésarany és a galenit jelenlétét.

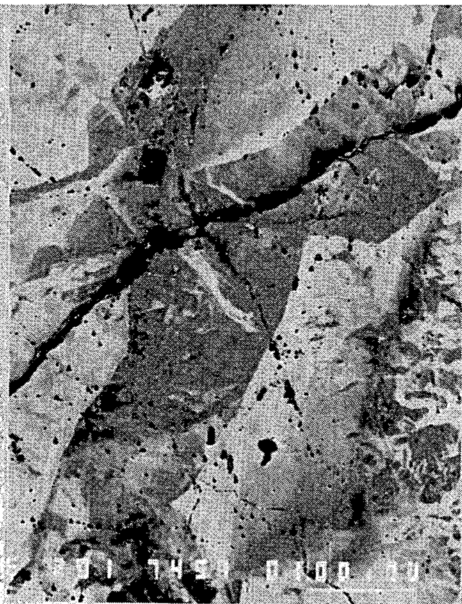
A recski lahócai ércesedés ásványparagenezisében új tagként kimutatott ásványfázisokkal felhívják a figyelmet arra, hogy a lahócai tömzsös ércesedés és a közeli parádfürdői teléres ércesedés, a Recsk mélyszinti ércesedés felszínközeli, nemesfémekben dúsult részeinek tekinthetők.

Plate I — I. tábla

Back-scattered electron images of zoned luzonites. Within each zoned grain the dark zones indicate the parts rich in arsenic, and light zones show parts enriched in antimony.

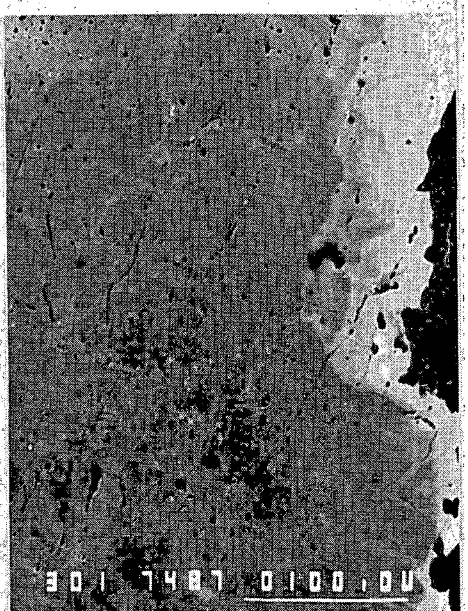
1. Sample R4, Lahóca, stock II.
2. Sample R10, Lahóca, stock V.
3. Sample R16, Lahóca, stock VIII.
4. Sample RD4, inclined shaft near borehole Rm 48.

1



2

3



4

Plate II — II. tábla

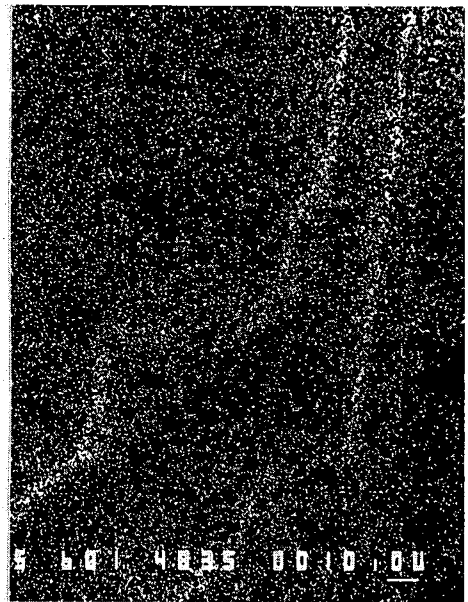
1. A back-scattered electron image of a zoned luzonite from sample RL-3 (inclined shaft near borehole Rm 48). The zoning is due to changes in Sn content.

2. Sn distribution.

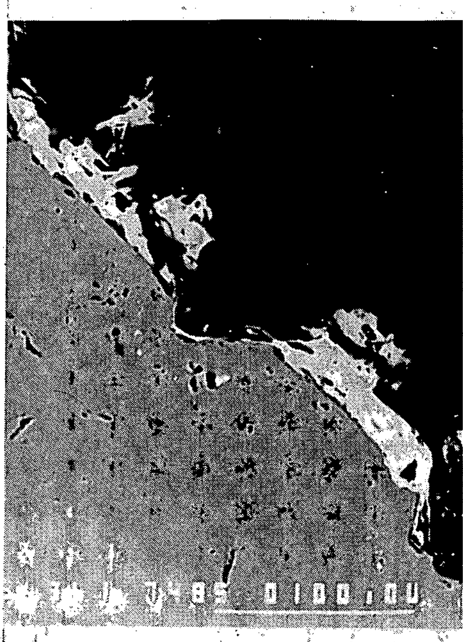
3. Chalcostibite at the edge of luzonite, in sample R15 (Lahóca, stock VIII). A back-scattered electron image; the light grey phase is chalcostibite.

4. An Sb distribution, showing the place of chalcostibite.

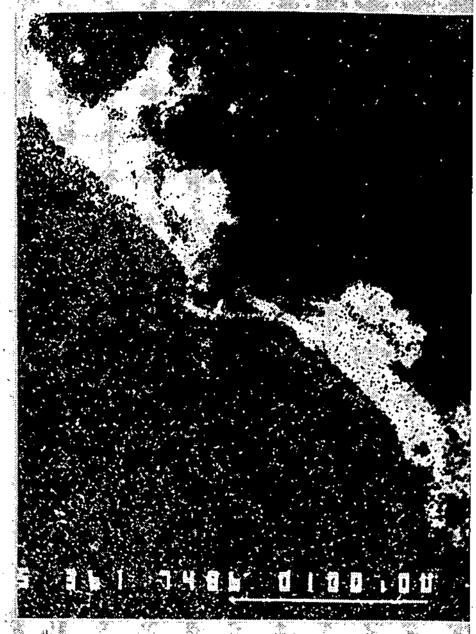
1



2



3



4

Plate III — III. tábla

Mn-bearing fahlore and Bi-telluride inclusions in enargite. Sample RD3, inclined shaft near borehole Rm 48.

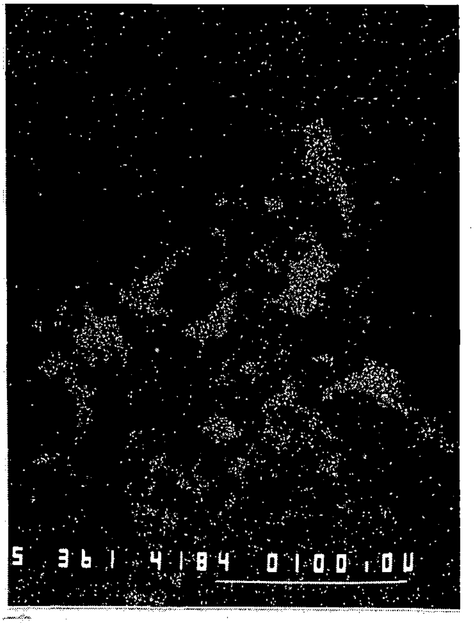
1. A back-scattered electron image. The dark grey phase is enargite, and the light grey phase is an Mn-bearing fahlore. Each white inclusion is Bi-telluride.

2. the Mn distribution, indicating the place of Mn fahlore.

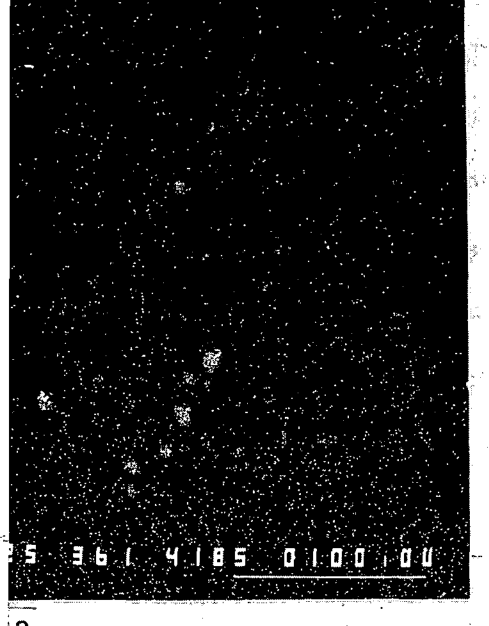
3. Te distribution.

4. Bi distribution. The last two elements indicate the places of Bi-Te inclusions.

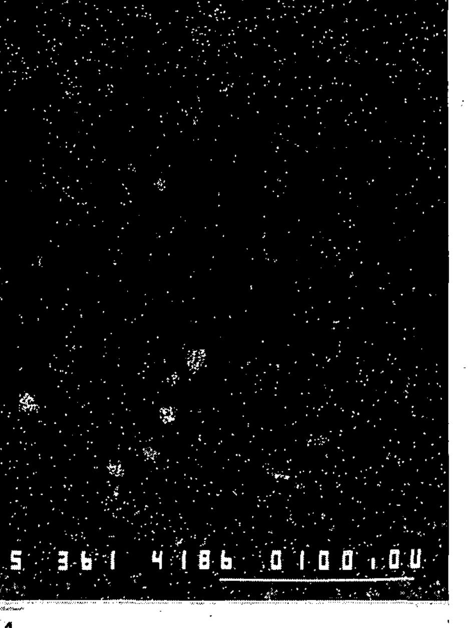

1



2



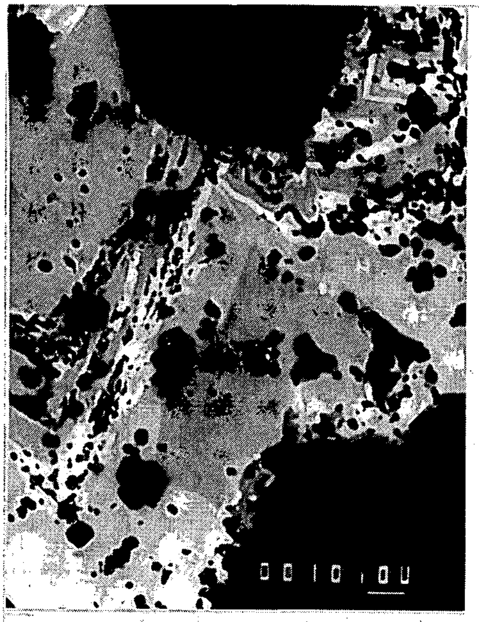
3



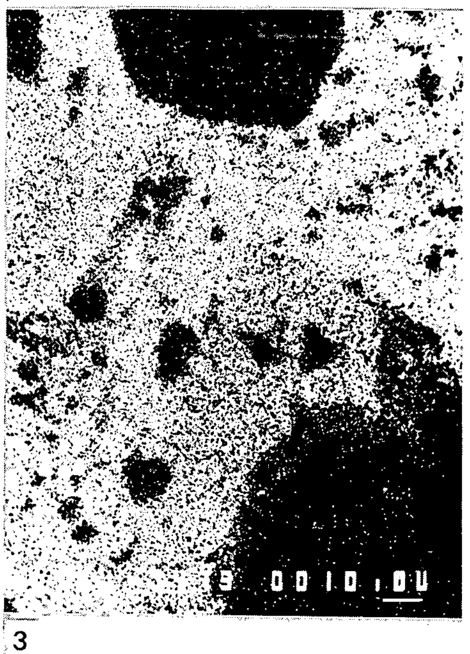
4

Plate IV — IV. tábla

1. Goldfieldite with Ag-telluride plates in sample R2 (Lahóca, stock II). A back-scattered electron image. Goldfieldite is grey, and Ag-telluride is white.
2. Ag distribution.
3. Te distribution.
4. Au-Ag tellurite (white) in goldfieldite (grey). Sample R2, stock II. A back-scattered electron image.


1


2


3

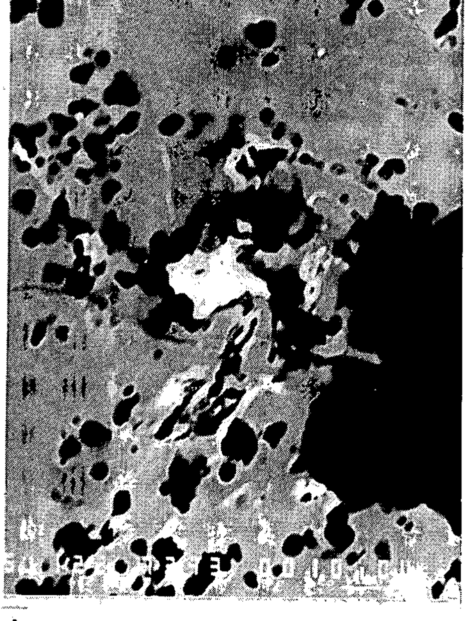
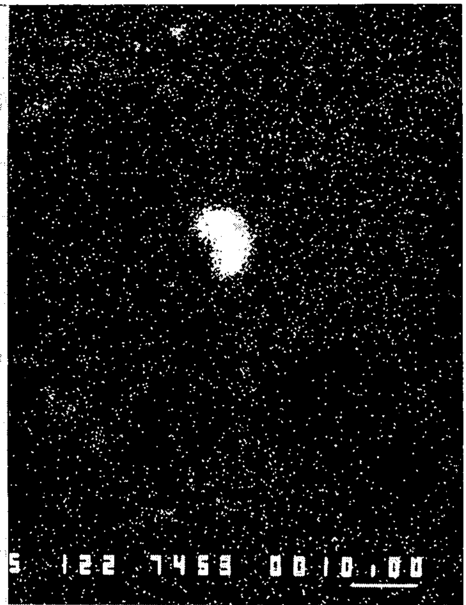

4

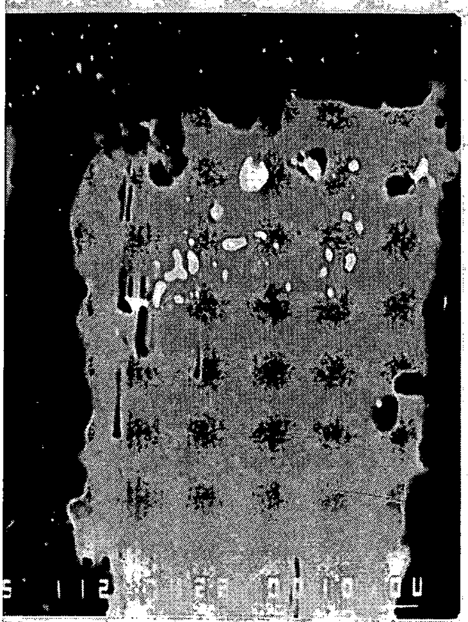
Plate V — V. tábla

1. Ag-telluride (white) at the boundary of fahlore (light grey) and pyrite (grey). Sample R10, Lahóca, stock V. A back-scattered electron image.
2. Ag distribution.
3. Bi-selenide (guanajuatite) inclusions in enargite. Sample R3, Lahóca, stock II. A back-scattered electron image.
4. Se distribution.

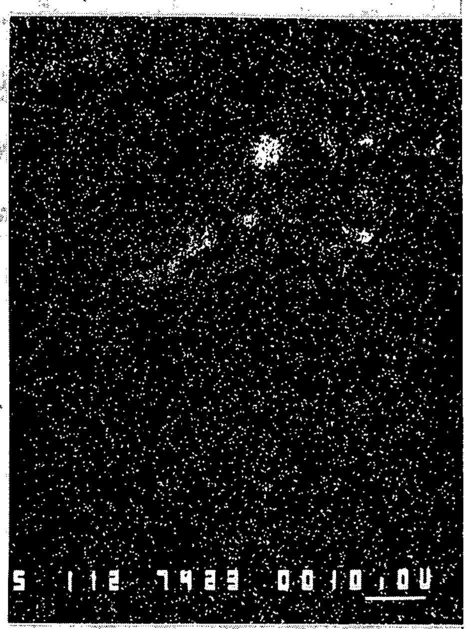
1



2



3



4

Plate VI — VI. tábla

1. A grain (white) containing Ag-Bi-Se elements but not suitable for a more precise identification, in goldfieldite. Sample R2, Lahóca, stock II. A backscattered electron image.
2. Ag distribution.
3. Bi distribution.
4. Se distribution.

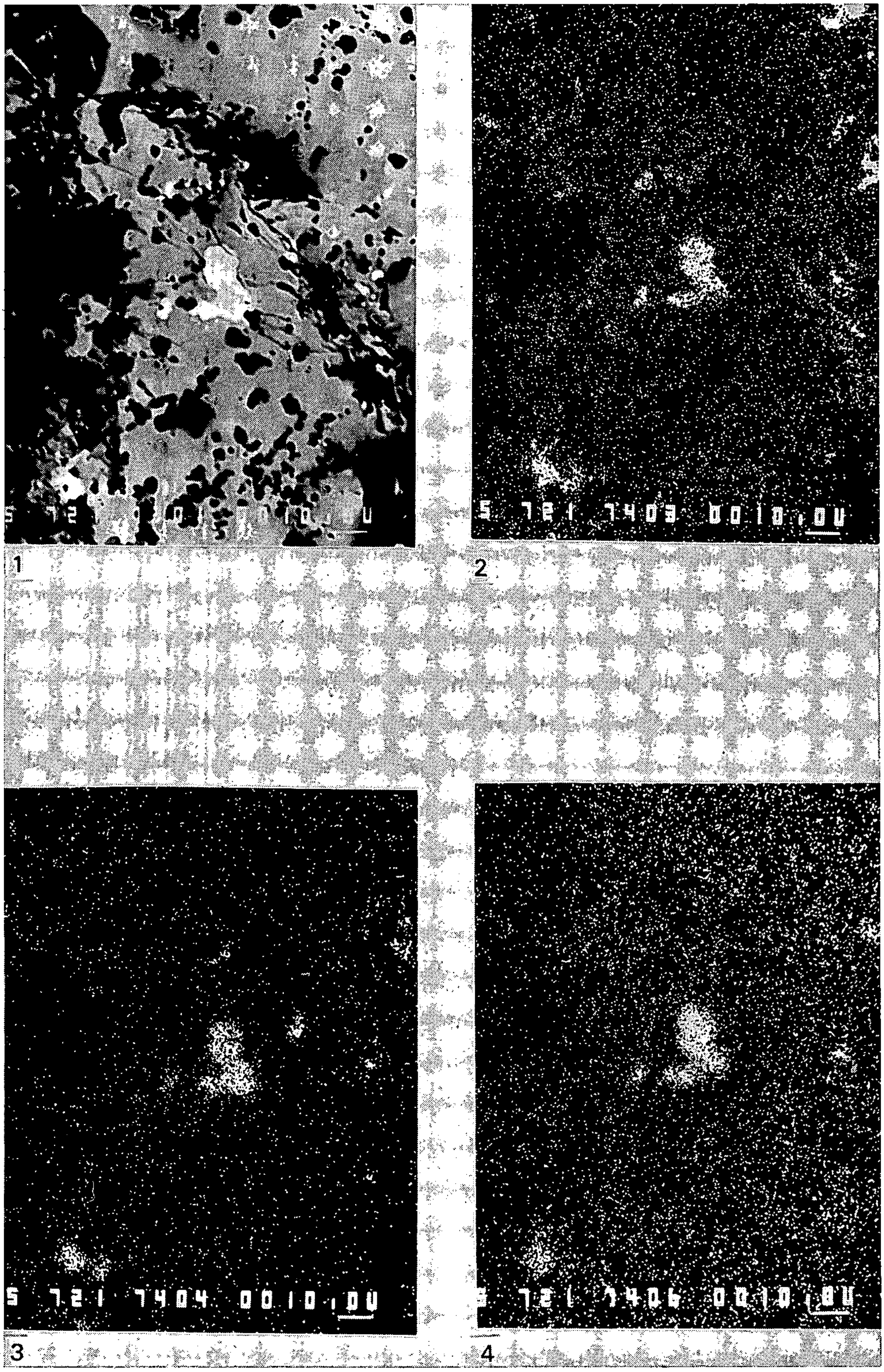

1
2
3
4

Plate VII — VII. tábla

1. Native gold inclusions (white) in luzonite. Sample R2, Lahóca, stock II. A back-scattered electron image.

2. Au distribution.

3. Native gold inclusion (white) in enargite. Sample R12, Lahóca, stock V. A back-scattered electron image.

4. Au distribution.

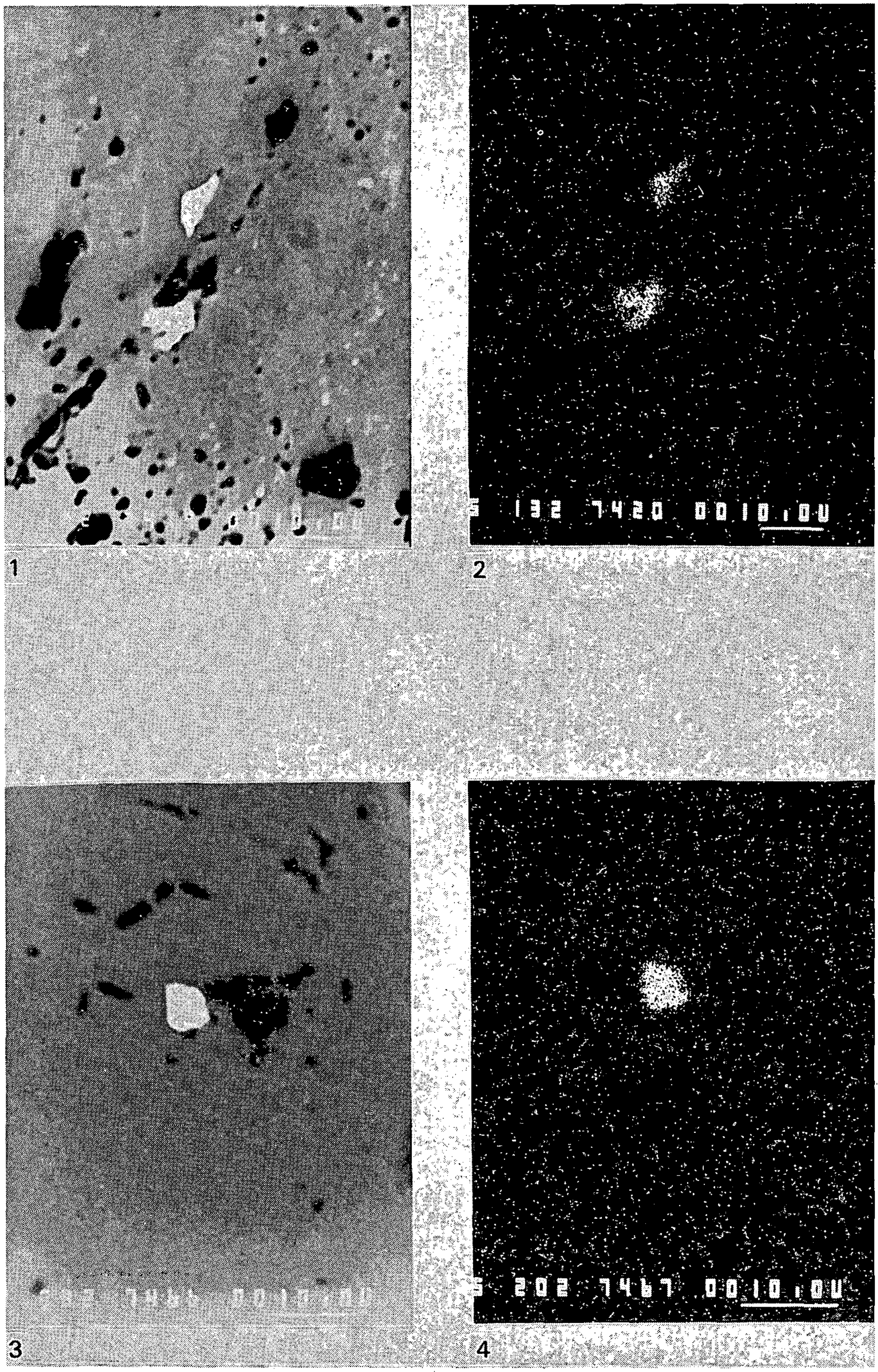
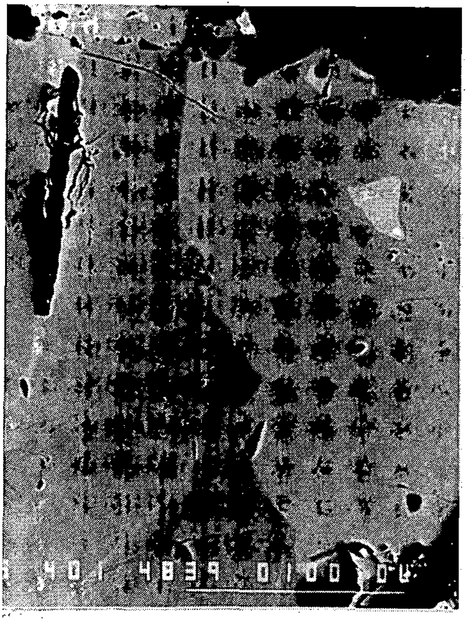
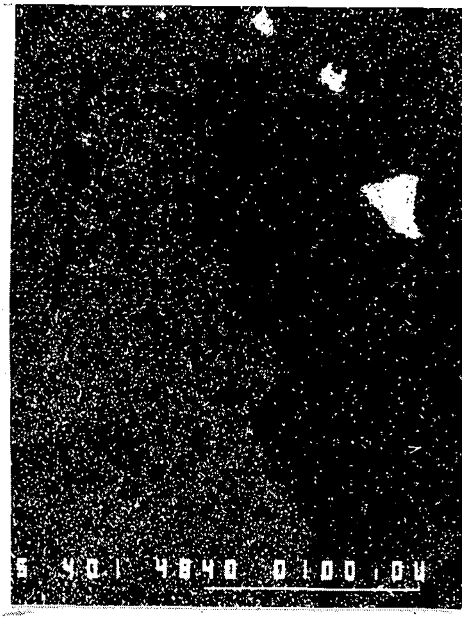

1
2
3
4

Plate VIII — VIII. tábla

1. Kesterite with fahlore and luzonite. Sample RL3, inclined shaft near Rm 48. A back-scattered electron image. The light grey grain is kesterite, and the grey phase is fahlore. The darker-grey mineral reflecting a zoning of growth is luzonite.
2. Sn distribution, showing the place of kesterite.
3. Zn distribution, showing the places of kesterite and fahlore.
4. Sb distribution, showing the places of fahlore and luzonite.



1



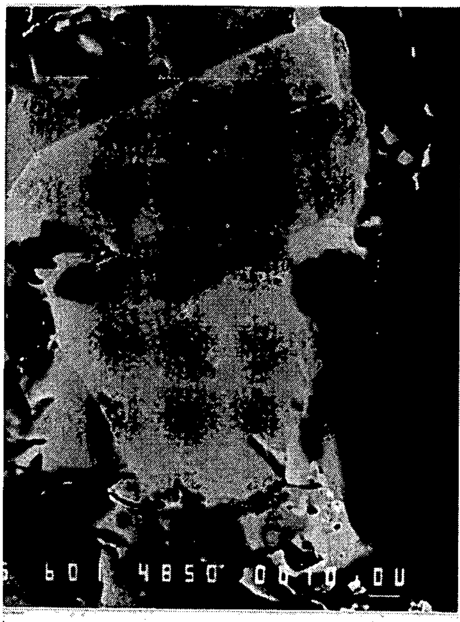
2

3

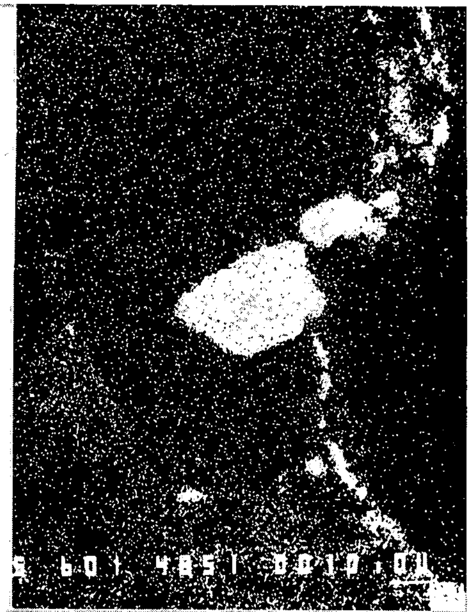
4

Plate IX — IX. tábla

1. Kesterite in fahlore, surrounded by luzonite. Sample RL3, inclined shaft near Rm 48. A back-scattered electron image.
2. Sn distribution, showing the place of kesterite.
3. Sb distribution, showing the fahlore.
4. Zn distribution, showing the places of fahlore and kesterite.



1



2

3

4

Table 2—2. táblázat

Representative analyses of some minerals of the Cu-As-Sb-S system from the hydrothermal ore of Recsk, Lahóca. Chemical formulae of the minerals were calculated for 32, 29 and 4 atoms for enargite-luzonite, fahlores and chalcostibite, respectively

A Cu-As-Sb-S rendszer reprezentatív elemzése egyes ásványoknál a recski és lahócai hidrotermális ércesedésnél. Az ásványok kémiai képletét 32, 29 és 4 atomra állapították meg az enargitra és luzonitra, illetve a fakóércekre és kalkostibitre

	1	2	3	4	5	6	7	8	9	10	11
Cu	47.56	48.06	45.36	44.15	46.02	46.01	39.33	45.17	39.54	43.27	25.74
Ag	—	—	0.10	0.11	0.86	0.28	1.38	0.23	0.52	0.36	0.10
Zn	—	—	—	—	—	—	6.64	—	3.07	0.09	—
Fe	0.17	0.08	—	—	0.25	4.27	0.05	0.10	0.69	0.25	—
Mn	0.13	—	—	0.34	1.57	—	0.42	—	—	6.13	—
Sn	—	—	—	—	—	—	—	—	—	—	—
Sb	0.31	3.16	13.24	22.51	3.60	1.38	21.36	3.52	12.37	2.38	47.51
As	18.88	17.02	10.15	4.08	15.03	19.18	5.37	3.89	8.17	18.73	1.79
Te	—	—	—	—	—	—	—	21.37	—	—	—
Bi	—	—	—	—	—	—	—	—	9.81	—	—
S	33.53	32.62	30.92	29.78	32.07	29.25	26.18	25.37	25.37	28.30	25.05
sum	100.45	100.94	99.90	100.97	99.40	100.73	100.37	99.65	99.54	99.51	100.19
Chemical formulae											
Cu	11.672	11.931	11.869	11.909	11.702	10.589	9.940	11.749	10.398	10.106	1.012
Ag	—	—	0.015	0.017	0.129	0.038	0.205	0.035	0.081	0.050	0.002
Zn	—	—	—	—	—	—	1.632	—	0.785	0.020	—
Fe	0.047	0.023	—	—	0.072	1.118	0.014	0.030	0.206	0.066	—
Mn	—	—	—	—	—	—	0.123	—	—	1.656	—
Sn	—	—	0.018	0.049	0.214	—	—	—	—	—	—
Sb	0.040	0.409	1.808	3.169	0.478	0.166	2.818	0.478	1.698	0.290	0.975
As	3.930	3.584	2.253	0.933	3.242	3.744	1.151	0.858	1.822	3.710	0.060
Te	—	—	—	—	—	—	—	2.768	—	—	—
Bi	—	—	—	—	—	—	—	—	0.785	—	—
S	16.311	16.052	16.037	15.922	16.164	13.344	13.116	13.081	13.225	13.101	1.952

1. Enargite, sample R3, Stock II
2. Luzonite, sample R16, Stock VIII
3. Luzonite, sample RD4, Shaft Rm 48.
4. Famatinite, sample R8, Stock IV.
5. Sn-bearing luzonite, sample R16, Stock VIII
6. Tennantite, sample R10, Stock. V.
7. Tetrahedrite, sample R8, Stock. IV.
8. Goldfieldite, sample R2, Stock. II.
9. Annivite, sample R4, Stock. II.
10. Mn-fahlore, sample RD3, Shaft. Rm48.
11. Chalcostibite, sample R8, Stock IV.

A COAL-PETROLOGICAL STUDY OF BROWN COAL SEAM FARKASLYUK II IN WEST BORSOD COUNTY, NORTH HUNGARY

by

MARIA HÁMOR-VIDÓ

Hungarian Geological Survey
Budapest, Stefánia út 14.
H-1143

UDC:552.57 (439.134.3)

Keywords: brown coal, coal petrology, evolution of marsh, W Borsod county, Miocene

With the parallel application of microlithotype and maceral analyses it has been made an effort to detect the evolution of a mire and the changes in its environmental conditions as in the case of the East Borsod region (HÁMOR-VIDÓ, M. 1992).

As a result of the examinations of two sites the coal seam reflects the following phases of development: initial swamp environment followed by a swamp-marsh complex facies. The final stage of existence of the marsh reflects a decrease of water level and a short period of existence of swamp — desiccating swamp facies which ends, abruptly, with a brown coal bed deposited in the marsh area as indicating a later, repeated rise of water level.

Introduction

A team comprising 11 researchers has been involved in the reconstruction of the Miocene swamp environment of the Borsod Basin for four years, under the direction of GY. RADÓCZ, followed by M. BOHN-HAVAS. In the year 1991 the investigations were performed in the W Borsod region (Fig. 1) The coal-petrological experience obtained by studying eight sections of seams IV and V in E Borsod has been used in the examination of a total of 24 coal samples from seam II in two inclined adits of mine Farkaslyuk II. The samples were taken from two sites by Z. PARTÉNYI. Powder and polished sections were prepared.

The two sampling sites are found at a distance of approx. 40 m from each other in a NW-SE orientated inclined adit. Every sample was labelled by indicating the bed and the serial number of the sample. At sampling site 1 canal samples (1 to 25) were collected covering thereby the full interval of the middle part of seam. As for sampling site 2, the samples represent the initial part (26—28) and the closing part (30—33) of the seam. Samples 26 through 28 cover a range from the immediate underlying bed to the first tuffaceous

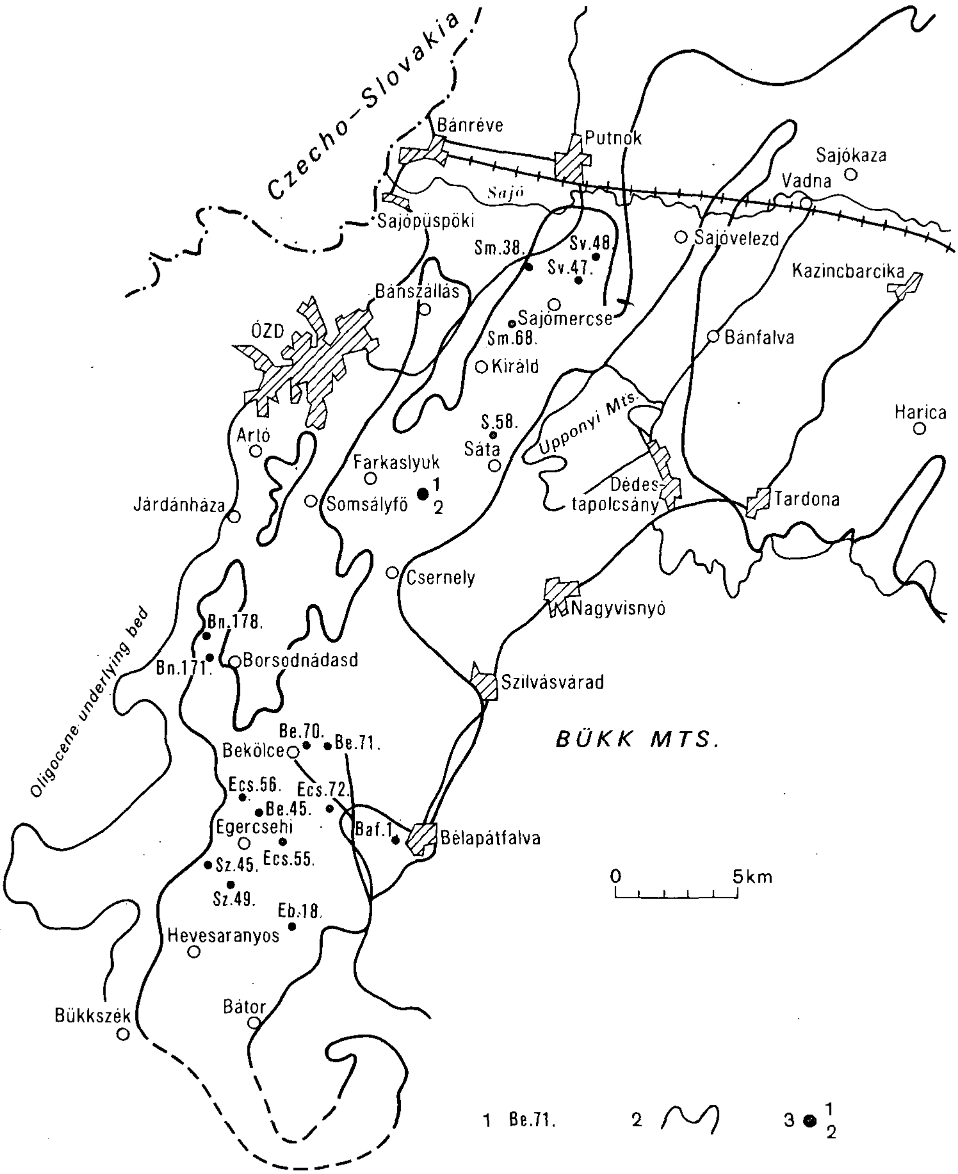


Fig. 1. The location of sampling sites Farkaslyuk 1—2 in the W Borsod basin

1. borehole, *2.* boundary of lignite deposits in the area, *3.* site of the profile studied

1. ábra. A Farkaslyuk 1—2. sz. mintavételi hely helyzete a Ny Borsodi-medencében

1. fúrás, 2. a barnakőszén lehatárolása a területen, 3. a vizsgált szelvény helye

sandbed. Macroscopically, the material of sample 28 is the same as that of the sample 1 taken from sampling site 1. For samples 30 through 33, their correlation with those of sampling site 1 was made according to their degree of silicification. In this case it was impossible to identify each portion of the seam on a coal-petrological basis. Therefore the final episodes of coal seam development cannot be interpreted but in a mosaic-like manner only.

The material of the coal seam c. 4 m thick was examined according to an interval of 10 cm on an average. Deviations from this are observable in the case of samples 2/8, 2/9, 6—10, 12/23 as clearly shown in Fig. 3 as well as in case of sample 14/30. When describing the latter five samples, only the results of macroscopic examination and photodocumentation of Z. PARTÉNYI were relied upon owing to the lack of rock samples.

For evaluation, data obtained from the parallel microlithotype and maceral analyses, in conjunction with an updated facies analysis showing considerable coincidences with examinations formerly performed by A. JUHÁSZ, were adopted. Except for the aforesaid five samples, each coal sample was described micro/macroscopically, followed by quantitative interpretations and graphic representation in a triangle (Fig. 2).

A swamp zone classification worked out by MUKOPHADHYAY et al. (1988) was used to identify the environment of development. In my study the ICCP (International Commission of Coal Petrology) terminology has been used.

Macroscopic and microscopic study of coal samples from seam II in Farkaslyuk mine

Considering that this paper is devoted to coal petrology, therefore all descriptions of samples in the study are restricted to rocks that are distinguished as brown coal or carbonaceous clay, with the unaided eye. The samples collected represent the whole cycle of seam deposition, since both the underlying beds and the overlying strata can be identified in the geological profile.

The beginning of swamp development is represented by sample 13/27 with a thickness of 16.5 cm taken from sampling site 2. The dark grey, micaceous sand with organic colouration has a 4-cm-thick brown coal intercalation consisting mainly of densinite and, to a lesser extent, from telogelinite of medulla origin, as well as of plant remains of phloem or cortex origin.

Sample 2/2 is a dark grey, poorly laminated one with a xylith content. Several tree types can be distinguished in this section that has resin-telogelinite bearing phloem and cortex tissues as obserbed by unaided eye.

This dark grey, poorly laminated, xylith-bearing brown coal shows identity with sample 2/3 (10 cm). When examined under microscope, it still displays dominantly wood tissues but the tissues have a higher degree of alteration. In addition to clarain-bearing wood tissues, telogelinite is also dominant.

In sample 2/4 (14 cm) the rock consists of an alternation of well laminated, 2-to-3-mm-thick, clarite-bearing xylith lenses and of durite laminae. A pattern of average samples as observed under microscope consists of mixed telogelinitic, sometimes degradotelinitic remains as well as a considerable amount of attrinite.

The brown coal in sample 2/5 (8 cm) is a clarite-bearing, medium-laminated rock with a 5-mm-thick, dark grey silt lens at its middle part. The pattern

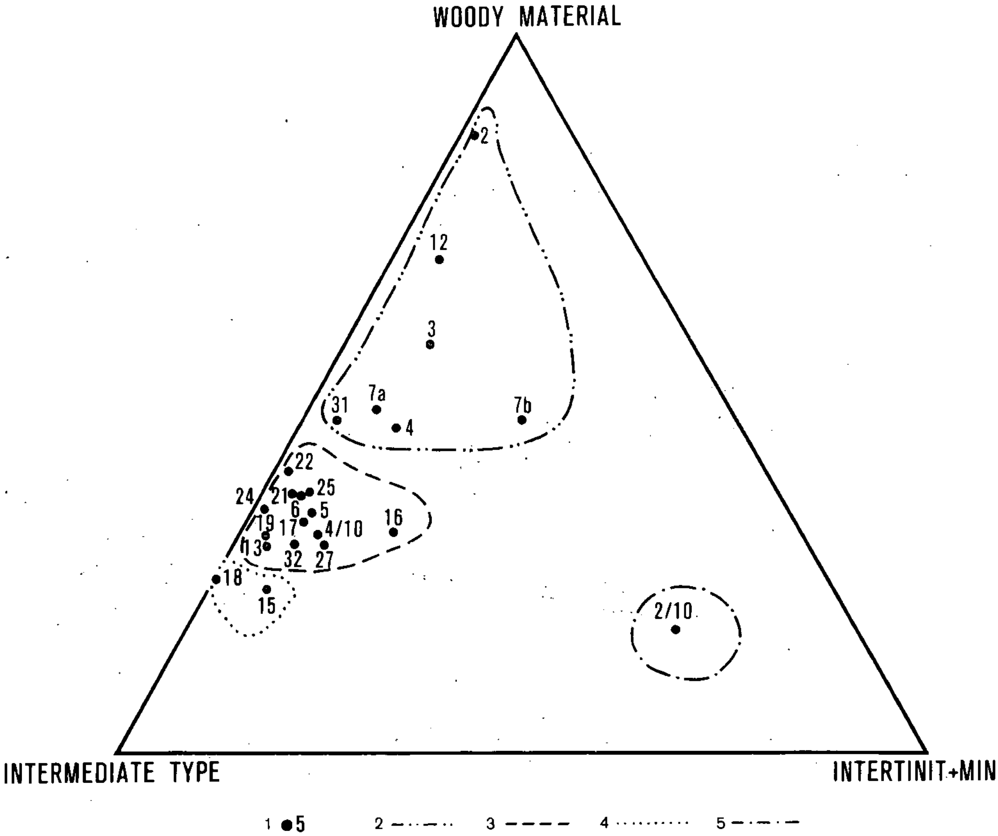


Fig. 2. The maceral triangle for sampling sites 1 and 2 of coal seam Farkaslyuk II
1. sample No., *2.* swamp facies, *3.* swamp–marsh komplex, *4.* marsh facies, *5.* aquatic facies

2. *ábra.* A Farkaslyuk II. telep 1. és 2. sz. mintevételi helyének macerál háromszög diagramja
1. minta száma, 2. láperdei kifejlődés, 3. átmeneti övi „Swamp Marsh" területén képződött minta, 4. síklápi kifejlődés, 5. nyílt vízi kifejlődés

of the sample as observed under microscope contain a tissue consisting mainly of densinite also with telogelinite and litodetrinitic carbominerite.

Sample 2/6 (9 cm) is well laminated and contains clarite. Its middle part is brown coal showing a poorer lamination, containing 1-mm-thick stripes of vitrite. The joint face of the duritic stage consists of a set of scale-like detrital fragments smaller than 0.5 mm. The organic matter, in regard to its maceral composition, consists mainly of densinite. Its structure is more homogeneous in this sample than in sample 2/5, and here the plant origin cannot be recognized any longer. The shaped components observable here and there are shapes reminding of long, elongated levigelinite or root, without any well-distinguishable protective tissue.

Sample 2/7 (12 cm) is poorly laminated and has "rosette-like" pyrite segregation on its cleavage area as well as a rust-coloured resin at its top. The

12-cm-long sample was divided into two parts for microscopic examination. Thus, in the lower part of the sample referred to as sample 2/7a a heavily altered rock consisting mainly of telogelinite has been observed, whereas the other part of the sample referred to as sample 2/7b features resinous tissue remains as well as heavily decomposed, epigenetic wood tissues impregnated with silica.

Samples 8 and 9 from bed 2 were not examined. As observed with the unaided eye, sample 2/8 is a 14-cm-long brown coal sample, with vitritic, semi-bright laminae 2 to 5 mm thick visible in the dull groundmass. Along vertical cracks pyrite grains are observed as ranging from 1 to 3 mm in diameter which can be encountered, in addition to the cracks, also in the coal itself. (Z. PARTÉNYI).

Sample 2/9 represents 23 cm of brown coal, in which maximum 1-mm-thick semi-bright plates are found in a dull groundmass. These laminae attain even 5 mm at the bottom and top parts of the sample. A small-grained segregation of pyrite has been observed along the vertical cracks. The segregation of rust-coloured resin is also linked with the cracks (Z. PARTÉNYI).

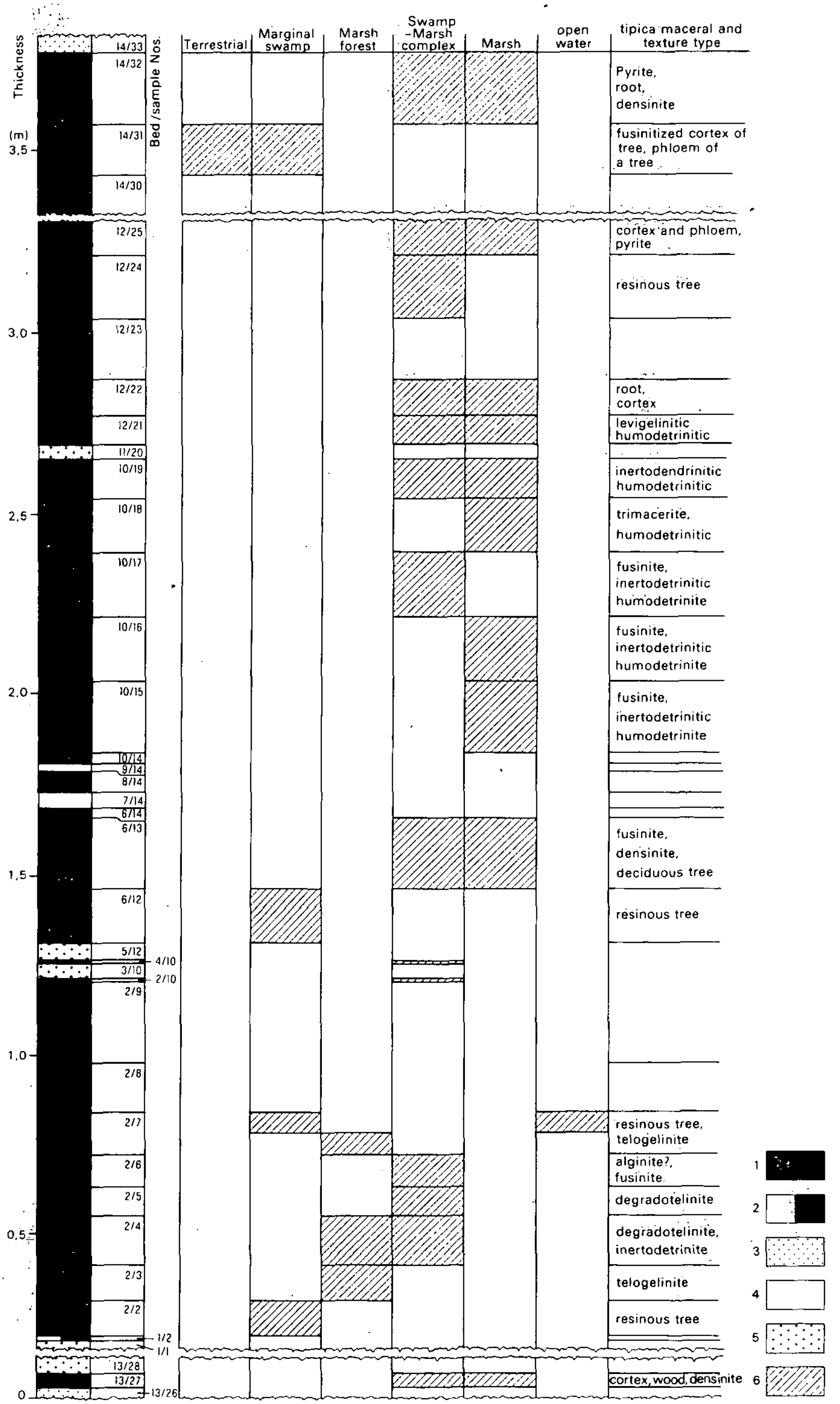
The brown coal of sample 2/10 (0.5 cm) contains clarite and is unlaminated and of straight fracture. As shown by optical examinations, wood matter can still be observed in the organic matter of this stage but huminitic fragments are dominant. Carbominerite represents the greater part of the sample incorporating sometimes degradotelinite. Somewhere the fragmental pieces are embedded in a groundmass of silica.

From the bottom of bed 2 upwards, it can be stated that the proportion of inertinite, and within this the proportion of inertodetrinite show a steady increase. In addition, macrinite is also observed, starting from sample 2/4. Moreover, fusinite is independently observed in samples 2/6 and 2/7. The occurrence of inertodetrinite is observed in a groundmass of humo-densinite throughout the profile.

Sample 4/10 (8.5 cm) contains clarite and is unlaminated and of straight fracture. In regard to its composition and appearance, it is nearly identical with sample 2/10. The differences between the two samples are observed in the carbominerite content and, within huminites, in the greater per cent proportion of telogelinite.

Sample 6/12 (16 cm) is a medium-laminated coal with claritic lustre: in regard to its microlithotype it is also dominated by wood tissues with a claritic texture and a high resinite content. However, in addition to resinous wood types, also telogelinite is included in the rock.

Sample 6/13 (19 cm) is a dark brown to black, unlaminated, semibright, clar bearing brown coal. Its composition is dominated by huminites and within this, densinite. Densinite appears in two forms. As for the first, the densinite texture can only be recognized in traces, since it has become gelly and shows an eugenitic feature (for instance, inertodetrinitic humodetrinites having vitrinertite texture). As far as the other form of appearance is concerned, it is a humite detritus consisting of monomacerite.


Thickness (m)
Bed / sample Nos.
Terrestrial
Marginal swamp
Marsh forest
Swamp -Marsh complex
Marsh
open water
tipica maceral and texture type
3,5
3,0
2,5
2,0
1,5
1,0
0,5
0
14/33
14/32
14/31
14/30
12/25
12/24
12/23
12/22
12/21
11/20
10/19
10/18
10/17
10/16
10/15
10/14
9/14
8/14
7/14
6/14
6/13
6/12
5/12
4/10
3/10
2/10
2/9
2/8
2/7
2/6
2/5
2/4
2/3
2/2
1/2
1/1
13/28
13/27
13/26
Pyrite, root, densinite
fusinitized cortex of tree, phloem of a tree
cortex and phloem, pyrite
resinous tree
root, cortex
levigelinitic humodetrinitic
inertodendrinitic humodetrinitic
trimacerite, humodetrinitic
fusinite, inertodetrinitic humodetrinite
fusinite, inertodetrinitic humodetrinite
fusinite, inertodetrinitic humodetrinite
fusinite, densinite, deciduous tree
resinous tree
resinous tree, telogelinite
alginite?, fusinite
degradotelinite
degradotelinite, inertodetrinite
telogelinite
resinous tree
cortex, wood, densinite
1
2
3
4
5
6

Sample 14 representing beds 6,7,8,9 and 10 can only be presented on the basis of a description by Z. PARTÉNYI, for reasons mentioned in the introductory part of this study. Thus, the 17.5-cm-thick brown coal will be described according to the following division:

Sample 6/14—2.5 cm brown coal, Sample 7/14—4.5 cm silicified brown coal, Sample 8/14—5.5 cm brown coal, Sample 9/14—2 cm silicified brown coal, Sample 10/14—3 cm brown coal.

In each of the three brown coal bands a parallel cracking can be observed which is normal to silicification and the strike of these planes is approx. 45°. Each brown coal sample is semi-bright. A pyrite segregation can be observed along the cracks intersecting all bands." — as stated by Z. PARTÉNYI.

Sample 10/15 (20 cm) comprises a poorly laminated semi-bright brown coal which is identical, in regard to composition, with sample 6/13.

In sample 10/16 (18 cm) the lower, 9-cm-thick portion is unlaminated and of straight fracture, with a lustre of clarite, whereas the upper part is an earthy, fine-laminated brown coal with a durite appearance. A film-like silica segregation can be observed between the bands. This is clearly backed up by the picture seen under microscope, in which the carbominerite contains silica. In regard to the distribution of various organic components, humites are dominant, but vitrinertite and trimacerite are also included. The huminites consist of densinite and telogelinite.

Sample 10/17 is a claritic, unlaminated brown coal with straight fracturing as observed by unaided eye. In regard to its maceral composition, it contains mainly inertodetrinitic humodetrinite, whereas its smaller part is a largely gelly telogelinite. Fusinite forming an independent sort of stripe (microlithotype) is considerably enriched in the rock.

Samples 10/18, 10/19 and 10/19a (26 cm) are macroscopically, dark brown, or black, poorly laminated brown coal samples. In regard to maceral composition, they show great similarities to one another, containing mainly densinite and telogelinite. Although densinite is encountered in samples 10/18 and 10/19 also in vitrinertitic form, mixed with inertodetrinite, but its frequency is considerably less than in sample 10/17, and sample 10/19a contains no inertodetrinite. Huminites in the three samples show roughly the same composition.

The brown coal bed no. 12 following the tuffaceous sand in sample 11/20 is poorly laminated and has a lustre of clarite, except the 10-cm-thick, well laminated portion of sample 12/22 and the 16-cm-thick part of sample 12/23 described by Z. PARTÉNYI. In regard to maceral composition, samples 12/21—22 and 12/24—25 are rather uniform. The humite content of samples 12/21—25 consists mainly of densinite and telogelinite and, to a lesser extent, eugelinite. The evolution of marsh is mainly indicated by the submaceral changes of

---

Fig. 3. A coal-petrological facies diagram for sampling sites 1 and 2 of seam Farkaslyuk II
1. lignite, 2. carbonaceaus clay, 3. sand, 4. silt, 5. tuff, 6. site of development of the sample studied

3. ábra. A Farkaslyuk II. telep 1. és 2. számú mintavételi hely szénkőzettani fácies diagramja
1. barnakőszén, 2. szenes agyag, *3.* homok, *4.* aleurit, 5. tufa, 6. vizsgált minta keletkezési helye

eugelinites and the densinite. Thus, as shown by the preliminary examinations of L. RÁKOSI, algae can be observed in the densinite tissue of sample 12/21. These are long, elongated plant remains that remind us of rootlets and exhibit levigelinitic features.

In sample 12/22 true root sections as well as phloem and cortex tissue elements can be identified.

As stated by Z. PARTÉNYI, sample 12/23 (16 cm) is a brown coal sample which in regard to its appearance, represents a continuation of the well-laminnated brown coal found in sample 12/22 and containing xylith remains. A considerable pyrite segregation is also observed. Two types of pyrite, namely the framboidal and spherulitic ones, can be distinguished.

In samples 12/24—25 the phloem and cortex tissues indicated in sample 12/22 are dominant.

The upper portion of sampling site 2 begins with sample 14/30. As stated by Z. PARTÉNYI, the 18-cm-thick brown coal band consists of the alternation of carbonaceous and siliceous streaks as follows:

Brown coal, 7cm — silicified silt, 2 cm, thick brown coal, 4 cm, including 2 silicified silt stripes, both with a thickness of 5 mm, — thick silicified silt, 1 cm, — brown coal, 4 cm.

The brown coal itself is strongly fractured. Segregation of pyrite can be observed along the joints. In the silicified bands light grey, whitish spots and stripes can be observed, mostly in conformity with stratification.

The sample from the two brown coal bands studied and found beneath the micaceous, small-grained molluscan sand of sample 15/33 taken from the overlying bed has the following composition:

Sample 15/31 is poorly laminated and has a claritic lustre. The rock consisting dominantly of humite is telogelonitic and has a high densinite content and a remarkable eugelinite content. This sample features the frequent fusiniticaton of the edges, of cortex tissue, and even at some points the whole tissue turned into fusinite. Densinite tissue is frequently mixed with inertodetrinite.

Megascopically sample 15/32 has a well-laminated material with a lustre of clarite. The organic matter content mainly includes humodetrinite. The proportion of wood tissue remains as compared to the previous sample, is reduced. Moreover, in addition to telogelinites, well preserved textoulminitic tissues can also be sporadically observed. Throughout the entire profile the pyrite content is highest here. In the material powdered to a size less than 1 mm, the size of homogeneous pyrite grains with smooth surface frequently attains the powdering size. Their carbomineritic occurrence is not typical.

A summary of maceral and microlithotype analyses

The precise time of the rise of swamp is not known.

It is only a 4-cm-thick material of sample 13/27 from collecting site 2 indicating that the environment turned paludal, however, not for long yet. This

4-cm-thick brown coal band, by passing into carbonaceous clay, indicates a gradual transition from the swamp marsh to marsh environment of deposition into an openwater one. This stage is represented by a micaceous sandbed.

The genuine coal deposition can be observed from bed 2 at sampling site 1. Here a marginal swamp facies containing strongly resinous plant material preserved mainly after trees, can be observed. Upon the testimony of samples 2/3 and 2/4, this facies contains already more altered, gelly wood tissues. Minor change in facies is only shown by the composition of samples 2/5—2/6 which is characteristic of a swamp marsh. This is followed by a swamp-march environment again, as shown by sample 2/7. Bed 2 ends with sample 10 having a composition featuring high silica content and indicative of marsh facies. A typical feature of this bed is that the proportion of inertinites increases with time. The inertodetrinite mixed with densinite may point to nearby swamp fires, or to lava flows which is also backed up by an increased silica content observed when examining the samples.

Although sample 4/10 following tuff bed 3/10 has a lower silica content, its composition shows similarities to sample 2/10. This is followed by another rhyolite tuff intercalation. In sample 6/12 the environmental conditions are further shifted towards terrestrial conditions. This sample points to a marginal swamp facies.

The composition of sample 6/13 indicates again a marshy environment with great similarities to the open-water facies.

This tendency is assumed to have continued, as heading towards the open water, according to sample 14 intersected with silicified silt streaks that were not studied.

As attested to by samples 10/15—19, the environment of marsh development was fluctuating between the swamp-marsh and the marsh facies. At this portion inertinites have a considerable proportion again, but in these sample the proportion of fusinite and inertodetrinite decreased with the advancing time, with minor fluctuations.

Samples 12/20—25 following the decomposed rhyolite tuff in sample 11/20 feature a swamp-marsh facies.

In sample 14/30 the material I have not examined indicates, as shown by its repeatedly silicified beds, the advancement of an open-water environment followed by a desiccating swamp facies (15/31).

The swamp development ends with a repeated rise of water level and the development of marsh.

Conclusions

The changes in habitat are shown in a coal-petrological facies diagram for a better representation (Fig. 3).

The development of the seam begins with a marsh development assumed to start several times. This is followed by a swamp developed in a comparatively elevated position. Minor changes in plant associations as well as the varying degrees of the state of preservation of tissue remains can be observed in the bed of swamp facies showing a thickness of c. 1 m. As experienced hitherto, the state of tissue is greatly dependent on the type of the preserved plant and, to a lesser extent, on the one-time environment.

This is followed by rise of water level. Here an alternation of marsh with swamp-marsh facies types is verifiable. At a portion representing some two-thirds of the profile, the presence of detrital huminite is dominant. The composition of samples taken from this part of the profile is so similar (Fig. 2) that they cannot be distinguished in the ternary plot, unless the minor differences observed under microscope are also regarded. The end of swamp development must have attributed to a sudden fall of water level, resulting in the formation of sediments indicative of drying out, followed by open-water facies brought about by the rising water level.

In the profile as a whole, the more or less inertodetrinite content of the huminitic detritus is a striking feature. This content is mainly encountered in the form of fusinite spicules that are likely to have been transported from a vegetation burning in the swamp foreland to the site of development.

As a summary, with the previous-coal petrological examinations also taken into consideration, it can be stated that the material of a series of samples from sampling sites Farkaslyuk 1 and 2 fits well, in regard to facies, into a swamp-belt classification system worked out by A. JUHÁSZ (1988). Considering the seam as a whole, this region was dominated by marginal swamp to swamp-marsh transitional environments of deposition.

Acknowledgement

My thanks are due to M. BOHN—HAVAS and Gy. RADÓCZ for charging me with this job and for their special guidance, and to E. NAGY and L. RÁKOSI for their practical advices and help.

REFERENCES — IRODALOM

ELEK, I. 1978: Mikófalvi barnakőszénkutatás szénkőzettani vizsgálatának eredményei. — Kézirat. MÁFI, Budapest.

ELEK, I. 1987: Sajómercse-II barnakőszén kutatás szénkőzettani vizsgálata. Uppony 16—17. számú fúrás anyagának szénkőzettani összehasonlítása. — Kézirat. MÁFI, Adattár, Budapest.

HÁMOR-VIDÓ, M. 1992: Reconstruction of peatforming environments on Miocene brown coal sequences (N-Hungary). — Acta Geol. Hung. No. 2.: 81—98.

JUHÁSZ, A. 1987: Bányatelepítési lehetőség Dubicsányban. — Földtani Kut. XXX/4. 17—25.

JUHÁSZ, A. 1988: A Nyugat-borsodi medence kőszéntelepei képződésének körülményei a lápövekben. — Földt. Közl. 118., 125—145.

MUKOPHADHYAY, P. K. et al. 1988: Generations of hydrocarbons from the Tertiary coals of Texas-Coal as potential source rock for liquid hydrocarbons in a deltic basin? — Org. Geochem. Vol. 14. No. 3, 351—352.

SMYTH, M. 1985: Coal microlithotypes related to sedimentary enviroments in the Cooper Basin, Australia. — In Sedimentology of Coal and Coal-bearing Sequences. (ed. RAHMANI R. A.— FLORES R. M.) Spec. Publ. No. 7. of the I.A.S. Blackwell Sci. Pub. Oxford. 333—347.

RADÓCZ, GY. 1966: A Borsodi-medence helvéti összletének barnakőszén Prognózisa. — MÁFI Évi Jel. 1964-ről: 495—501.

RÁKOSI, L. 1989: Jelentés a borsodi bányaszelvények makroflóra, paleokorpológiai és xilotómiai vizsgálatáról. — Kézirat. MÁFI. Budapest.

RÁKOSI, L. 1989: A harmadkori barnakőszénképződésre alkalmas vegetációtipusok elméleti összefoglalása. — Kézirat. MÁFI. Budapest.

SZÁDECZKY, K. E.—SOÓS L. 1959: Szénkőzettani vizsgálatok felsőnyárádi és homokterenyei miocén barnakőszenek fúrásmintáin. — Kézirat.

SZÁDECZKY, K. E.—SOÓS L. 1964: Barnakőszenek szénkőzettani gyorselemzése és a lápöves rendszer. Kőszén és kőolaj anyagismereti monográfia sorozat — Akadémia Kiadó, Budapest.

VARGA, I. 1985: Borsodi barnakőszenek szénkőzettani vizsgálata. — Közp. Bány. Fejl. Int. Kézirat Budapest.

A NYUGAT-BORSODI TERÜLET FARKASLYUK II. TELEP 1. ÉS 2. SZÁMÚ MINTAVÉTELI HELY SZÉNKŐZETTANI ELEMZÉSE

HÁMORNÉ VIDÓ MÁRIA

Magyar Állami Földtani Intézet
Budapest, Stefánia u 14.
H-1143

ETO: 552.57 (439.134.3)

Tárgyszavak: barnakőszén, szénkőzettan, lápfejlődés, Nyugat-Borsod, Miocén

Bevezetés

RADÓCZ GYULA, majd BOHNNÉ HAVAS MARGIT irányításával tizenegy kutatóból álló munkacsoport dolgozik immár négy éve a Borsod-medence láprekonstrukcióján. A kutatások 1991-ben a nyugat-borsodi területen folytatódtak (1. ábra). A kelet-borsodi IV—V. telepeket feltárt nyolc szelvény szénkőzettani tapasztalatai alapján került feldolgozásra a Farkaslyuk 11/2 ereszke bányabeli szelvény II. telepének 24 darab kőszén mintája. A minták két mintavételi helyről származnak, amelyekből por és felületi csiszolatok készültek. A mintagyűjtést PARTÉNYI ZOLTÁN végezte.

A mintavételek helye az ÉNY—DNY-i irányú ereszkében egymástól kb. 40 m távolságra helyezkedik el.

Vizsgálati módszerként a párhuzamos mikrolitotípus és macerál elemzés adatait, valamint JUHÁSZ ANDRÁS korábbi kutatásaival jól egybevágó, korszerűsített fácies analízist fogadtam el. A kőszén minták feldolgozását makroszkópos, mikroszkópos kőzetleírással, mennyiségi kiértékeléssel és háromszög diagrammos ábrázolással (2. ábra) végeztem. A keletkezési környezet azonosításához MUKOPHADHYAY et al. (1988) lápöv beosztását alkalmaztam. Munkám során az ICCP (Nemzetközi Szénkőzettani Munkabizottság) által kidolgozott nevezéktant használom.

Az eredmények értékelése

Az életterek változását a szemléletesség kedvéért szénkőzettani fácies diagramon ábrázoltam (3. ábra).

A telepfejlődés feltételezhetően többször meginduló mocsárképződéssel indul, melyet viszonylag kiemelt helyzetű láperdei kifejlődés követ. A kb. 1 m vastagságot kitevő láperdei kifejlődésben a növénytársaságok kisebb változása és a szövet maradványok megtartásának különböző fokozatai figyelhetők meg. A szövetek állapota eddigi tapasztalataim szerint nagy mértékben függ a fennmaradó növény típusától kisebb mértékben pedig a keletkezési környezettől.

Ezt a vízszint emelkedése követi. Itt kisebb ingadozásokkal síklápi és átmeneti típusú fáciesek váltják egymást. A szelvény mintegy kétharmadát kitevő szakaszon a törmelékes huminit anyag jelenléte meghatározó. Az e szakaszra eső minták összetétele annyira közel esik egymáshoz (2. ábra), hogy a háromszög diagramon való elkülönítésük csak a mikroszkópos leírásban szereplő kisebb eltérések figyelembevételével oldható meg. A láp fejlődés végét a vízszint hirtelen csökkenése, láperdei valamint kiszáradólápi képződmények jellemzik, melyet vízszint emelkedés, nyíltvízi fácies követ.

A szelvény egészét tekintve feltűnő a huminites törmelék több kevesebb inertodetrinit tartalma. Ez leginkább fuzinit tűk formájában fordul elő, mely feltehetően a láp előterében égő vegetációból került keletkezési helyére.

Áttekintve a korábbi szénkőzettani vizsgálatok eredményeit megállapítható, hogy kifejlődésére nézve a Farkaslyuk 1—2. sz. mintavételi helyeken visgált mintasorozat anyaga jól illeszkedik JUHÁSZ ANDRÁS (1988) lápöves rendszerébe. A telep egészét tekintve a peremi láperdei majd átmeneti övi környezet volt az uralkodó ezen a területen.

THE GEOLOGY OF THE GÖDÖLLŐ AGROGEOLOGICAL MODEL AREA AND ITS ENVIRONS

by

JÁNOS KALMÁR

Hungarian Geological Survey
Budapest, Stefánia út 14
H-1143

UDC: 551.7 (439.153.2)

Keywords: Pliocene, clastic sediments, geomorphology, stratigraphy, sedimentology, paleoenvironment, Gödöllő Hills

In my agrogeological examinations performed in the Gödöllő Arboretum the morphological features and the nature of the Holocene and Late Pliocene sedimentation were studied. Four sand and three silty beds, both assigned to the Upper Pliocene, were surveyed. The silty beds are intercalated by carbonate strata. The typical rock is a lamellar limestone of algal origin. Sedimentation took place in a deltaic area with seasonal inundations.

The aim of this paper is to give a description of the morphological, stratigraphic and sedimentary features of the Gödöllő Arboretum and its region, recorded when an agrogeological study of the area was performed.

A review of examinations performed hitherto

The geological study of the Gödöllő Hills began with observations by BEUDANT, F. S. (1822) as early as the beginning of the last century.

This area found in the vicinity of Budapest was studied by a number of outstanding geologists (J. SZABÓ 1856—1888, J. BÖCKH 1872, T. SZONTAGH 1882, GY. HALAVÁTS 1898. and 1910, J. LÖRENTHEY 1904, V. VOGHT 1907). The map sheets of the area concerned were prepared by F. HAUER (1867—1875), K. HOFFMAN (1871) and F. SCHAFARZIK (1902).

A report by J. FERENCZI (1936) on a paleovertebrate fossil found in a railway cut at Gödöllő represented the starting point of the paleontological, age dating and follow-up examinations of the area concerned. Afterwards, the results of additional studies and re-interpretations made by M. MOTTL (1939, 1947), T. GAÁL (1946 — 1953) and F. SZENTES (1941, 1958). Papers by V. VOGL (1907), G. STRÖMPL (1912), J. SÜMEGHY (1952, 1955), A. RÓNAI (1956, 1958) and M. PÉCSI (1968) dealing with the Quaternary of the area are also included here.

Area and scope of the study

The Gödöllő Arboretum was established in the year 1902 for the acclimatization of various pine species, including their presentation to the general public (F. GÜNTHER 1914, GY. RÓTH 1953).

The first step of the field study in the Arboretum was to make trenches for pedological examinations and to drill boreholes with a depth ranging from 2 to 10 metres. Each sample was subjected to sedimentological, mineralogical and petrological examinations. By surveying the Arboretum and its vicinity, a map on the scale of 1:10 000 was prepared for the correlation of the boreholes sections. When surveying, morphological and stratigraphic observations were made and a total of 346 samples were studied in regard to sedimentology, mineralogy and sedimentary petrology. The data obtained in this way were also dealt with from an agrogeological-environmental-geological angle in a separate paper (J. KALMÁR 1991).

Morphological data and the Quaternary sedimentation

The highest point in the area is Öreg-hegy found on the eastern margin of the Arboretum (248.5 m), whereas the lowest point in the area is encountered at the foot of the Isaszeg bridge (172.8 m). In regard to morphology the area can be divided into three zones trending in a NW-SE direction (Fig. 1.), which are as follows:

a) Rákos-patak valley. This is a negative morphological element that consists of the Rákos-patak channel, including its terraces as well as the deluvial deposits connecting them, and of scree accumulated on slope or at the foot of slopes.

The brook bed of Rákos-patak is found at an altitude of 172.8 to 183.4 m a.s.l. The marshy, 100-to-400-m-wide channel that is, at places banked up for making fish-ponds, is filled with a black, fine-grained, sand-bearing mud rich in organic matters. The clay mineral typical of the fraction below 2 nm is poorly arranged illite. In these sediments a calcite content of 41% which is likely to be of biogenic origin, can also be found. Till the end of the 50's the peat beds 1 to 2 m thick were extracted from the bed of Rákos-patak (J. DÖMSÖDI 1977).

A 0.5-to-1.5-high and 50-to-100-m-wide flood plain flanks the channel, with yellow and grey fine-grained sand and two diminutive sandstone and limestone gravel horizons at the bottom.

The first of the terraces, with a relative height ranging from 2 to 5 m, can be traced in a width of 150 to 200 metres from Gödöllő to Isaszeg, along the mainroad and the railway line. In the area of Isaszeg this terrace becomes wider, to a width of 2 km. At this point the terrace is divided into two sub-levels, with a difference of approx. 1.5 m in level between them. The terrace contains fine-to-medium grained quartzsand. The lower part of the sequence

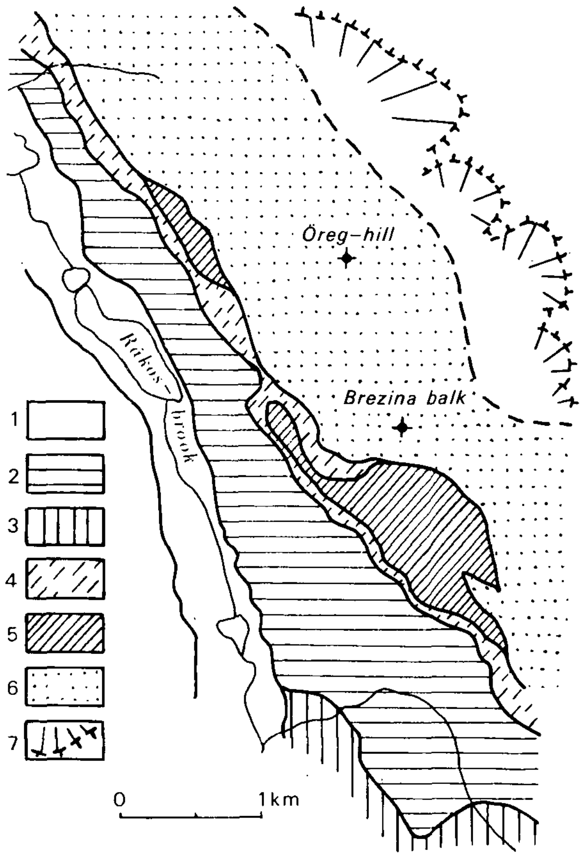


Fig. 1. A morphological sketch of the area between Gödöllő and Isaszeg
1. the flood plain of the brook Rákos-patak, *2.* the upper level of terrace I, *3.* the lower level of terrace I, *4.* deluvium and proluvium, *5.* terrace II, *6.* the Öreg-hegy—Brezinia-dűlő hill ridge, *7.* the hill range of Valkó-völgy

1. ábra.. A Gödöllő-Isaszeg közti terület morfológiai vázlata
*1.*Rákos-patak ártéri síksága, *2.* I. terasz felső szintje, *3.* I. terasz alsó szintje, *4.* deluvium és proluvium, *5.* II. terasz, *6.* Öreg-hegy—Brezinia-dűlő dombhát, *7.* Valkó-völgyi dombvonulat

contains gravels of small quartz and limestone particles. The deposit is 2 to 3 m thick.

The second terrace has a relative height of 8 to 12 m in the northern corner of the Arboretum, as far as the open-air theatre, and in the southern part of the new Arboretum (Kutyatelep, Öreg szőlők, Szárítói Nyiladék). In both areas wind-blown sand-dunes now covered by a forest are found on the terrace surface. The terrace deposit is a fine or small-grained sand accumulation 2 to 4 m thick which also contains, in its lower part, grits and small limestone gravel.

The terrace levels are linked with the flood plain by a 20-to-300-m-wide and 1-to-4-m-thick deluvium consisting of cross-bedded fine-grained and coarse-grained sandbeds, including humic soil zones. The proluvium (slope-foot deposit) connecting the terrace with the hillside is of similar structure. This deposit becomes 250 m wide at the portion between the State Vehicle Factory and Kutyatelep.

The terraces I have distinguished form a continuation of S. LEÉL-ÖSSY'S (1953) terrace levels towards the north. These terraces join the Danube terrace system in the areas of Rákosvidék and Pestlőrinc (M. PÉCSI 1958). This means that terrace I may be related to the sub-Atlantic optimum, whereas terrace II is to be assigned to the Early Holocene. However, in this respect the deposits still have to be subjected to a pollen analysis in order to make the age dating of the Rákosvölgy terrace more precise.

b) Gödöllő Hills. In the surveyed area (Esze Tamás utca — Öreg-hegy — Brezinia dűlő) these hills represent the highest morphological unit. This NW — SE oriented ridge is transversally cut by three valleys, namely, Pálfa-árok, Horhos-árok and Kőmalom úti árok. The ridge is asymmetrical, with its SE slope attaining even 7 to 10°, mainly in the middle portion of the Arboretum, whereas its NE slopes (Közlekedési út, Brezinia dűlő) reaching only 2 to 5°.

The plain areas found atop the ridge are part of an erosional platform that is likely to correspond to an Early Pleistocene relief. It is this relief where a gravel deposition older even than the upper terraces of River Danube took place and on which a loess bed was deposited in the Late Pleistocene (Würmian). This loess bed had been eroded off Öreg-hegy and its environs. Now it is encountered between Isaszeg and Nagytarcsa only.

Prior to the deposition of the loess bed, an active alteration process took place on top of the erosional platform and caused the Pliocene deposits to be impregnated with limonite which led, in some places, for instance, along Király út, to a secondary cementation of the sand (Plate I, Photo 1).

c) The hill range between Nagyfenyves and Szárítópuszta (200 to 230 m) represents and intermediate level between Öreg-domb and Valkó-völgy, the latter found towards NE. This area only incorporates a small part of the area I have surveyed, ranging from the extreme houses at Gödöllő, through Király-út, as far as the road to Szárítópuszta. In this area NW-SE oriented, 1-to-2-km-long hill ridges with a gentle slope are found and they are separated by ravines belonging to the Valkó-völgy water catchment area.

Stratigraphy

The area of the Arboretum and its environs are built of rocks belonging to the Levantine or Villafranchian substages of the Upper Pliocene, or the upper one-third of the sequence overlying the Unio-level and containing vertebrate fossils such as *Mastodon (Bunlophodon) longisrostris* KAUP et M; *Dicerorhinus megarhinus* DE CHRIST and *Hipparion crassum* GR that are referred to by J. FERENCZI (1936), M. MOTTL (1941, 1944) and F. SZENTES (1948).

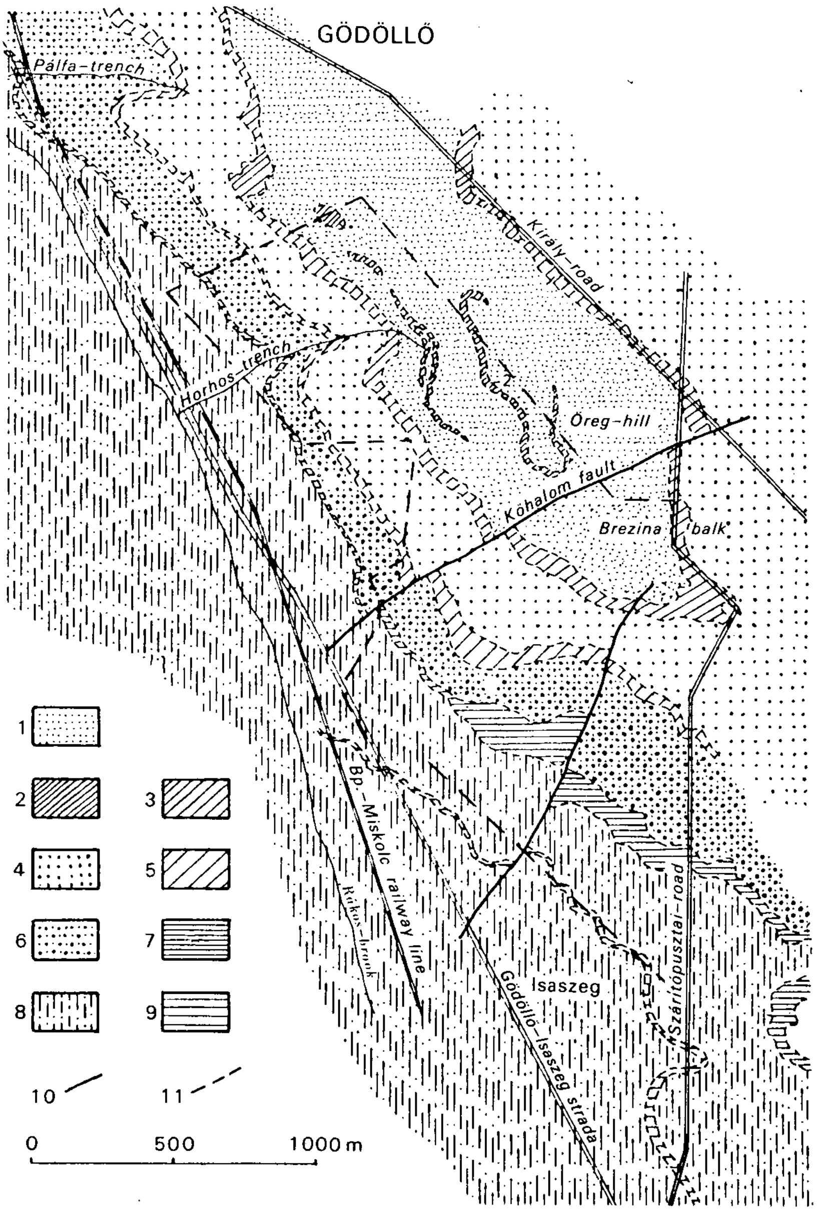


Fig. 2. Subcrop geological map of the Gödöllő Arboretum and its environs

1. Upper sandbed, *2.* silty-carbonate intercalations, *3.* main silty bed, *4.* middle sandbed, *5.* middle silty bed, *6.* main sandbed, *7.* lower silty bed, *8.* lower sandbed, *9.* silty intercalations, *10.* fault, *11.* Arboretum

2. ábra.. A Gödöllői Arborétum és a környező terület fedetlen földtani térképe

1. felső homokréteg, *2.* aleuritos-karbonátos betelepülések, *3.* fő aleuritos réteg, *4.* középső homokréteg, *5.* középső aleuritos réteg, *6.* fő homokréteg, *7.* alsó aleuritos réteg, *8.* alsó homokréteg, *9.* aleuritos betelepülés, *10.* vető, *11.* Arborétum

This 130-m-thick sequence can be divided into 7 mappable members (Fig. 2). As shown in the geological columns of survey boreholes drilled in the vicinity, the aforesaid members are likely to have continued beyond the area concerned (P. SCHAREK 1982). Now, here comes a description of a detailed geological columnar section of the Arboretum area (Fig. 3):

a) Upper sandbed, which appears atop the hill Öreg-hegy and in the northern part of Brezinia dűlő, with a thickness attaining 23 m. For the time being, this bed is the uppermost part of the sequence. However, the original closing bed is likely to have been removed by erosion as early as the Pleistocene. The comparatively homogeneous sandbed has three intercalations, which are limestone, sandstone, and a bed mixed with clay, silt and sand to different ratios. In some places quartz gravel strings of pieces a few centimetres large are also encountered (Esze Tamás utca, Nagyfenyves).

b) The main silty bed, which can be detected on the eastern slope of Öreg-hegy, around Brezinia dűlő and along Király út, is 4 to 8 m thick. The main constituent of this bed is silty clay with two carbonate intercalations.

c) The main sandbed, which appears on Pálfa-domb, on the NW sloping part of the Arboretum and in the SW half of the new area (Öreg Szőlők) is about 22 m thick. The upper part contains fine-grained sand, and the lower one-third part medium-grained sand with a calcareous-argillaceous intercalation.

d) The middle silty bed, encountered in exposures or in the form of detritus in Pálfa-árok, around the spring at Horhos-árok, in Kőmalom-árok and along the road winding towards Szárítópuszta, has a thickness ranging from 5 to 9 metres. The upper half of the silty sand or clay bed also contains sandstone and limestone intercalations.

e) The middle sandbed, which appears along Isaszegi út at Gödöllő, in the ravines of Baromfi-telep, at the entrance to the Arboretum, at the Open-Air Theatre and in the southern part of the new Arboretum (Hosszú Nyiladék), comes to a thickness of 13 to 16 m. The fine-to-medium grained sandbed displays thin limestone, intercalation in its lower part.

f) The lower silty bed can be observed in an exposure by the Open-air Theatre and on the left-hand side of Hosszú Nyiladék. The thickness of this bed varies from 4 to 10 m. Between the topmost and lowermost argillaceous limestones, sandy or argillaceous siltbeds are present.

g) The lower sandbed is only known from boreholes, with a thickness exceeding 35 m. This bed consists of fine-to-medium grained sand, including a thin silty-argillaceous bed.

The subsequent beds overlie one another conformably, outlining a 5-to-10-m-deep syncline of NW-SE trending axis.

This structure is crossed by two faults of which the first strikes transversally to Kőmalom-út and is likely to have been continued beyond the area studied. This fault has thrown the concerned beds by 8 metres towards the south.

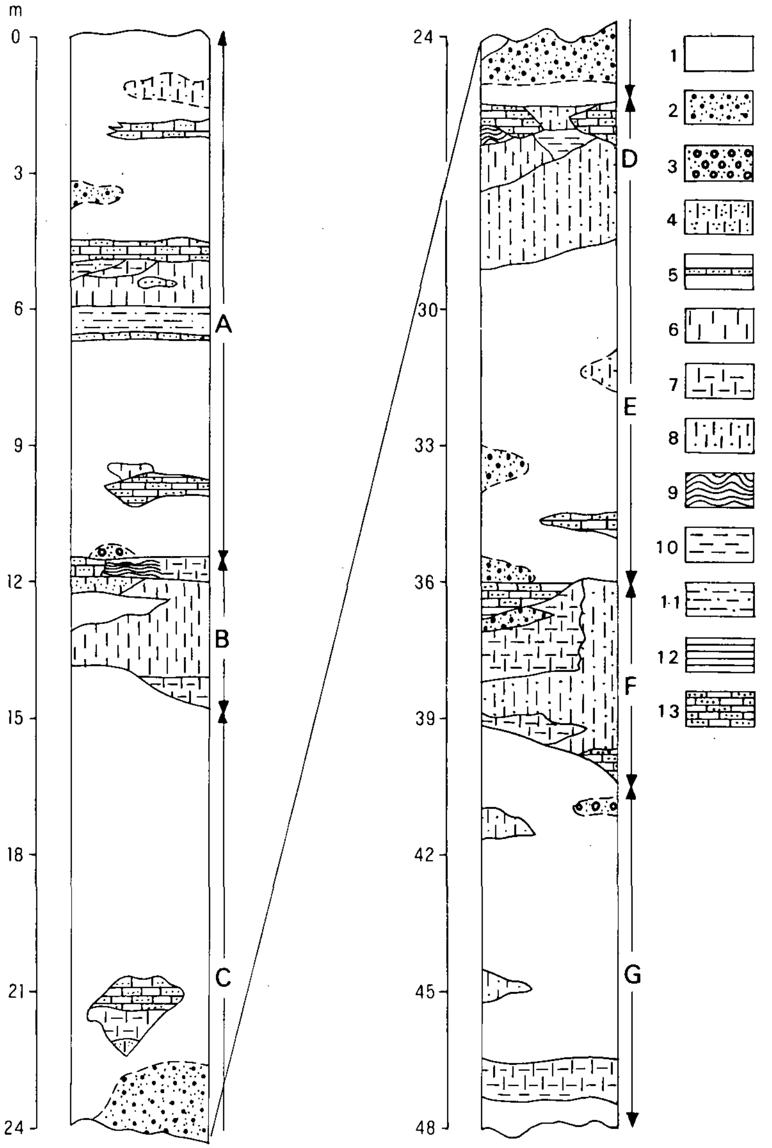


Fig. 3. An Upper Pleistocene lithostratigraphic column plotted upon drilling data

1. fine-to-medium grained sand, *2.* coarse-grained sand — fine-grained sand, *3.* small-grained gravel, *4.* silty sand, *5.* sandstone, *6.* silt, *7.* argillaceous silt, *8.* sandy silt, *9.* marl, *10.* clay, *11.* sandy clay, *12.* limestone, lime marl, *13.* sandy limestone; *A.* upper sand bed, *B.* main silty bed, *C.* middle sandbed, *D.* middle silty bed, *E.* main sandbed, *F.* lower silty bed, *G.* lower sandbed

3. ábra. A felső pliocén rétegoszlopa, a fúrási adatok alapján

1. finom-közepes homok, *2.* durva homok - finom homok, *3.* aprókavics, *4.* kőzetlisztes homok, *5.* homokkő, *6.* kőzetliszt, *7.* agyagos kőzetliszt, *8.* homokos kőzetliszt, *9.* márga, *10.* agyag, *11.* homokos agyag, *12.* mészkő, mészmárga, *13.* homokos mészkő; *A.* felső homokréteg, *B.* fő aleuritos réteg, *C.* középső homokréteg, *D.* középső aleuritos réteg, *E.* fő homokréteg, *F.* alsó aleuritos réteg, *G.* alsó homokréteg

The second fault is located the southern half of the new Arboretum between Alsó Nyiladék and Fenyves utca at Isaszeg, ending at Brezinia Dűlő. The throw calculated from boreholes data is approx. 5 m.

As shown by the satellite imagery of the region of Gödöllő, the channel of Rákos-patak follows a preformed structure line as far as its bend at Isaszeg. The above-mentioned two minor faults meet the latter tectonic line as being presumably responsible for some horizontal displacements of secondary order.

Sedimentology

Although few exposures were encountered when surveying the area, however, trenching was instrumental in dealing with sedimentological phenomena.

The sandy deposits are constituted by few-cm-thick, here and there sorted elementary layers dipping 5° to 10° and separated from one another by silty films. These layers are grouped in beds 10 to 40 cm thick of undulating surface, in which each elementary bed is cut unconformably. At the bottom of the thicker beds well-rounded quartz gravels, of the size of hazel-nut or a pea, are encountered.

The silty and marly deposits are either unstratified or, on the contrary, are built up of fine, laminated elementary beds. The argillaceous-marly beds frequently contain calcareous marl or lacustrine limestone lenses intercalated. The thickness of limestone lenses varies from a few centimetres to 1—2 metres and the main calcareous levels can be correlated from borehole to borehole. Sandstone appears as a lateral facies of the limestone lenses or as independent beds with a thickness of 5 to 10 cm.

Each sample from a borehole was examined for grain-size distribution and carbonate (calcite and dolomite) content. The results obtained are as follows:

a) In regard to granulometric composition the sandy deposits included in different beds show great similarities: the fine-grained and medium-grained fractions are dominant. A detailed study examining the relation between various grain fractions, with the silt and clay fractions also regarded (Fig. 4) shows that each layer has its own "character" and within it, considering the beds, as a whole, sand becomes homogenized and gets free of both fine-grained and coarser fractions.

In regard to the grain-size distribution, the silty-argillaceous deposits are more heterogeneous than sand is. However, in this case certain common features can also be stated. Unlike sandy deposits, the silty rocks become heterogeneized in a visible manner upwards in the profile. In other words, the proportion of fine-grained and mainly of coarser-grained fractions becomes higher, at the expense of the silty component.

b) Examining the proportion of carbonates it is observed that a number of compositions corresponding to marl, calcareous marl or detrital limestone are included in the samples taken from boreholes. As a result of the presence of dolomite, the composition of the deposit is directed towards dolomitic marl,

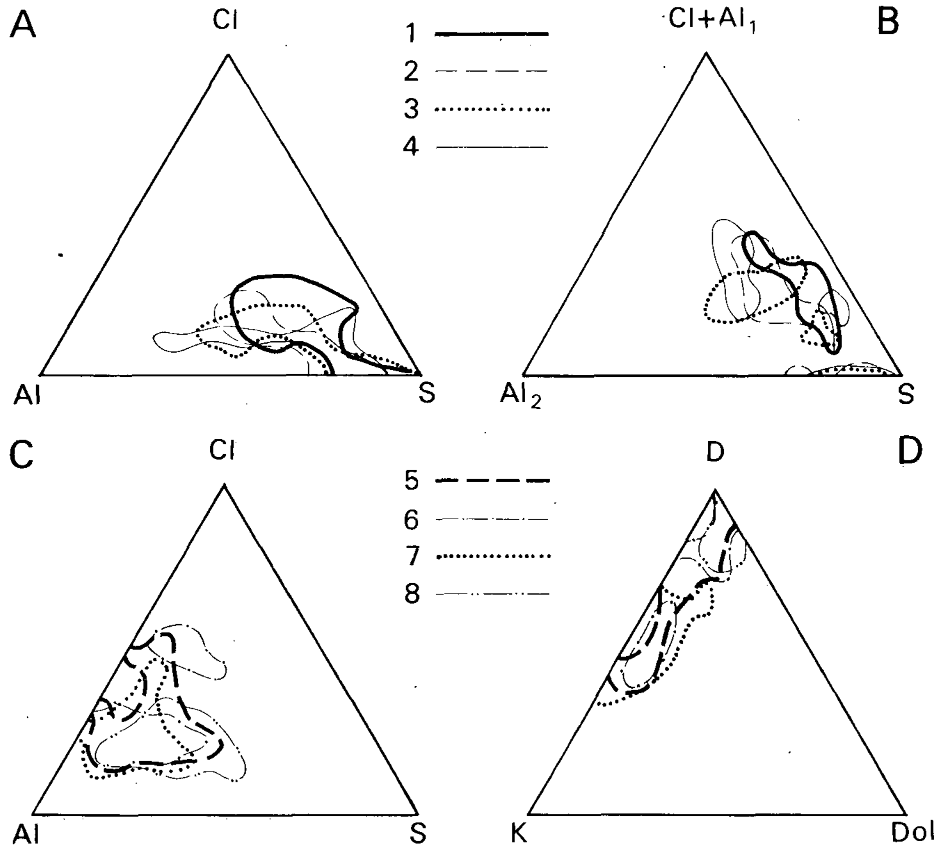


Fig. 4. The Upper Pliocene deposits of the Gödöllő area as shown by their grain-size distribution and carbonate content

Cl. clay, *Al.* silt, *S.* sand, *Dol.* dolomite, *K.* calcite, *D.* clastic component; A, B, sandy deposits: *1.* upper sandbed, *2.* middle sandbed, *3.* main sandbed, *4.* lower sandbed; *C, D,* silty deposits: *5.* silty-carbonate intercalation in the upper sandbed, *6.* main silty bed, *7.* middle silty bed, *8.* lower silty bed

4. ábra. A gödöllői felső-pliocén üledékek jellemzése szemcseméret és karbonáttartalom szempontjából

Cl. agyag, *Al.* kőzetliszt, *S.* homok, *Dol.* dolomit, *K.* kalcit, *D.* törmelékes komponens; A, B, homokos üledékek: *1.* felső homokréteg, *2.* középső homokréteg, *3.* fő homokréteg, *4.* alsó homokréteg; *C, D,* aleuritos üledékek: *5.* aleuritos-karbonátos betelepülések a felső homokrétegben, *6.* fő aleuritos réteg, *7.* középső aleuritos réteg *8.* alsó aleuritos réteg

calcareous marl etc. Upward in the profile the dolomite content decreases, whereas the proportion of calcite and clastic material increases.

Mineralogical-petrological examinations

The mineralogical examinations were done in thin sections and, for the fine-grained deposits, X-ray diffraction and thermal methods were also used. For the microscopic study consolidated sand samples were used, and thin sections of sandstones of nearly silty composition were prepared (Plate I, Photo 1).

The deposits studied are fine-to-medium grained and the grains are medium-rounded. In the sands a secondary, clayey-limonitic coating is present, which is missing from the grains of sandstone cemented with calcite. Micas in the fine-grained sandstone produce an orientation parallel with bedding.

The following components were detected in the psammites (in the order of frequency of occurrence): quartz, plagioclase, orthoclase, microline, rock fragments, muscovite, biotite (partly chloritized), spare calcite, zircon, apatite, rutile, tourmaline, epidote, titanite, opaque minerals (Plate I, Photo 2). Lithoclasts are formed by a great variety of rocks: andesite, microdiorite-porphyry, microgranodiorite, calcareous sandstone, dolomite, micro-brecciated limestone, bioclastic-foraminiferal limestone, flint, shale, sericite schist, chlorite schist, micaceous quartzite and gneiss grains have been observed.

The cement for naturally consolidated sand is limonitic clay that appears at the contact points between grains (menisc cement). The cement of sandstone is spare or microspare calcite which is of pore-filling or basal type.

Using X-ray and DTA analyses the following minerals have been detected in the silty deposits: quartz, plagioclase, chlorite, muscovite/illite, montmorillonite, mixed-layer minerals (illite/montmorillonite, montmorillonite/chlorite), haematite, lepidochrocite, calcite and amorphous material.

In the examination of carbonate deposit samples silty calcareous marl, marly limestone and micritic and pelmicritic limestone were identified (Plate I, Photo 3). Pellets of algal origin, ostracoda fragments, spongia spicule fragments (Plate I, Photo 4) worm tracks, as well as desiccation cracks filled with fresh sparite are also included therein.

Sedimentation and diagenesis

The examinations described above have led me to the conclusion that a deltaic sequence in which sands alternate with silty-argillaceous beds was developed in the area between Gödöllő and Isaszeg, in the marginal area of a freshwater sedimentary basin at the end of the Pliocene. The sediment was "spread" in response to the changing direction of streams; as a result, beds with comparatively same thickness were developed from different directions and at different rates of sedimentation.

Sand may also have originated from the redeposition of Miocene, Oligocene or Mesozoic rocks that were being eroded off at that time and from the denudation of igneous rocks of the present-day Börzsöny or Cserhát mountainous regions.

The energy of stream transporting sediments greatly decreased at regular intervals. As a result, only fine-grained detritus was transported into the sedimentary basin. In some areas where no deposit of detrital origin was produced, instead, micritic, or pelmicritic, slightly dolomitic limestone was produced from the calcareous mud that had been developed in the green, gelatinous algal mats. The desiccation cracks point to temporary, shallow plashes around which even the sand was cemented by carbonate. The transport of the limonitic-argillaceous cement is a secondary process that can be linked with a later, Pleistocene sub-aerial alteration.

REFERENCES — IRODALOM

BÖCKH, J. 1872: Gödöllő, Aszód környékének földtani viszonyai. — Földt. Közl. 2:6—18.

DÖMSÖDI, J. 1977: Lápi eredetű szervesanyag-tartalékaink mezőgazdasági hasznosítása. — Mezőg. Kiad. 72—75.

FERENCZI, I. 1936: A gödöllői MÁV bevágás szelvénye. — MÁFI adattár, kézirat.

GÜNTHER, FR. 1914: A „József főhercegliget" m. kir. fenyőkísérleti telep. — Az erdészeti kísérleti állomások nemzetközi szövetségének VII. nagygyűlése. 12—25. Selmecbánya.

KALMÁR, J. 1991: A Gödöllői Arborétum agrogeológiai helyzete különös tekintettel a növényzet fejlődésére. 100 éves az agrogeológiai kutatás. — MÁFI—MFT rendezvény (in print).

LEÉL-ÖSSY, S. 1953: A Rákosvidék geomorfológiája. — Földr. Ért. 2. 1:70—76.

MOTTL, M. 1939: A gödöllői vasúti bevágás középső pliocénkorú emlősfaunája. — Földt. Int. Évk. 32. 3:255—265.

PÉCSI, M. 1968: A Duna-ártéri szintek kialakulása és fontosabb agrárföldrajzi vonatkozásai. Földr. Közl. XVI (XCII):267—271.

RÓTH, GY. 1953: A Gödöllői Arborétum. A magyar erdőművelés különleges feladatai. — Mezőg. Kiad. 234—242.

SCHAREK, P. 1984: A gödöllői dombság mérnökgeológiai viszonyai. — Doktori disszertáció, ELTE—TTK.

SZENTES, F. 1941: Jelentés Aszód távolabbi környékén végzett részletes földtani felvételekről. — Földt. Int. Évi jel. 1936—1938-ról: 465—468.

A GÖDÖLLŐI AGROGEOLÓGIAI MINTATERÜLET ÉS KÖRNYEZETE FÖLDTANI ÉS RÉTEGTANI VISZONYAI

KALMÁR JÁNOS

Magyar Állami Földtani Intézet
Budapest, Stefánia út 14.
H-1143

ETO: 551.7 (439.153.2)

Tárgyszavak: Pliocén, törmelékes üledék, geomorfológia, rétegtan, szedimentológia, őskörnyezet, Gödöllői Dombvidék

A gödöllői agrogeológiai mintaterület az 1902-ben telepített Arborétumot foglalja magába. Az agrogeológiai adatok feldolgozása során e terület részletes földtani szerkezetét is tanulmányoztam.

Morfológiai szempontból a terület három, ÉNy-DK irányú sávra tagolható: a) a Rákos-patak völgye, két terasz-szinttel; b) az Öreg-hegy — Brezinia Dűlő dombhát és c) a Valkó-völgyet lehatároló alacsony dombvonulat.

A felsőpliocén rétegsor jellemzője a homokos és az aleuritos szintek váltakozása. Terepi térképezés és a fúrások segítségével egy részletes rétegsort és az ennek megfelelő fedetlen térképet készítettem. Az elkülöníthető rétegek a következők: a) Felső Homokréteg; b) Fő Aleuritos Réteg; c) Fő Homokréteg; d) Középső Aleuritos Réteg; e) Középső Homokréteg, f) Alsó Aleuritos Réteg, g) Alsó Homokréteg. A homokrétegek vastagsága 13—35 m, az aleuritos rétegeké 4—10 m. Az aleuritos rétegek feküjében és fedőjében mészkő, mészmárga vagy meszes homokkő található. A rétegek egy sekély, ÉK—DNy irányú szinklinálist alkotnak melyet DNy-on két vető szel át.

A pszammitok szemcseösszetételére jellemző a finom- és közepes homokfrakció. A rétegek szemcseösszetételét vizsgálva, alulról felfelé bizonyos fokú homogenizálódást tapasztaltam: csökken a finom és a durva frakciók részaránya. Az aleuritokban az agyagos, homokos és karbonátos rész vagy mint önálló betelepülés, vagy mint komponens jelenik meg. E kőzetekben a fiatalabb rétegekben nő az üledék inhomogenitása, azaz a homokos és az agyagos frakciók részaránya az aleurit-frakció rovására.

A jellegzetes karbonátos kőzet az alga-pelletes, finomszemcsés édesvízi mészkő, kalcittal kitöltött beszáradási repedésekkel.

A homokban számos litoklaszt található: kristályos palák, dolomit, biogén mészkő, magmás kőzet. Helyenként a homokot limonitos agyag köti meg, ill. pátos kalcitcement a karbonátos rétegek közelében.

Az üledékképződés a felső pliocénben egy delta-jellegű időszakosan elöntött területen történt. A törmelékszállító vízfolyás energiája ingadozó volt, hol homokot, hol finom üledéket hozott.

Plate I—I. tábla

1. Secondary limonitic cement (1) at the bottom of the upper sanbed; a. andesite clasts, f. feldspar. Király út, thin section
12 x IIN

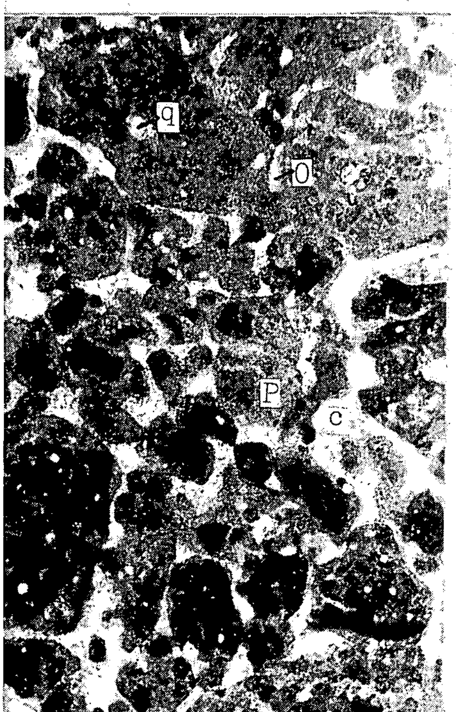
2. Inclusions in at orthoclase grain (o); t.tourmaline, T. titanite, a. apatite, z. zircon. The cement in the sandstone is spare calcite (c). The topmost part of the main sanbed, a road cut of Kőmalom út
32 x +N

3. Algal pellets (p) in spare calcite; o. ostracoda shell debris, q. quartz grain. Lower Silty Formation, Horhos-árok ————
32 x IIN

4. Sandy limestone with a spongia spicule (s); Q. quartz, m. muscovite, spare limestone fragment. Microsparitic cement. Waterwork of the state Vehicle Factory. The silty bed.
32 x +N

1

2



3

4

A METHOD OF PALEOGEOGRAPHICAL MAP PLOTTING DEMONSTRATED BY TAKING AS EXAMPLE THE LOWERMOST PART OF A SENONIAN SEQUENCE IN THE TRANSDANUBIAN CENTRAL RANGE

by

E. JOCHA-EDELÉNYI

Hungarian Geological Survey
Budapest, Stefánia út 14
H-1143

UDC: 551.8 (439.11)
551.763.3 (439.11)
912.55 (439.11)

Keywords: Transdanubian Central Range, Senonian, paleogeographical reconstruction, bauxite deposition, coal deposition, horizontal strip-slike fault, paleokarst, digital map edition

A Late Cretaceous — Senonian sedimentation started on a first-order unconformity surface linked with the pre-Gosau phase, in the Transdanubian Central Range. A large amount of data available on the terrestrial — fluvial —coal swamp — lacustrine phase of sedimentation have made it possible to plot paleogeographical maps. A map series comprising a total of eight maps also shows the principle of preparing paleogeographical map versions. In the map compilation an unprecedented, computer-aided technique has been applied.

Paleogeographical reconstructions of the Senonian units in the Transdanubian Central Range have already been made (HAAS, J.—JOCHA-EDELÉNYI, E., 1978, 1979, JOCHA-EDELÉNYI, E. 1988). However, the amount of contributions to the existing data made it possible, and a need for a better established mineral resources prediction necessitated to compile a new, more detailed map showing the paleogeographical conditions prevailing at the beginning of Senonian time. However, the aim of the papers also comprising paleogeographical reconstructions was mainly to have a better knowledge of the one-time areas where coal and bauxite deposition took place (HAAS, J. et al. 1984, GÓCZÁN, F. et al. 1987, CSÁSZÁR, G.—GÓCZÁN, F. 1988, SIEGI-FARKAS, Á. 1988, MINDSZENTY, A. 1983, JUHÁSZ, E. 1989). The map series dealt with in this paper gives a description of the history of evolution of the entire Senonian depositional area in the Transdanubian Central Range during the Early Senonian.

A method of plotting paleogeographical maps

The Senonian beds in the Transdanubian Central Range can be grouped into a total of seven, markedly separated units fairly representing each phase of the evolution history of the area concerned. These units are encountered in specific combinations that were developed in zones 8 to 10 km wide, trending NE—SW (JOCHA-EDELÉNYI, E. 1988). Their deposition started on an unconformity surface that is of first-order according to the stratigraphic interpretation of the sequence, and is linked with the Austrian pre-Gosau phase which resulted in a remarkable elevation, denudation and regional karstification (JOCHA-EDELÉNYI, E. 1981).

The simplest sequence contains rocks of the Ugod Limestone Formation of reef facies and of its overlying pelagic Polány Marl Formation, indicating that the sedimentation area was elevated when the deposition began.

Another combination — indicating that sedimentation took place in a deeper-situated zone of the pre-Senonian surface — includes rocks of the fluvio-lacustrine Csehbánya Formation and/or the coal-bearing Ajka Coal Formation. They are overlain by the lagoonal-neritic Jákó Marl Formation covered by the Polány Marl Formation which is well-known from the former combination. Bauxite and bauxitic clay have been encountered at the base of the sequence in the SE and S parts of the depositional area, on the slopes and their environs connecting the one-time elevated and deeper areas (GELLAI—LUDAS 1983, JUHÁSZ 1989). Considering that most information on the history of development of the area are supplied by the initial period of the Senonian sedimentation, that is, the period prior to the time when the area turned to be invaded by sea, in addition, the knowledge of the paleogeographical conditions prevailing during the Early Senonian also is most informative for us in regard to mineral resources prediction, therefore three phases of this period have been reconstructed on a detailed paleogeographical map. To compile the maps, tectonic, paleomorphological and facies analyses had to be performed (JOCHA-EDELÉNYI, E. 1991). The aim of the tectonic analysis was to theoretically replace each studied unit in a site where it had been originally formed, since otherwise no paleogeographical map can be compiled. The information needed to detect the displacements following deposition, were supplied by geological map plotted on base of the Senonian units and by thickness maps of the units studied (Figs. 1, 2, 3). The basement map — showing the one-time unconformity surface in a considerable area due to the coverage — displays two NE—SW oriented, 5-to-10-km-wide synclinal zones also containing younger — (Middle Cretaceous) — units, with a distance of 7 to 8 km from each other situated within the synclinorium structure, in a zone 30 to 40 km wide consisting of Triassic rocks. Of course, later tectonic influences are reflected by the zones stretching SW of Ugod as far as Zalaszentlászló or NE of Halimba through Csehbánya towards Pénzesgyőr (Fig. 1).

The two zones observed on the basement map are also outlined on an isopachous map of the Ajka Formation, of course, only within the area where

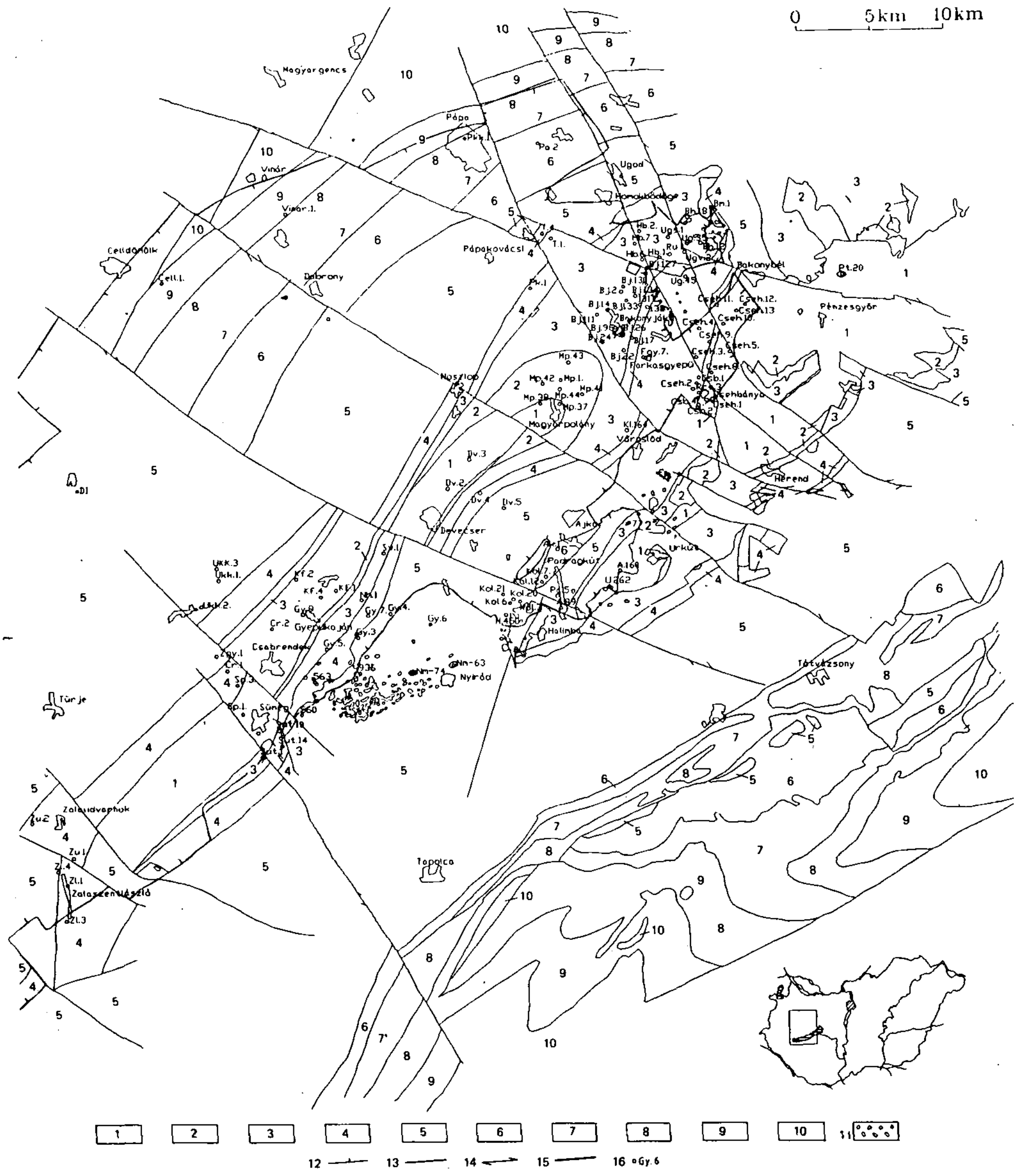


Fig. 1. Geological map of the basement of the Senonian formations

1. Middle and Lower Cretaceous rocks, *2.* Jurassic rocks, *3.* Kardosrét Limestone F., Dachsteinkalk F., *4.* Kössen Beds or "transitional beds", *5.* Haupdolomit F., *6.* Veszprém Marl F., *7.* Middle Triassic rocks, *8.* Lower Triassic rocks, *9.* Permian rocks, *10.* Paleozoic rocks, *11.* bauxite, *12.* present boundary of extent of the Senonian rocks, *13.* boundary of rocks, *14.* strike-slip fault (post-Senonian), *15.* fault, *16.* important borehole

1. ábra. A szenon képződmények alatt települő képződmények földtani térképe

1. Középső—alsó-kréta képződmények, *2.* jura képződmények, *3.* Kardosréti Mészkő F., Dachsteini Mészkő F., *4.* Kösszeni Formáció, ill. „átmeneti rétegek", *5.* Fődolomit F., *6.* Veszprémi Márga Formáció, *7.* középső-triász képződmények, *8.* alsó-triász, *9.* perm, *10.* paleozoós képződmények, *11.* bauxit, *12.* a szenon képződmények mai elterjedési határa, *13.* képződményhatár, *14.* szenon utáni horizontális elmozdulás, *15.* vető, *16.* fontosabb mélyfúrás

R

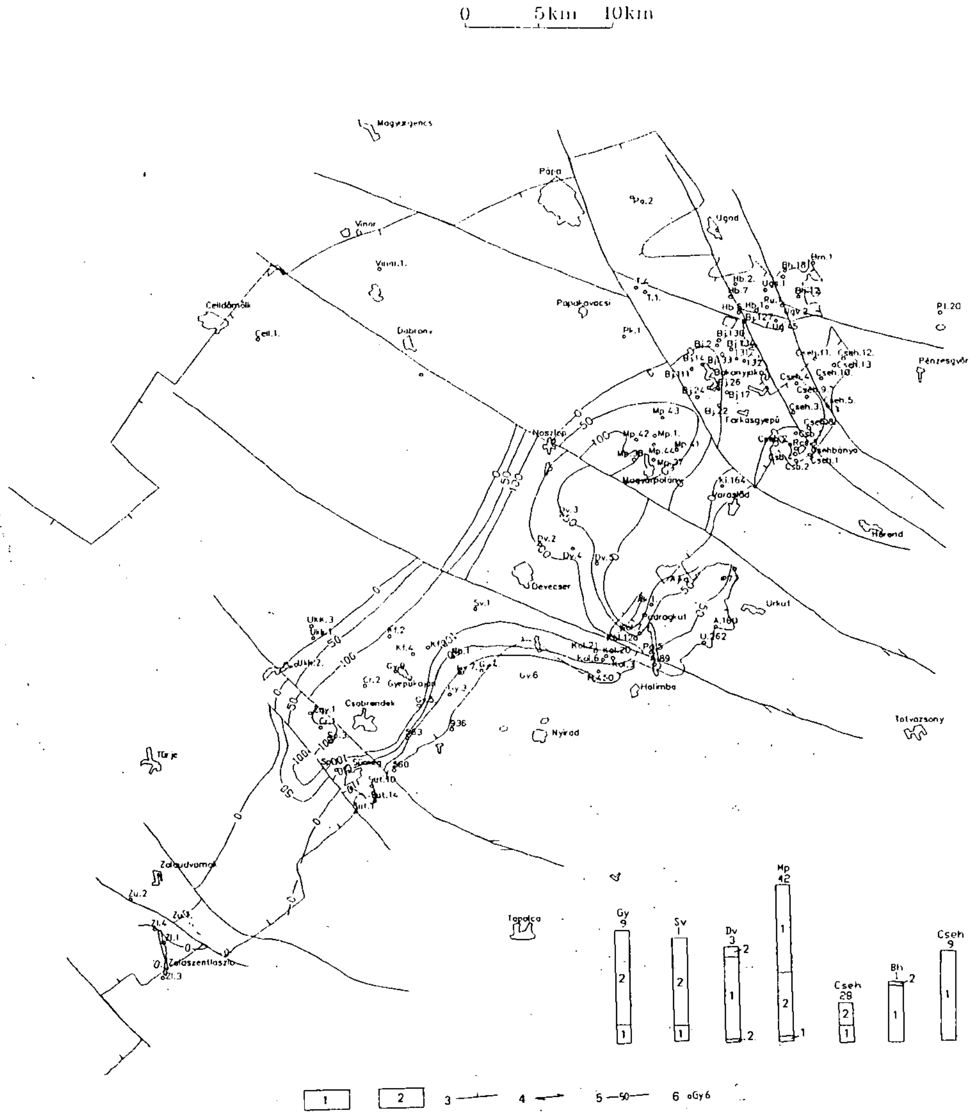


Fig. 2. Thickness of the Ajka Coal Formation — Relationship between the Csehbánya and Ajka Formations

1. Csehbánya Formation, *2.* Ajka Formation, *3.* present boundary of extent of the Senonian rocks, *4.* strike-slip fault (post-Senonian), *5.* isopach line, *6.* important borehole

2. ábra. Az Ajkai Kőszén Formáció vastagsága — A Csehbányai és az Ajkai Formáció kapcsolata

1. Csehbányai Formáció, *2.* Ajkai Formáció, *3.* a szenon képződmények jelenlegi elterjedési határa, *4.* szenon utáni horizontális elmozdulás *5.* vastagsági isovonal, *6.* fontosabb mélyfúrás the Upper Cretaceous strata can be encountered. These two zones exhibit an interrelationship in the middle part of the area — between Devecser and Kolontár — where their thickness is greatest (Fig. 2).

On the thickness map of the Csehbánya Formation the unit appears partly again according to the well-kown zones that show an interrelationship between each other, not only in the Devecser—Kolontár zone known from the Ajka Formation, but also in the NE part of the area between Csehbánya and Magyarpolány. A new feature of great significance is that the greatest thickness is encountered in a 10-to-15-km-wide zone along the line Pápa—Dabrony, stretching at a distance of 5 to 10 km from the previously described ones and found in the N part of the area concerned — in the N wing of the area of extent. A decrease in thickness is experienced towards SW in the entire area of extent of this unit (Fig. 3).

The tectonic lines that can be recognized on the maps showing the Csehbánya and Ajka Formations are identical with those visible on the basement map, and are interpreted as strike-slip faults. This is also backed up by changes in facies that will be described hereinafter. It is this fact that has allowed us to compile a tectonically reconstructed paleogeological map (Fig. 4). The aim of paleomorphological analysis was to get at the knowledge of the morphological conditions of the one-time depositional basin. This needed to clarify the relations in time and space between the deposits. The occurrence of lithostratigraphic units in specific combinations has already been discussed in this paper (Fig. 5). However, paleontological — mainly palynological, moreover macro- and microfaunal studies have allowed us to understand their temporal relations (GÓCZÁN, F. 1964, 1973, GÓCZÁN et al. 1987, SIEGL-FARKAS, Á. 1988, BENKŐ-CZABALAY 1961, Sidó 1980). As shown by these examinations, the sedimentation started in the Santonian, dominantly in Zone B according to a palynological classification by GÓCZÁN. However, a few data also indicate the presence of older units (such as Zone A in the middle zone of extent of the Csehbánya Formation) (JUHÁSZ, M. 1980). For us it is of great importance that the fossil content of the Ajka Coal Formation consists mainly of fossils of brackish-water origin in the eastern part of the extent of the formation, including limnic specimens occurring here and there at its lower part. In the western part of the formation concerned, marine faunal elements also occur in the unit of cyclic sedimentation. These marine elements have turned out to be exclusive in the known westernmost occurrence of this formation (Zalaszentlászló) (JOCHA-EDELÉNYI, E. 1987). Another paleontological datum of great importance is that the first purely marine unit of the Senonian sequence, that is, the base of the Jákó Marl Formation can be regarded as an isochronous surface (the lower part of palynological Zone D) which means that the thickness of the underlying beds nearly images the morphological picture of the initial stage of sedimentation. Considering that the original positions of the units, i.e. their positions when they were formed are well known owing to the "paleogeological" map showing a reconstruction of the geological conditions of the specific time, therefore a combined, reconstructed isopach map of the Ajka and Csehbánya Formations

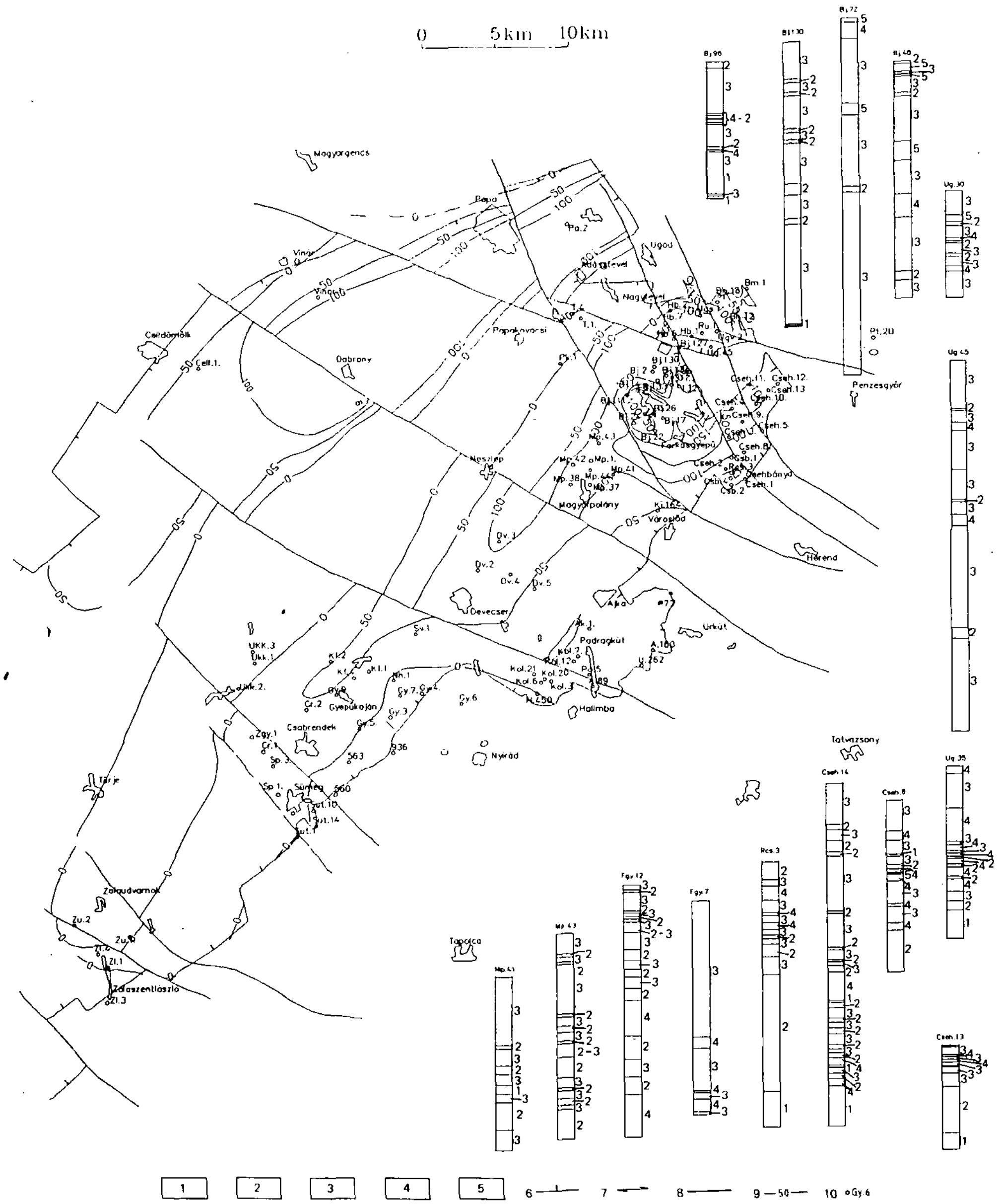


Fig. 3. Thickness and facies map of the fluvio-lacustrine Csehbánya Formation

1. Alluvial fan, *2.* channel load facies, *3.* flood plain facies, *4.* deep flood plain, *5.* marsh, *6.* present boundary of extent of the Senonian rocks, *7.* strike-slip fault (post-Senonian), *8.* fault, *9.* isopach line, *10.* important borehole

3. ábra. A fluvio-lakusztrikus Csehbányai Formáció vastagság és fácies térképe

1. Alluviális törmelékkúp, *2.* meder fácies, *3.* ártéri fácies, *4.* mély ártér, *5.* mocsár, *6.* a szenon képződmények mai elterjedési határa, *7.* szenon utáni horizontális elmozdulás, *8.* vető, *9.* vastagsági isovonal, *10.* fontosabb mélyfúrás

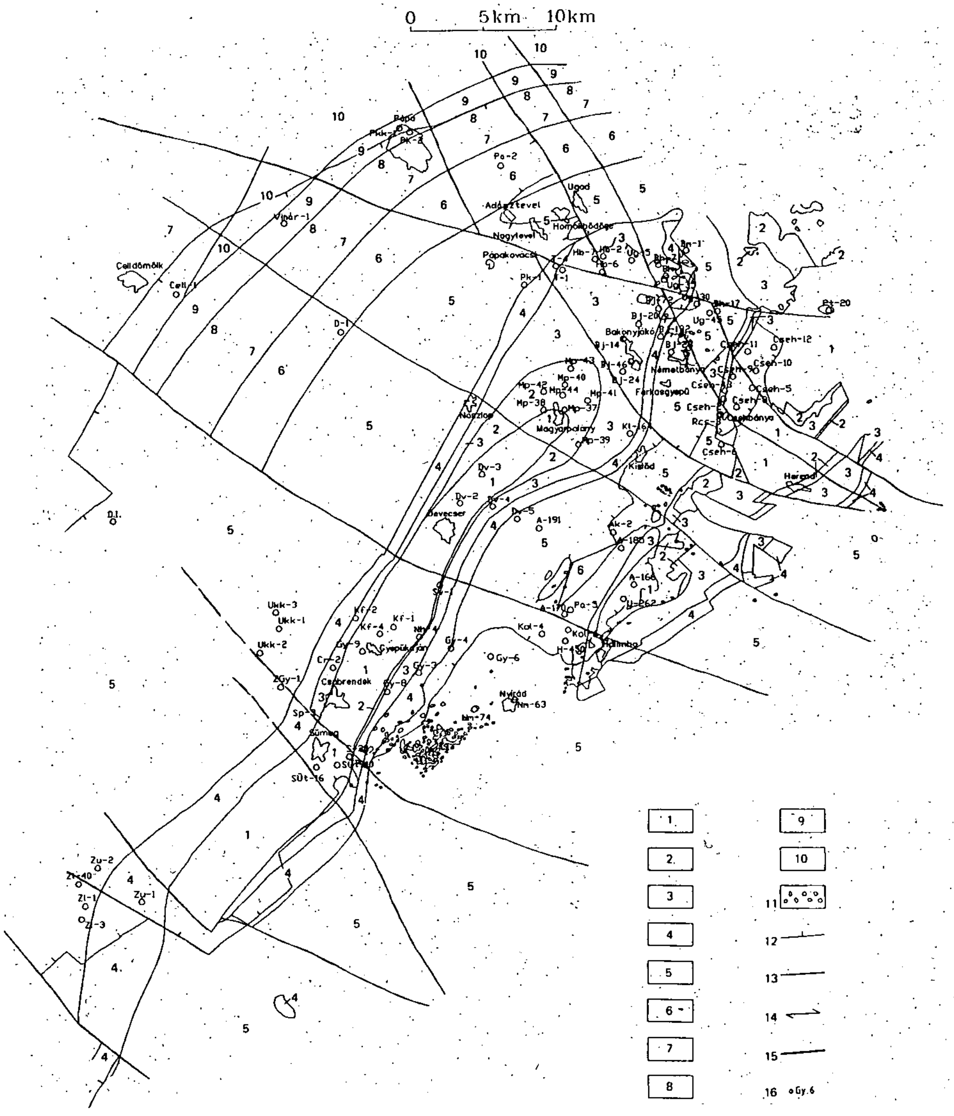


Fig. 4. "Paleogeological" map of basement of the Senonian formations (A palinspatic-type map reconstructing the geological conditions at the period of rise of the bauxite horizon)

1. Middle and Lower Cretaceous beds, *2.* Jurassic beds, *3.* Kardosrét Limestone F., Dachsteinkalk F., *4.* Kösseen F. or "transitional beds", *5.* Haupdolomit F., *6.* Veszprém Marl F., *7.* Middle Triassic rocks, *8.* Lower Triassic rocks, *9.* Permian rocks, *10.* Paleozoic rocks, *11.* bauxite, *12.* present boundary of extent of Senonian rocks, *13.* boundary of rocks, *14.* strike-slip fault (post-Senonian), *15.* fault, *16.* important deep borehole

4. ábra. A feküképződmények „paleoföldtani" térképe (A bauxitszint képződési idejére visszarendezett állapot)

1. Középső—alsó-kréta képződmények, *2.* Jura képződmények, *3.* Kardosréti F., Dachsteini Mészkő F., *4.* Kösszeni F., ill. átmenet rétegek, *5.* Fődolomit F., *6.* Veszprémi Márga F., *7.* középső-triász képződmények, *8.* alsó-triász képződmények, *9.* perm képződmények, *10.* paleozóos képződmények, *11.* bauxit, *12.* a szenon képződmények mai elterjedési határa, 13. képződményhatár, 14. szenon utáni horizontális elmozdulás, 15. vető, 16. fontosabb mélyfúrás

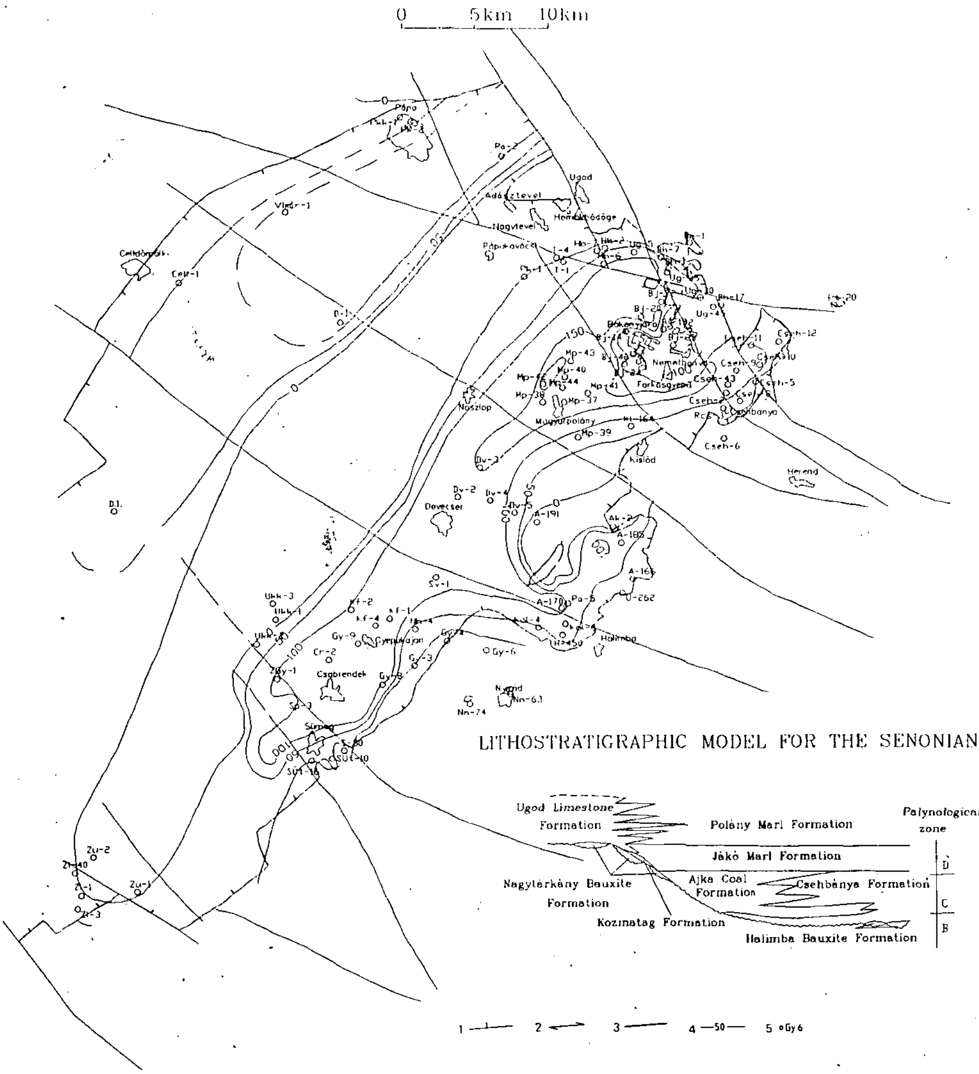


Fig. 5. The combined thickness of the Csehbánya and Ajka Formations, reconstruced according to a former tectonic position

1. Present boundary of extent of the Senonian rocks, *2.* strike-slip, fault (post-Senonian), *3.* fault, *4.* isopach line, *5.* important borehole

5. ábra. A Csehbányai Formáció és az Ajkai Formáció együttes vastagsági térképe (tektonikailag visszarendezett állapotban)

1. A szenon képződmények mai elterjedési határa, *2.* szenon utáni horizontális elmozdulás, *3.* vető, *4.* izovonal, *5.* fontosabb mélyfúrás

(Fig. 5) would supply important information for reconstructing the paleomorphology.

Another important information is that the greatest thickness of the Csehbánya Formation has been encountered in its northernmost zone. This is where the coarsest grain-size composition is also found and the formation is directly overlain by the euhaline beds of the Jákó Marl. These facts indicate that the morphological position of the zone of the area had been deeper than that of the subsided zones lying toward the south.

The assumption is supported by the fact that bauxite deposits are only known in the southern and south-eastern parts of the area of extent. This fact indicates that these parts of the area had a more elevated morphological position representing a transition to the even more elevated background areas supplying the groundmass of bauxite. The increasing dominance of marine species in the fossil content of the Ajka Formation observable toward SW indicates a W—SW oriented transgression. All these have allowed us to outline the picture of a basin sloping toward NW—W and broken up by NE—SW oriented elevated ridges, pre-existent at the beginning of the sedimentation in Senonian time.

For sketching up a paleogeographical picture of this basin taking shape, and to reconstruct the pertinent depositional evolution, a facies analysis should be performed, to achieve a better knowledge of each facies of the basic formations, including their relationships. As a first step, the relationship of basic formations has to be studied (geological columns in Fig. 2). The development successions of the Ajka and Csehbánya Formations are likewise corresponding to a regular order of transgressive deposition in their respective areas of sedimentation, that is fluvial beds are overlain by coal-bearing swamp sediments. A different order of beds is encountered in a part of the middle facies zone which shows relation to the Csehbánya area, i.e. in the vicinity of Magyarpolány where fluvial deposits rest on paludal beds at the base.

Studying the facies of the Csehbánya Formation and revealing their relationships it supplies most information on the way how sedimentation took place. All facies that can be recognized within this fluvio-lacustrine unit are as follows: channel load facies consisting of gravel and grey sandbeds; flood plain facies consisting of variegated day (in colour varying as a function of granulometric size) and silt (with grey silt and clay in the deeper areas); swamp facies represented by rocks that are rich in organic matters and contain, in some places, thin coal bands; and finally, the alluvial fan (channel bar) facies containing unsorted, unrounded clasts embedded in argillaceous (frequently red) rock (see geological columns in Fig. 3). In each partial area of the area of extent of the unit characteristic facies combinations can be observed. The eastern part of the southern facies zone, the northern part of the Csehbánya area — showing transition to the middle zone — is featured by alluvial fan facies, whereas the middle part is describable by channel load and flood plain facies. The SW part features deep flood plain and swamp facies. As far as the area found between the southern and the middle zones — near

Farkasgyepű — is concerned, its northern part features channel load and flood plain facies, whereas the southern part is of flood plain facies. The eastern part of the middle zone — near Ugod-Bakonybél — is dominated by channel load and flood plain facies, whereas the northern part displays deep flood plain and swamp facies. Toward the south, in the northern part of the Bakonyjákó region a similar facies pattern is encountered. The middle and southern parts of the region are dominated by flood plain facies with subordinate channel load facies. In the western part of the area, the paludal beds that are frequent near the base, show transition to the Magyarpolány area (where the sequence begins with the Ajka Coal Formation). Near Magyarpolány the Csehbánya Formation features channel load and flood plain facies. Only few data are available on the facies of the northern zone. However, based on a few hydrocarbon boreholes drilled here, the dominant facies are of channel load and flood plain constitution.

A paleogeographical picture of the Senonian depositional basin

Upon paleogeological, paleomorphological and facies analyses, a paleogeographical picture of the Senonian depositional basin, regarding the initial phase of sedimentation, can be sketched out. In the area concerned the development of synclinorium structure is linked with the Austrian—pre-Gosau phases. As a result of a substantial denudation taking place in the elevated areas, the Upper Triassic carbonate rocks became exposed in large parts of the area and underwent an intensive karstification. In the southern wing of the synclinorium laterization is likely to have started on Paleozoic beds found in the highest morphological position. Thus, this laterite might have partly supplied a groundmass for bauxite deposits by being reworked to the karstic terrain found at a deeper level. In the Late Santonian an epeirogenetic subsidence of the area forced the groundwater level to rise i.e. open-water subbasins to develop. Sedimentation started in the three subsided zones separated from one another by NE—SW oriented elevated ridges (Fig. 6) in these zones, in the NE part terrestrial, whereas in the SW part — W of Sümeg — marine sedimentation took place. The southern zone — the Ajka Basin — was dominated by limnic swamp environment and was separated from the other parts of the depositional basin. In the middle zone limnic swamp facies appeared almost entirely, and only in its SW part, in the direct vicinity of the coast, limnobrackish or marine-brackish swamp facies were present (HAAS et al. 1984). In the northern zone swamp is unlikely to have been formed, except for a very small zone of the area; a direct contact between fluvial and marine facies is assumed. On the S—SE margin of the depositional basin and on the ridge separating the southern and the middle zones (Kislőd—Iharkút) a clastic material that had been redeposited from the SE towards the deeper areas and bauxitized in a varying degree was sedimented and underwent a further bauxitization in karst traps (MINDSZENTY, A. 1983, JUHÁSZ, E. 1989).

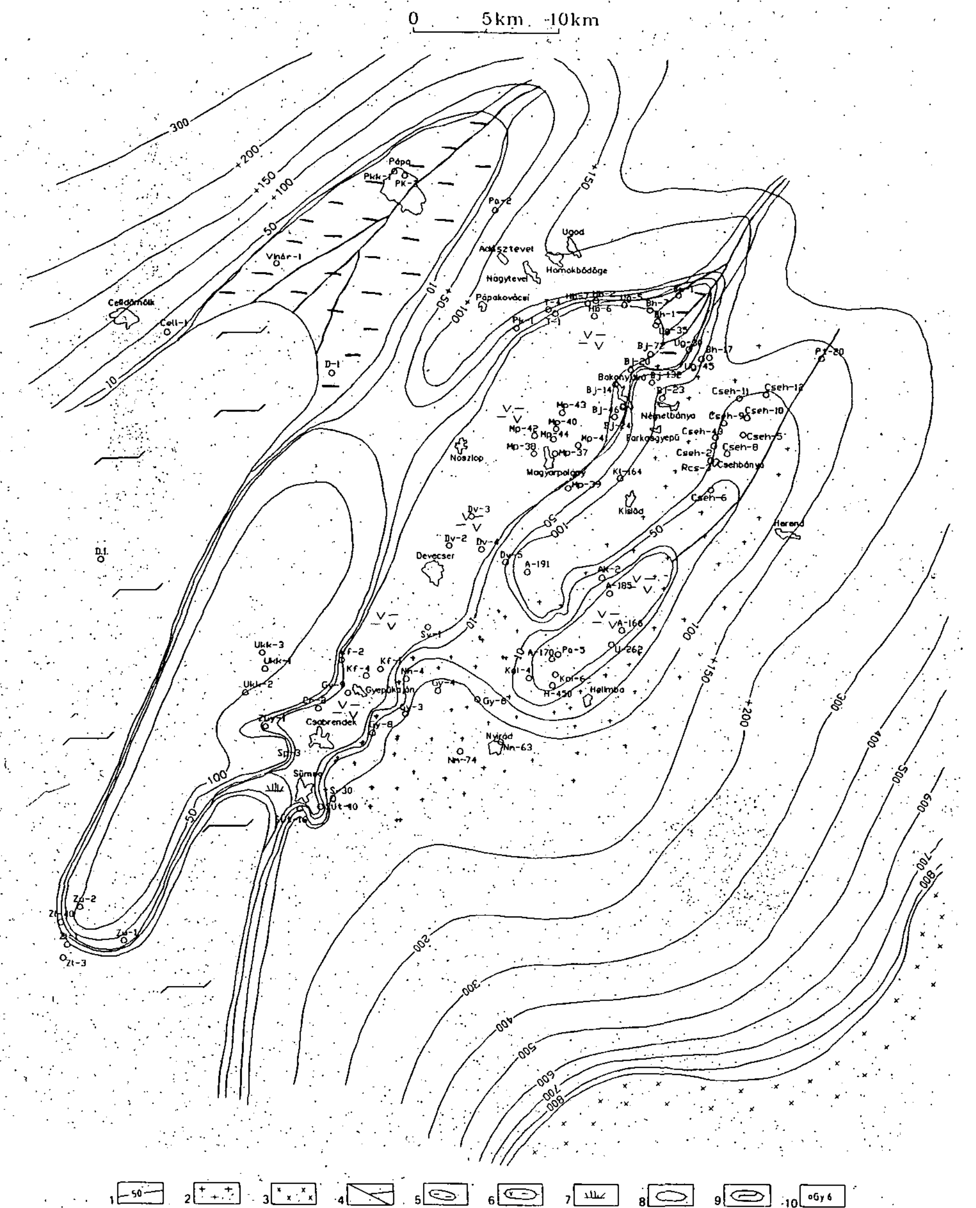


Fig. 6. Paleogeographical conditions at the beginning of the Senonian deposition (palynological zone B-Upper Santonian)

1. Height a.s.l. of the cont. areas, *2.* areas of bauxite accum. *3.* laterite plateau inferred, *4.* river bed, *5.* flood plain, *6.* limnic swamp, 7 limnobrackish swamp, 8. marine-brackish swamp, *9.* sea, *10.* important borehole

6. ábra. Ősföldrajzi helyzet a szenon üledékképződés kezdetén (palynológiai „B" zóna - felső szantoni)

1. Szárazulati területek tengerszinthez viszonyított magassága, *2.* bauxitfelhalmozódási területek, *3.* feltételezett lateritplató, *4.* folyómeder, *5.* ártéri síkság, *6.* édesvízi láp, *7.* limnobrakk láp, *8.* marinbrakk láp, *9.* tenger, *10.* fontosabb mélyfúrás

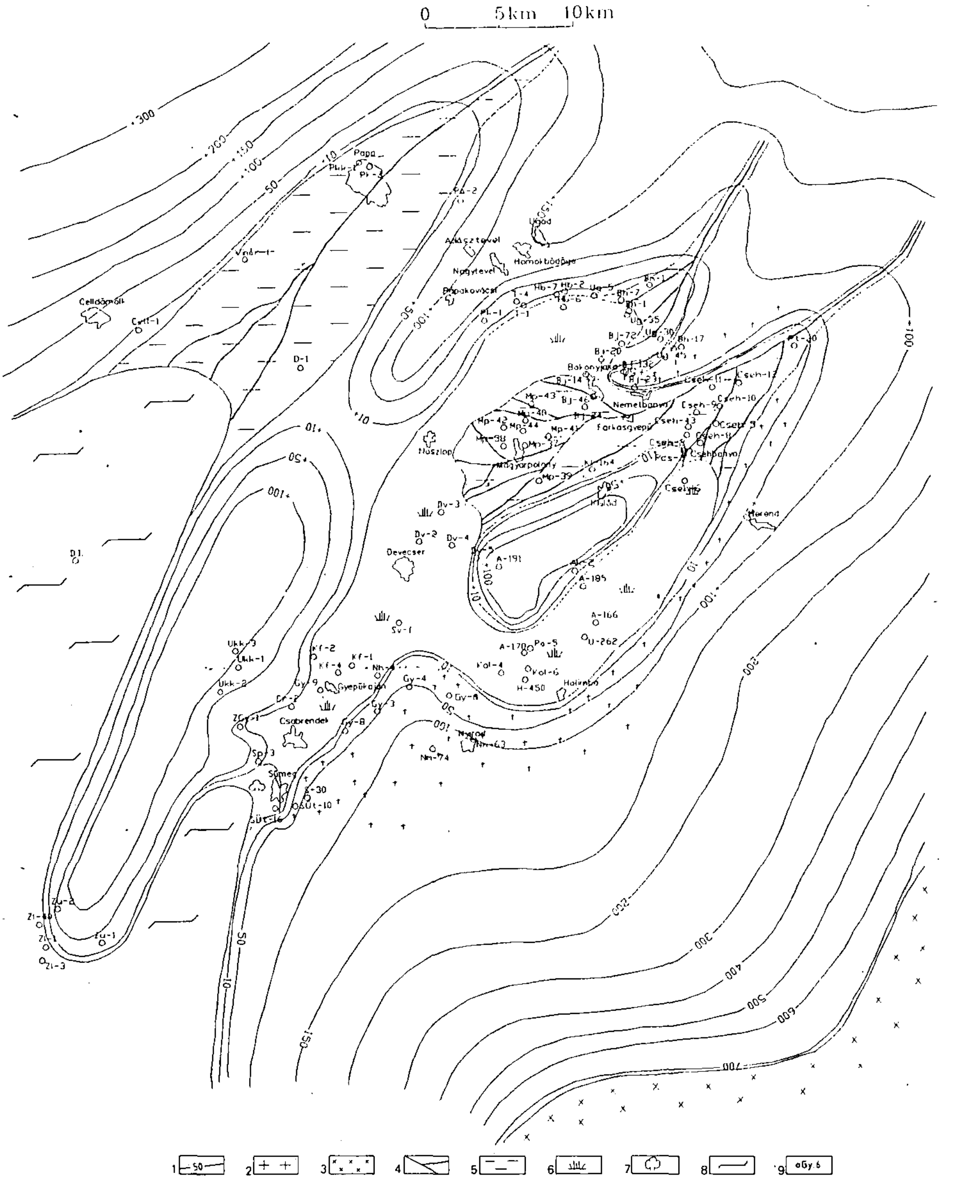


Fig. 7. Paleogeographical situation at the time of accomplishment of the fluvio-lacustrine sedimentation. (palynological zone C-Upper Santonian-Lower Campanian)

1. Height a.s.l. of the continental areas, *2.* areas of bauxite accumulation, *3.* laterite plateau inferred, *4.* river bed, *5.* flood plain, *6.* limnobrackish swamp, *7.* marine-brackish swamp, *8.* sea, *9.* important borehole

7. ábra. Ősföldrajzi helyzet a fluvio-lakusztrikus üledékképződés kiteljesedése idején (palynológiai „C" zóna—felső-szantoni—alsó-kampaniai)

1. Szárazulati területek tengerszinthez viszonyított magassága, *2.* bauxitfelhalmozódási területek, *3.* feltételezett lateritplató, 4. folyómeder, 5. ártéri síkság, 6. limnobrakk láp, 7. marinbrakk láp, 8. tenger, 9. fontosabb mélyfúrás

For the end of the Late Santonian — the beginning of the Early Campanian (palynological Zone B) a perfection of fluvio-lacustrine and limnobrackish facies is verifiable (Fig. 7). As a result of the continuous subsidence of the area, the ridges separating the zones that had been subsided to a greater depth more and more turned into a depositional area. Between Iharkút and Kislőd a connection was established between the Csehbánya and Magyarpolány areas, and in the vicinity of Magyarpolány the paludal facies was replaced by fluvial sedimentation. In places where earlier limnic swamps had existed, then limnobrackish facies was formed and the area of the swamp at Ajka considerably increased toward Csehbánya. A subsequent essential phase of development of the basin in Senonian time is witnessed at the boundary between palynological Zones C and D in the lower Campanian with the prevailing role of the swamp facies (Fig. 8). As a result of a further transgression the connection between the southern and middle sedimentary zones became rather explicit — due to the fact that the area of the middle ridge was strongly reduced and turned into an island —, swamp facies became dominant over fluvial facies, and the marine—brackish-water swamp facies gained considerable space. At that time there was still chance for the accumulation of bauxite deposits on the southern margin of the sedimentary basin. During the slow transgression these bauxite deposits were preserved by an advancing settlement of sedimentary rocks. As a result of the uninterrupted subsidence of the source-material-supplying background areas that may have been situated formerly at an altitude of 700 to 800 m a.s.l. as estimated on the basis of analogies, subsided several hundred metres.

The subsequent event of great importance in the history of development of the sedimentary basin is that marine facies considerably extended, and thus the elevated ridges and basin margins became inundated by water, and reef facies started to develop. In the deeper areas shallow-marine sedimentation replaced the fluvial and swamp environments (HAAS, J.—JOCHA-EDELÉNYI, E. 1979).

As shown by the paleogeographical reconstruction, the area was part of the SE margin of the Senonian sedimentary basin. The NW boundary of the area of extent of Senonian units is, at present, a tectonic zone referred to as Rába line. This line is considered as a major structure line causing a considerable displacement of some hundred kilometers (KÁZMÉR, M.—KOVÁCS, S. 1985). This fact means that each heteropic facies of the interior of the basin of Senonian units found on the basin margin of the Transdanubian Central Range has to be searched for at a distance of a few hundred kilometers toward SW.

The relevant literature and my own field experiences show a Senonian sequence to be of great importance for us. This succession is found in Austria, 70 to 80 km from Graz to the SW, in the Gosau of Krappfeld near Klein St. Paul in Karinthia (NEUMANN H. 1989). The thin conglomerate overlying the basement is overlain by a rudist-bearing reef limestone bed (that can well be correlated with the Ugod Limestone). This is followed, upwards, by open-marine marl and calcareous marl beds with a facies that is identical with that of the Polány Marl. This sequence exhibits a great number of similar features

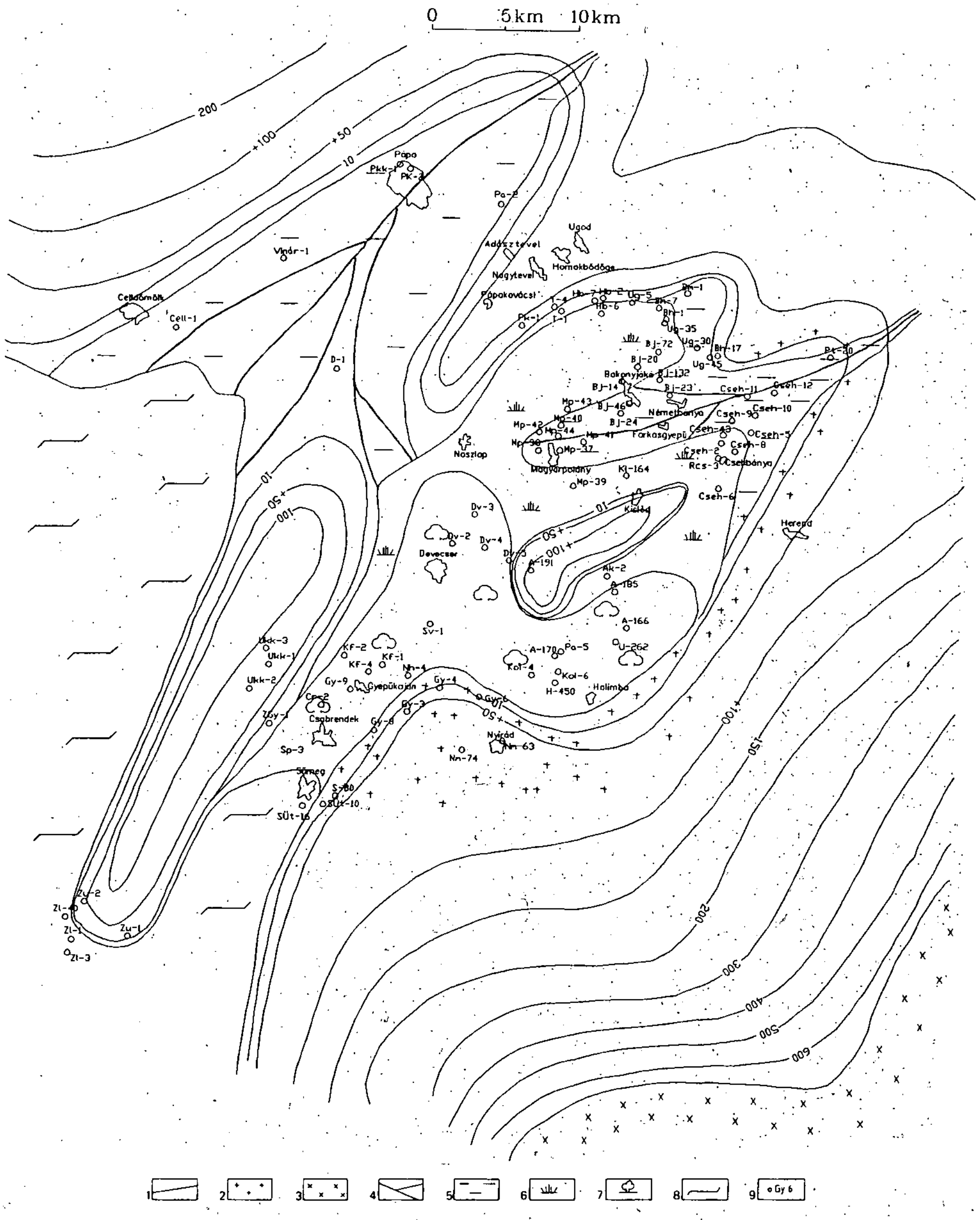


Fig. 8. Paleogeographical situation at the final period of coal formation (boundary of palynological zones C and D - Companian)

1. Height a.s.l. of the continental areas, *2.* bauxite deposition areas, *3.* laterite plateau inferred, *4.* river bed, *5.* flood plain, *6.* limnobrackish swamp, *7.* marine-brackish swamp, *8.* sea, *9.* important borehole

8. *ábra*. Ősföldrajzi helyzet a kőszénképződés záró szakaszában (a palynológiai C—D zónák határa — Kampaniai)

1. Szárazulati területek tengerszinthez viszonyított magassága, *2.* bauxitfelhalmozódási területek, *3.* feltételezett lateritplató, *4.* folyómeder, *5.* ártéri síkság, *6.* limnobrakk láp, *7.* marinbrakk láp, *8.* tenger, *9.* fontosabb mélyfúrás and an identical age with those of the profiles of the northern facies zone containing no fluvial beds, thus it can be regarded as the heteropic facies of the marginal sequence in the basin of the Transdanubian Central Range.

Finally, a few words about some technical questions of the compilation of the paleogeographical maps described in this paper. These maps have also been edited as part of a bauxite prediction map series of the Transdanubian Central Range. Considering that editing the maps in printed form is rather expensive and, as far as these maps are concerned, a smaller number of copies will meet the needs, therefore a new technique has been applied. The maps in manuscript form are digitalized using an AUTOCAD program, then each version is compiled using a computer. Finally, a copy printed out on a scale of 1:250 000 for each version is manually coloured, then copied using colour photo copying machine.

Hereby I express my due thanks to my colleagues working for the Remote Sensing Department of the Geological Survey for their assistance in my work. This method has some advantages which are as follows: the production cost is considerably lower (reduced to approx. one-tenth); "reprinting" at a later date is very simple; all contributions are easy to incorporate into the map; any kind of version is very quickly and easy to produce (for example the figures of this paper).

Last but not least I express my due thanks to companies which drilled a number of boreholes in the area concerned during the exploration of mineral resources — first of all, to Bauxitkutató Vállalat (Company for Bauxite Exploration) as referred to at that time, for allowing me to study the samples, and to my colleagues, particularly, technician Cs. JERABEK, for this collaboration in data acquisition, field work and map plotting, and to J. KNAUER for the extensive reading.

REFERENCES — IRODALOM

BENKŐ-CZABALAY, L. (1961): A Déli-Bakony tengeri szenon képződményeinek malakológiai vizsgálata (Malacological investigation of the marine Senonian formation of the South-Bakony Mts)—Földt. Közl. 91, 421—425.

CSÁSZÁR, G.—GÓCZÁN, F. (1988): Bakonyi felső-kréta kőszénkutatás és kőszénláp vizsgálat. — MÁFI Évi Jel. 1986-ról: 155—178.

GELLAI, M.—LUDAS, F. (1983): Adatok az Ugodi Mészkő Formáció és a Jákói Márga Formáció bázisrétegeinek megismeréséhez (Data on the base strata of the Ugod Limestone Formation and of the Jákó Marl Formation).—Földt. Közl. 113/2 147—162.

GÓCZÁN, F. (1964): A Bakonyi szenon palynológiai standardja (Palynological standard of the Senonian in the Bakony)—MÁFI Évi. Jel. 1961-ről: 253—261.

GÓCZÁN, F. (1973): Comparative palynology and the paleoclimate of bauxite formation.—Őslénytani Viták, 21, 51—53.

GÓCZÁN, F.—SIEGEL FARKAS, Á.—MÓRA-CZABALAY, L.—RIMANÓCZY, L.—VICZIÁN, I.—RÁKOSI, L.—CSALAGOVITS, L.—PARTÉNYI, Z. 1987: Ajka Coal Formation: biostratigraphy and geohistory—Acta Geol. Hung. 29. (3—4), 221—231.

HAAS, J. (1979): Tengeri szenon képződmények a Bakonyban. (Marine Senonian formations in the Bakony)—Theses for C. Sc. Manuscript.

HAAS, J.—E. JOCHA-EDELÉNYI (1978): A Dunántúli-középhegység bauxitföldtani térképe. Felső-kréta bauxitszint (Bauxite-geolgical map of the Transdanubian Central Range. Upper Cretaceous bauxite horizon). Budapest, 1:200 000.

HAAS, J.—E. JOCHA-EDELÉNYI (1979): A dunántúli-középhegységi felső-kréta üledékciklus ősföldrajzi elemzése (Paleogeographical analysis of the Transdanubian Central Range).—MÁFI Évi Jel. 1977-ről: 217—224.

HAAS, J.—E. JOCHA-EDELÉNYi—GIDAI, L.—KAISER, M.—ORAVECZ, L. (1984): Sümeg és környékének földtani felépítése.—Geol. Hung. Ser. Geol. Tom 2O. Budapest.

HAAS, J.—E. JOCHA-EDELÉNYI—CSÁSZÁR, G.—PARTÉNYI, Z. (1987): A bakonyi szenon kőszénösszlet képződési körülményei (Formation conditions of the Senonian coal sequence of the Bakony).—MÁFI Évi Jel. 1984-ről: 343—352.

JOCHA-EDELÉNYI E. (1981): A halimbai bauxit számítógépes vizsgálatának eredményei. (The bauxite deposits of Halimba in the light of a computerized data processing).—MÁFI Évi Jel. 1979-ről: 561—582.

JOCHA-EDELÉNYI E. (1987): A Keszthelyi hegység ÉNy-i előterében végzett bauxit előkutatás földtani eredményei—MÁFI Évi Jel. 1985-ről.

JOCHA-EDELÉNYI E. (1988): History of evolution of the Upper Cretaceous Basin in the Bakony Mts at the time of formation of the terrestrial Csehbánya Formation.—Acta Geol. Hung. vol 31/1—2. 19—31.

JOCHA-EDELÉNYI E. (1991): Paleogeographical reconstruction of the Upper Cretaceous bauxitic level in Hungary.—Abstr. EUG. VI. 163. Strasbourg.

JUHÁSZ, E. (1989): Sedimentological features of the Halimba karstic bauxite — Acta Geol. 31. (1—2) 111—136.

JUHÁSZ, M. (198O): A Bakonyjákói-medence szenon képződményeinek palynológiai vizsgálata. (Palynological investigation of Senonian formations of the Bakonyjákó Basin)—Manuscr. JATE, AD.

KÁZMÉR, M.—KOVÁCS, S. (1985): Permian—Paleogene paleogeography along the eastern part of the Insubric—Periadriatic lineament system: Evidence for continental escape of the Bakony-Drauzug unit. — Acta Geol. Hung. 28. (1—2), 71—84.

MINDSZENTY, A. (1983): Az iharkúti bauxit litológiai jellegei, üledékföldtana és felhalmozódási körülményei (Lithology, gedimontology and conditions of accumulation of the Iharkút bauxite).—Theses for C. Sc. Manuscript.

NEUMANN, H. H. (1989): Die Oberkreide des Krappfeldes. — in: Arbeitstagung der Geologischen Bundesanstalt, 1989. Blatt 186 St. Veit an der Glan. 7O-79. Wien.

SIEGL-FARKAS, Á. (1988): Az Ajkai Kőszén Formáció palynosztratigráfiája és fejlődéstörténete. —MÁFI Évi Jel. 1986-ról: 179—191.

SIDÓ, M. (1980): Magyarországi tengeri szenon formációk szintezése plankton Foraminiferákkal (Stratigraphic horizons of marine Senonian formations of Hungary based on planktonic Foraminifers).—Theses for C. Sc. Manuscript.

ŐSFÖLDRAJZI TÉRKÉPEK SZERKESZTÉSI MÓDSZERE A DUNÁNTÚLI-KÖZÉPHEGYSÉGI SZENON SOROZAT KEZDETÉNEK PÉLDÁJÁN

JOCHÁNÉ EDELÉNYI E.

Magyar Állami Földtani Intézet
Budapest, Stefánia út 14.
H-1443

ETO: 551.8 (439.11)
551.763.3 (439.11)
912.55 (439.11)

Tárgyszavak: Dunántúli-középhegység, szenon, ősföldrajzi rekonstrukció, bauxitképződés, kőszénképződés, horizontális elmozdulás, paleokarszt, digitális térképszerkesztés

A Dunántúli-középhegységi szenon képződményekről korábban készült ősföldrajzi rekonstrukcióknál (HAAS—JOCHÁNÉ 1978, 1979, HAAS et al 1987. JOCHA EDELÉNYI 1988) részletesebb és pontosabb elemzés elkészítését az időközben felgyülemlett nagymennyiségű adat lehetővé, a megalapozottabb földtani modellek és prognózisok iránti igény pedig szükségessé tette.

A Dunántúli-középhegységi szenon képződmények lerakódása az ausztriai-pregozaui fázishoz kapcsolódó, jelentős kiemelkedést, lepusztulást, regionális karsztosodást eredményező — a szekvencia sztratigráfia értelmezésében elsőrendű — diszkordancia felületen indult meg. (JOCHA-EDELÉNYI, 1988). Mint a korábbi publikációk alapján már ismert, a szenon képződmények hét markánsan elkülönülő, a terület fejlődéstörténeti szakaszait jól reprezentáló egységbe sorolhatók be. Az egységek meghatározott kombinációkban fordulnak elő, melyek ÉK—DNy-i irányú, 8—10 km széles sávokban fejlődtek ki. E kombinációk egyike a reef-fáciesű Ugodi Mészkőből és a fedőjében települő pelagikus Polányi Márga kőzeteiből áll, a lerakódás kezdetén kiemelt helyzetű képződési környezetre utalva. A másik kombinációban — jelezve a mélyebb térszini képződési környezetet — a preszenon felszínen a fluvio-lakusztrikus Csehbányai Formáció és/vagy a kőszéntartalmú Ajkai Kőszén Formáció kőzetei települnek. Fedőjükben a neritikus Jákói Márga, majd a Polányi Márga fejlődött ki. Az egykor kiemelt, illetve mélyebben fekvő területeket összekötő lejtőkön és környezetükben — a kifejlődési terület D-i részén — bauxitot ismerünk a rétegsor bázisáról (GELLAI—LUDAS 1983, JUHÁSZ 1989).

Az elsősorban lényeges — korai — szenon időszak paleogeográfiai fejlődéstörténetét három Ősföldrajzi térkép mutatja be.

Elkészítésükhöz tektonikai, paleomorfológiai és fácies analízis elvégzésére volt szükség (Jocháné 1991). A tektonikai analízis célja a vizsgált képződmények helyükre történő visszarendezése. A képződést követő elmozdulások felderítéséhez az aljzat földtani térképe, az egyes egységek (esetünkben az Ajkai és a Csehbányai Formációk) elterjedési, vastagsági térképei adnak információt (1. 2. 3. ábra). E térképek alapján a szinklinórium szerkezeten belül három 5—10 km széles, ÉK—DNy-i irányú, egymástól 78—15 km távolságban lévő egykor mélyebb helyzetű sáv körvonalazódik. A térképeken azonos helyeken kirajzolódó — horizontális elmozdulásokkénté értelmezett — tektonikai vonalak lehetőséget adtak a tektonikailag visszarendezett paleogeológiai térkép elkészítésére (4. ábra).

A paleomorfológiai analízis célja az egykori üledékgyűjtő morfológiai képének megismerése. Az üledékek tér- és időbeli kapcsolatainak tisztázására elsősorban a paleontológiai vizsgálatok eredményei alapján nyílik lehetőség (GÓCZÁN 1964, 1973, GÓCZÁN et al. 1986, CSÁSZÁR—GÓCZÁN 1988, BENKÓNÉ-CZABALAY 1961, SIDÓ 1980, JUHÁSZ 1980, SIEGLNÉ 1988). A vizsgálatok szerint az üledékképződés a szantoni emeletben indult meg.

Ugyancsak igen fontos paleontológiai adat, hogy az első már tisztán tengeri képződmény — a Jákói Márga — bázisa isochron felületnek tekinthető („D" palynológiai zóna alsó része), vagyis az alatta települő képződmények vastagsága „leképezi" az üledékképződés kezdeti szakaszának morfológiai képét.

Az Ajkai és a Csehbányai Formáció együttes eredeti képződési helyére visszarendezett vastagsági képe (5. ábra) lényeges információkat szolgáltat a paleomorfológia rekonstruálásához. Az Ajkai Formáció fossziliáiban a tengeri alakok DNy felé növekvő súlya Ny—DNy-i irányból érkező transzgressziós hatást jelöl. Fontos hogy a Csehbányai Formáció legnagyobb vastagságát legészakibb kifejlődési sávjában éri el, s itt fedőjében közvetlenül tengeri rétegek települnek.

A paleomorfológiai analízis alapján a szenon üledékképződés kezdetén egy ÉK—DNy-i kiemelt hátakkal tagolt, ÉNy—Ny-i irányba lejtő medence képe rajzolódik ki.

Az üledékképződés menetének rekonstruálásához fáciesanalízist kell végeznünk. Az Ajkai és a Csehbányai Formációk kapcsolata a kifejlődési terület csaknem egészén egy szabályos transzgressziós ciklusnak megfelelő, csupán a középső kifejlődési zóna középső részén — Magyarpolány környékén — fordított, vagyis itt a lápi környezetet képviselő egység fölött települ a fluviális sorozat (2. ábra rétegoszlopai). Az üledékképződés menetére a legfontosabb információkat a Csehbányai Formáció fácieseinek elemzése nyújtja. A meder, ártéri síkság, mélyártér, mocsár és alluviális törmelékkúp fáciesek az egyes részterületeken jellegzetes fácieskombinációkat alkotnak (3. ábra rétegoszlopai).

Az elvégzett paleogeológiai, paleomorfológiai és fáciesanalízis alapján elkészíthetők az üledékgyűjtő ősföldrajzi térképei.

Az üledékképződés a felső-szantoniban kezdődött meg a három lesüllyedt, egymástól elválasztott sávban (6. ábra), az ÉK-i részen szárazulati, a DNy-i részen tengeri szedimentációval (HAAS et al 1984). A szárazulati üledékképződési területek közül D-en — az ekkor még elszigetelt Ajkai medencében-, és a középső sávban uralkodóan édesvízi lápi környezet uralkodott, az É-i sávban fluviális üledékképződés folyt. Az üledékgyűjtő peremén a délkeleten kiemelt és feltehetően lateritesedett háttérterületekről a karsztos térszínre szállítódott bauxitos üledékek felhalmozódása és bauxitosodása ment végbe (MINDSZENTY 1983, JUHÁSZ 1989).

A felső-szantoni végén — alsó-kampaniai elején (Góczán F. beosztása szerint „B" palynológiai zóna) a fluvio-lakusztrikus üledékképződés és a limnobrakk lápi környezet vált uralkodóvá (7. ábra). A déli üledékgyűjtő sávban a lápi környezet lényegesen nagyobb területen jelent meg (Ajka), s a sáv keleti része (Csehbánya) is üledékgyűjtővé vált, s az itt kialakult fluviális környezet kapcsolatba került a középső sávval (Magyarpolány).

Az alsó-kampaniaiban („C" és „D" palynológiai zóna határa) a lápi környezet kiteljesedése volt jellemző (8. ábra), s a marinbrakk lápi környezet erősen tért hódított.

Az üledékgyűjtő további fejlődéstörténete — a bekövetkező jelentős mértékű relatív tengerszintemelkedés következtében — már az újabb, kizárólag tengeri üledékképződési szakaszhoz tartozik (HAAS—JOCHÁNÉ 1979, HAAS 1979).

A paleogeográfiai rekonstrukció alapján a terület a szenon üledékgyűjtő DK-i peremi részét képezte. A szenon képződmények mai elterjedési területének északnyugati határa a nagyszerkezeti jelentőségű Rába-vonal, amely mentén többszáz km-es elmozdulást valószínűsítenek (KÁZMÉR—KOVÁCS 1985). Ez azt jelenti, hogy a dunántúli-középhegységi medenceperemi képződmények heteropikus fácieseit Graz környékén kell keresnünk, és — részben saját terepi tapasztalat alapján — véleményem szerint a karinthiai St. Kl. Paul környékén ismert „Krappfeldi Gosau" szenon rétegsorában meg is találjuk azokat. (NEUMANN H. H. 1989).

Végezetül ismertetni szeretném az 1:250 000-es méretarányú térképsorozat közreadásának technikai megoldását. Tekintettel arra, hogy a nyomdai megoldás igen költséges lett volna, a kéziratban elkészült — 1:100 000-es méretarányú térképeket AUTOCAD programmal digitalizáltuk és szerkesztettük, s egy-egy kinyomtatott példány kézi színezése után színes xerox eljárással sokszorosítottuk. A módszer előnyei e cikk készítése során is jelentkeztek, mivel a térképek — méretarányából következő — egyszerűsítése és kicsinyítése könnyen megoldható volt. A munkában a MÁFI Távérzékelési Osztályának munkatársai voltak segítségemre, amiért köszönetemet fejezem ki. Legvégül, de nem utolsó sorban köszönetemet fejezem ki a területen a nyersanyag kutatások során számos fúrást lemélyítő vállalatoknak, elsősorban — az akkori nevén — Bauxitkutató Vállalatnak, hogy lehetővé tették számomra a mintaanyagok feldolgozását és vizsgálatát; valamint a munka során az adatgyűjtésben, a terepi és szerkesztési munkákban közreműködő kollégáknak, különösen JERABEK CSABA technikusnak, valamint KNAUER JÓSZEFNEK a térképek igen alapos lektorálásáért.

NEW K/Ar DATA FOR HYDROTHERMAL ACTIVITY IN THE NEOGENE VOLCANIC REGION OF NAGYBÖRZSÖNY, NE HUNGARY

by

ZOLTÁN PÉCSKAY*—BÉLA NAGY**

*Institute of Nuclear Research of the Hungarian Academy of Sciences
Debrecen, Bem tér 18/c.
H-4026
**Hungarian Geological Survey
Budapest, Stefánia út 14.
H-1143

UDC: 553.2 (439.131.5)

Keywords: K/Ar dating, hidromuscovite, mineralization, Upper Badenian, Rózsa adit (Nagybörzsöny)

The problem of establishing the age of ore mineralization of Rózsa adit has always concerned geologists. Concerning the mineralization the most detailed work was made by PANTÓ, GY. and MIKÓ, L. (1964) pointing out that hydromuscovite is in close connection with ore mineralization. Well documented mineralogical and geochemical description of hydromuscovite collected from Nagybörzsöny was given by ERDÉLYI, J. et al. (1958). In hydrothermal mineralization hydromuscovite is of substantial interest with respect to the genesis of ores. As a K-bearing mineral it may serves as a possible isotopic geochronometer for K/Ar dating.

The investigated samples was collected from the Rózsa adit. According to the K/Ar age (14.6 ± 0.5 Ma) it can be stated that the most likely age of ore mineralization is Late Badenian.

Experimental methods

Measurement of K/Ar ages was performed in the Institute of Nuclear Research of the Hungarian Academy of Sciences (ATOMKI), Debrecen Hungary. The samples was pulverized for K determination.

An argon extraction line and a mass spectrometer, both designed and built in ATOMKI, were used for the Ar measurement. The rock was degassed by high frequency induction heating, the usual getter materials (titanium sponge, Cu0. SAES getter of 707 type and cold traps) were used for cleaning Ar. The ^{38}Ar spike had been introduced in to the system from a gas-pipette before degassing was started. The cleaned Ar was directly introduced into the mass spectrometer which was a magnetic sector type of 150 mm radius and 90° deflection it was operated in static regime. Recording and evaluation of Ar spectrum was controlled by a microcomputer.

0.1 g of the pulverized samples was digested in HF with the addition of some sulphuric and perchloric acids. The digested samples was dissolved in 100 ml 0.25 n HCL and after a fivefold dilution 100 ppm Na and 100 ppm Li were added as buffer and internal standard. K concentration was measured with a digitalized flame photometer of 0E/85 type manufactured in Hungary. The age calculation is based on the constants recommended by STEIGER, R.H. and JÄGER, E. (1977). The experimental error was given at 1 σ level.

The interlaboratory standards Asia 1/65, HD-B1, LP-6 and GL-0 and atmospheric Ar were used for controlling the measurements. Details of the instruments, the applied methods and results of calibration have been described elsewhere (BALOGH, KAD. 1985; ODIN, 1982).

Results and discussion

The first K/Ar results of the Miocene volcanic rocks of Börzsöny Mts were published by BALLA, Z. et al. (1981). This work demonstrated the absence of Palaeogene volcanic rocks from the Börzsöny Mts but analytical and geological errors prevented the reliable determination of the duration of volcanic activity. Additional investigations on unaltered whole rock samples and separated biotite and amphibole by PANTÓ, GY. et al. (1985) showed the production of volcanic material to be ended about 15Ma B.P. (in HÁMOR, G. et al., 1987). The reality of this age is supported by the good agreement of biotite and whole rock ages and the small scatter of results. On amphiboles, when they came from subvolcanic rocks, ages were little older (about 18 Ma). The age increase is attributed to incomplete degassing.

Our aim was to demonstrate that hydromuscovite is suitable for K/Ar dating and to verify that the apparent age dated upon it can be regarded as reliable.

No. of K/Ar lab	Locality	K (%)	$^{40}Ar_{rad}$ (%)	$^{40}Ar_{rad}$ (ccSTP/g)	K/Ar age (Ma)
2311.	Rózsa adit	3.09	33.2	$1.766.10^{-6}$	14.50±0.7
	259m.	3.14	39.6	$1.776.10^{-6}$	14.60±0.7

According to the K/Ar age obtained using hydromuscovite (14.6±0.5 Ma) it can be established that there is not significant age difference between the volcanic activity and the hydrothermal activity. From a group of informative papers on white micas it is well known that they show good retention properties for radiogenic argon, as they are stable over a wide range of temperature-pressure conditions. For well-crystallized samples the closure temperature for argon is significantly higher than that biotite, probably about 350 °C for moderate cooling rates (PURDY and JÄGER 1976). HUNZIKER et al. (1986) derived a closure temperature of 260±30°C for 2μm illite. On the other hand incorporation of extraneous argon in white micas does not normally seem to be a problem.

Finally it is necessary to emphasize that the new K/Ar age should be studied in the future by means of more datings on hydromuscovite as it makes topical the problem of the continuation of the hydrothermal mineralization during the Late Badenian, as well.

REFERENCES — IRODALOM

BALLA, Z.—CSONGRÁDI, J.—HAVAS, L.—KORPÁS, L. 1981: Age of the Börzsöny volcanics and accuracy of the K/Ar dating (In Hungarian) — Földt. Közl. 111.:307—324.

BALOGH, KAD. 1985: K/Ar dating of Neogene volcanic activity in Hungary: Experimental technique, experiences and methods of chronologic studies. — ATOMKI Rep. D/1.:277.

ERDÉLYI, J.—KOBLENCZ, V.—TOLNAY, V. 1985: Hydroparagonite, a new mica mineral, and its relations to hydromuscovite, natronillite and brammallite. — Acta Geologica Tom. V.p. 170—186.

HÁMOR, G.—RAVASZ-BARANYAI, L.—HALMAI, J.—BALOGH, K.—ÁRVA-SÓS, E. 1987: Dating of Miocene acid and intermediate volcanic activity in Hungary. — Proc. 8th RCMNS Congr., Annales Hung. Geol. Inst. 70.:149—154.

HUNZIKER, J. C.—FREY, M.—CLAUFER, N.—DALLMEYER, R. D.—FRIEDRICHSEN, H.—FLEHMING, W.—HOCHSTRASSER, K.—ROGGWILER, P.—SCHWANDER, H. 1986: The evolution of illite to muscovite: Mineralogical and isotopic data from the Glarus Alps, Switzerland. Contrib. Mineral. Petrol. 92.:157—180.

ODIN, G. S. et al. 1982: Interlaboratory standards for dating purposes. In: ODIN, G. S. (ed.): Numerical Dating in Stratigraphy. P. 123. Wiley and Sons, Chichester, New York, Brisbane.

PANTÓ, G.—MIKÓ, L. 1964: The Nagybörzsöny ore mineralization. — Annales Hung. Geol. Inst. 50.:1—154.

PANTÓ, GY.—PÉCSKAY, Z.—BALOGH, KAD. 1985: Unpublished results.

PURDY, J. W.—JÄGER, E. 1977: K-Ar ages on rock-forming minerals from the Central Alps. Mem.I.st. Geol. Min. Univ. Padova 30.:31.

STEIGER, R. H.—JÄGER, E. 1977: Subcommission on Geochronology: Convention on the use of decay constants in geo- and cosmochronology. — Earth Planet. Sci. Let. 36.:356—362.

K/Ar KORADAT A NAGYBÖRZSÖNYI ÉRCESEDÉS KORÁHOZ

PÉCSKAY ZOLTÁN.*—NAGY BÉLA.**

*MTA Atommag Kutató Intézet
Debrecen, Bem tér 18/c.
H-4026
**Magyar Állami Földtani Intézet
Budapest, Stefánia út 14.
H-1143

ETO: 553.2 (439.131.5)

Tárgyszavak: K/Ar kormeghatározás, hidromuszkovit, ércesedés, felső-bádeni, Rózsa-bánya (Nagybörzsöny)

A Nagybörzsönyi Rózsa-bánya ércesedése már a középkor óta ismeretes. Eddigi legrészletesebb ércföldtani leírása PANTÓ G. és MIKÓ L. (1964) nevéhez fűződik, akik megállapították, hogy az ércesedést a vizsgált területen hidromuszkovit kíséri. A hidromuszkovit ásványtani- kristálykémiai vizsgálatát ERDÉLYI J. et al. (1958) végezték.

Ez az ismeret arra ösztönözte a szerzőket, hogy az ércesedés korát a rendelkezésre álló hidromuszkoviton, a K/Ar radiometrikus kormeghatározási módszer alkalmazásával állapítsák meg. A 2311. sz. minta az Alsó Rózsa-táró 259 m-ből származik, és vizsgálatának eredménye, hogy az ércesedés kora 14.6±0.5 millió év, amely két mérés átlagaként adódott.

A méréseket a debreceni ATOMKI K/Ar laboratóriumában végezték 1991-ben.

"QUAL" — COHESION — REPLICATION

by

CSABA DETRE

Hungarian Geological Survey
Budapest, Stefánia út 14.
H-1143

UDC: 111.1:113:116

Keywords: cohesion–multiplication ("Qual"), ontogeny, phylogeny, replication, divergency

The study deduces the replication process strikingly characterizing the living world as the highest rank manifestation of the analogous properties of the realistic existing materialistic world.

A mystic problem of the evolution the emergence of the first stuctures capable for replication, i.e. the birth of the self-reproducing molecules. The majority of the experts dealing with evolution agree that this is the very property that distinguishes the living creatures from the inorganic ones, i.e. it is the safest "differentia specifica" of life.

In the following by getting rid of the rigid, or even inexact categories of literature, and by their hylosoistic explanation and possibly in a provocative manner declare "replication" by biology as it is really a conceptual eidos that may not be subordinated to conceptual genera, i.e. to express it in an onthological way, can the "replication" be restricted within the frameworks of the Bios. For the concept of the replication we accept the definition given by V. CSÁNYI and GY. KAMPIS (1984): "Replication is a process where a constructor has the necessary information concerning the goods to be produced in any form, creates a product the structure (organization) of which is the same as that of the constructor." Related to the emergence of self-reproducing structures, i.e. to the autogenesis, the aitological doubt immediately rises: what reasons led to the formation of these properties and what functions these properties had.

Each landmark in the evolutional history, the progressive phases are the result of force, determining the only direction, upwards. (DETRE, 1979, 1982, 1982, 1985, 1985a, 1985b, 1986). Now this progression forces will be used from the aspects of "replication". Further doubts concerning the exclusively biotic interpretation of replication:

— Why is it on a higher level as compared to the properties of the prebiotic levels

— At what scale this phenomenon is of higher rank
— Where the boundary lines of CSÁNYI's above cited and accepted conceptual definition can be deawn.

One thing is, however, obvious: no evolutional level marking attribute or, simply, nothing may exist that has no historical roots, although maybe precedence is something else but genetically it is consistent, and that is why it is qualitatively analogeous, too. The biotic replication, here, may not be an exception either. In the followings we shall also discuss that what phenomena could be the antecedents of the biotic replication and what causal led to its emergence. The biotic replication is considered to be the highest rank, most characteristic appearance as inherent attribute of the real world.

The attribute of any materialistic system is the cohesion and resistance in a quite general sense, that is a consistent attribute securing its existence.

This may be the property called "Qual" by JAKOB BÖHME. It is still to be considered if the category of "struggle for life" should be extended to the whole Material, as inherent attribute. And it is not mysthicism. The things considered mysthic are those very hidden properties that can be found in the Material as universe, or at least at its several organizational levels. A large part of the myths, sooner or later can be explained in some realistic and materialistic manner. Therefore the view is too narrow-minded that think the analogons of the features characteristic of certain organizational levels seem to seem to appear on other levels, mysthicism. By the way, the results of such views, in a negative sense are the "Social Darwinism", "biologism", "Hylosoism", etc.

The self-maintanence, the cohesion in a general sense is manifested against the different destructive impacts in a manner that the "attacked" system is scattered into succeeding systems. This system of succession offers the possibility for the different successor systems to get into different conditions from the environments of destructive impacts. This transplantation into a new environment may lead to the development of new systems of interaction and the successor may gain the possibility for the alteration from the predecessors.

Scattering of future generations is not only a characteristic feature of the living structures. This replicative phenomenon in the inorganic world is most characteristic in the field of crystal growth (HAECKEL, 1917). A greatly similar phenomenon to the bilogical replication can be found in case of the montmorillonite clay minerals (WEISS 1977, 1981; SZATHMÁRY 1981).

Similar processes can be observed in the world of crystals (Rundkviszt 1965) and they may be with great probability, observed in motions of planetary, astral and galactic types (HAMBARCUMJAN, 1980).

All these processes were excellently described by HAECKEL (1917) treating the problems also from biological points of view. It can be concluded, anyhow, that the higher organizational order a system has, the more able it is for replication, that is for producing successive generations.

The replication mechanism of the Bios is a revolutionary new manifestation of the self-preservation of the material in a more efficient way.

The lower-rank system breaks up for successors and the generations are getting farther and farther from each other. The replication capability of these successors, by applying CSÁNYI's scale (1979) with degrees ranging between 0—1 values, is rather small. In case of higher rank systems, like e.g. the Bios, the self-maintenance and the cohesion in a general sense are of such a high level that the successive generations are nearly self-reproducing, that is there is an autogenesis. The system capable for higher rank replication can be, however, broken down to non-replicative sections. The higher rank has the system the more destructive external intervention is required for eliminating the qualitative integration of the given system. An exploded supernova or a weathered rock are not able for real replication during their genesis because of their inherent, rather primitive structure. The genesis of a higher rank living creature may be realized in several ways. The genesis of the highest rank biological organisms is manifested in the specific biological genesis and the advanced level of replicative autogenesis.

The determination that how a replication of a given level should be evaluated on a scale 0—1 is extremely complicated because of the infinitive line of different organizational levels capable of replication of different "faithfulness". Here we risk the statement that the index criteria of the basic organizational levels are characterized by their highest-rank genesis, i.e. the most perfect form of replication, the method of the production of the successor. For this reason the belief that the autogenesis is a feature only of the living world, is common in the public opinion, although, in reality, the genesis of different replication faithfulness, borrowing the term from physics, is a scale-independent concept.

An important definitive of the evolution is the continuous improvement of the replication keeping also the dialectic aspect in mind that by this ever widening fields are opened for the succeding generations for an increasing qualitative divergence.

Practically, in this dualism a most general manifestation of HEGEL's "Aufheben" is present (DETRE 1986).

Within the living world the mechanisms of the reproduction like the gene structures and the formation of the sexes refers to the reinforcement of the above dialectic duality. The acceleration of the evolution is just the result of the dual mechanism of the replication-divergence in the course of the process of phylogeny.

Autogeny is the result of self-reconstruction trends as a reaction for the environmental provocations. This self-reconstruction is, however, never perfect, i.e. a disturbed system will be never perfectly rehabilitated. By abstract philosophical modelling the self-preservation is a cyclic phenomenon. It is, as an inherent attribute of each existing being is the result of trying to achieve balance, i.e. it is due to the force of ciclicity.

The more perfect is the cycle the more efficient is the self-preservation and cohesion and the system is not forced for the realization of self-reconstruction, that is for the autogenesis. The cycle is strained or broken only due to external influences. Toward the higher ranks the falling into generation cycles is more frequent. The successive partial cycles do not let the closing down the greater cycle they are part of. In a contrary manner, they rather straighten it. Charasteristic feature of the motion patterns of organizational levels of lower ranks is the monocyclicity that provides a high-scale, undisturbed self-maintenance and cohesion for the system. The existence of a lower-rank system is only one cycle, or the series of greatly analogous cycles following each other almost in a successive genetic manner. Here the "ontogeny" can be hardly distinguished from phylogeny. Of course, the infinitely immanent complicated features of the systems are present also here. Any system includes an infinite number of hierarchically organized horizons of different cycle dynamisms.

The cyclicity, the self-preserving cohesion is present at any organizational level but the higher rank the system is, the better it is characterized by the progressive irreversibility and not by the "treadmill" of the primitive material. The motion of the ideally infinitely low-rank system is the prefect cycle while that of the ideally highest rank ones is the complete irreversibility or, symbolically, the linearity.

Progression of the cycles, their opening is realized in a manner that from the original cycle, before its closing down, new cycles emerge. The successive cycles coming from each other the ontogeny of the different generations are not closing cycles, i.e. they are irreversible processes. Acccordingly, the closure of the cycles is made impossible by the ever newly appearing successive cycles. This process is proved by the phenomenon that the chronological overlapping of the existence of the generations towards the higher ranks is increasing. For these reasons the higher-rank structures are more structures increase the dynamism of evolution as self-generating process (DETRE, 1982a, 1982b, 1985b, 1986). At higher organizational levels historicism became more expressed including the variety of irreversible successive episodes. When investigating the phylogeny of materials (DETRE, 1985a, 1985b, 1986) the most primitive nucleuses and electrons are considered history-free by certain physicists (V. F. WEISSKOPF, 1976).

The replication process was initiated by the need for immanent cohesion within afight against external forces for existence and survival of the broken process. Successors of the broken-up cycle, by their re-deformation, i.e. reversibility are greatly similar to the source-cycle, i.e. their replicative features are obviously present. The replication can be considered as the result of a disturbed cohesion, that of the disequilibrum, reequilibrium, i.e. an attempt for the reconstruction of the native state, the constant pains of the "Qual", the Material for the survival.

By fracturing into replicative generations the higher rank system strives for stabilization also within the inseparable higher rank system while in the lower rank stable structure, in the monolithic system undivided both in space and time the higher ranking, dynamic, and just for these reasons, the qualitatively differentiated environment is not required. Such a system is "broken" upon the impulses of the dynamic environment with only a minimum level of replication. We should always keep in mind that the basic criteria of the higher ranking classification are the large-scale variety in time and space and the flexible reaction against external impacts. The guarantee for this flexibility is just the distribution for identical generations but a specific flexibility is always required for making possible the differentiation of the generations. The rapidly emerging evolutional situations provoke the conditions when the system, divided into generations, has successive generational stages where the degree of replication suddenly turns towards the 0 (zero) direction. By quoting of some of the ideas of Lampedusa the system is able to survive only if it changes. Another factor reinforcingthis conclusion is the evolutionary flexibility, i.e. the ability for changing. The "Qual", the self-maintenance and cohesion force provokes these changes.

Practically, in our opinion, this is the general dynamic essence of evolution.

Concerning this statement the problems of organization and invariance arise. The evolution is an obviously organizational change of levels (MATURANA, H. R., 1981, MATURANA, H. R. and VARELA, F. J. 1980). The certain consequent series of the changes of generations, the chlados (Cs. DETRE, 1986) is an evolutionary (time limited) intergrated system. Here it should be emphasized that the time is considered the same category as the development, i.e. evolution. Concerning this question, however, we do not wish to go into details within the present paper (It is discussed in details by Cs. DETRE 1976, 1986). The basic reasons for the coincidenc of these categories, however, are that no events may happen that are not the integral parts of the general trends of development, and also no development may take place without the time factor. An evolutional chlados is a genetical sequence that, just because it can be evaluated as a homogenous process on bases of certain criteria, can be also considered as an invariant system. Any chlados should bear a certain invariant qualitative sequence and only the genetical series can be treated as a homogenous chlados where the presence of such a sequence can be proved.

It may be also possible that the chlados may dominate any number of and greatly differring organizational levels may appear as a significantly more subjective process than the reconstruction of the different chladoi. The forced division into replicative generations creates such a time-space structure that is able be avoid flexibly the destructive, obstacling impacts thus increasing the inhomogeneity of the system and its structural complications.

The generations thus emerged form and irreversible chain of processes at an inverse ratio to the reliability of replication. These irreversible, and to a small extent replicative processes are called, altogether, phylogenetic processes. Accordingly, the phylogeny is the nonreplicative component of the evolution, while the ontogeny is the replicative process. To put it in a more general way, the phylogeny represents the totality of the irreversible phenomeny while the onthogeny is the collective phrase for the reversible processes.

These two processes markedly and spectacularly are separated only at a higher level, that is on the organizational level of the Bios. For instance, in case of the rocks, only a general genesis can be observed though in the most dynamically developing classes, i.e. the sedimentary rocks, phenomena may be suspected that are considered by RUNDKVISZT straightly as ontogenetic sequences of replicative type. It should be also remarked that just at higher levels, e.g. as a result of the more expressed genetic irreversibility present in the Bios is that classical relative geochronology is in harmony practically with the biochronological scale. The biological, dynamic irreversible time-scale could be used as a much finer instrument than the significantly more reversible lithostratigraphic scale (Cs. DETRE 1976). However, in a time scale of proper size the irreversibility of any seemeingly markedly reversible processes will appear. Here the several hundred million, or billion years, old lithogenetic sequences, or the emergence of stars expressed by the Hertzsprung-Russel diagram can be mentioned that practically is the model of the evolutionary tree.

Certain systems, typically on the highest rank basic organizational level i.e. on the biological and social ones, by their spreading into parts that are able for independent existence and "autoons" similar to the producer, and their division into generations can secure their survival in its parts. By this the system's inpulse adsorbing surface increases against the destructive impacts. The scattering and multiplication protecting against destruction, at the same time, increases the interaction interface of the system. Emergence of the increased and more manifold interaction system leads to a higher-rank organizational level. It, among others, also prove the fact that during the evolutionary process each step towards a higher level is forced by the "grinding mills" of the destruction (see DETRE, 1979, 1982a, 1982b, 1986).

This division, scattering influenced by cohesion, and also by the replicative force of the attribute of self.supporting may be called, in a general sense succession of generations. Visually, this breaking up into generations can be modelled by a system in dimensions of time with an articulated connection. The development of such systems becomes much more flexible as compared to the unarticulated ones, it can much easier go through the gaps of destructive obstacles, i.e. the ability for adaptation increases.

The higher rank levels of organization is examined, the ability for division into generations is the greater, that is why the higher rank units are, at the same time, more manifold. Accordingly, it is only logical that this breaking into generations becomes spectacular on the basic, biological organizational level and this is the measure for all the other, first of all lower rank organizational horizons. In case of a basic organizational level of higher rank than the biological one the division into generations becomes more complicated and manifold.

In the living world this "cutting across" the destructive obstacles is expressed in the adaptation ability from generation to generation, and in the selection. This ability for conformity, the adaptation flexibility lasts till the point, when the system existing in time (species, higher-rank taxa, any type of coenosis) meets an unavoidable destructive obstacle, i.e. gets into unbearable circumstances that leads to extinction. The last destructive threshold is that of the exterminating one.

The breaking into generation, the time-dependent process, at the same time, includes the possibility of selective change, i.e. the generations are differentiated among different conditions due to different interaction systems. It means that the division in time and space are inseparable features.

Of the general succession of systems in time ARISTOTLE (1959, p. 37) writes the following: "When... something" becomes "from something... then one of them will be destroyed... decay of the one is the emergence of the other." In fact the metamorphosis of the systems is always a finite process and does not take place in an infinitely short time interval. No perfect succession is possible in the real world (see DETRE 1976). In a process when the elements of a system are gradually transformed into the elements of another system, there is always a phase when the elements of the old and new system can be simultaneously found. When the rate of the new elements reaches a certain point then the whole system becomes a new quality. Recognizing the "new quality" bears the complete boundary problematics of philosophy.

Emergence of the new through the decay of the old system is more obvious in the lower rank, first of all, in the inorganic world. In the lower rank living world the multiplying by bipartition can be interpreted that the new specimens are born by the elimination of the parent. In the higher rank living world the birth of the new is related much less to the elimination of the parent specimen, and giving birth to the successor does not even endanger the life of the parent. The possibility of the coexistence and interaction of the parent and successor increase and this increasing interaction dynamism gives the impulse to the accelerating process of evolution.

The autogeny of biological level is fundamentally differentiated from the self-supporting suffering of small replicational fidelity, imperfect prebiotic levels, from their "Qual", that in their case such multiplying systems were developed where the successor is able to part with the producer, i.e. from the parent that the parent preserves its quality.

The "Aufheben" in the interrelationship of the progressive successive generations becomes increasingly dominant. The generations become increasingly similar but, at the same time, they are markedly different. The trend of the progressive evolution is the trend of the emergence of greater qualitative diversity that increasingly forms a homogeneous system. Autogeny, ontogeny are the coherence-side aspects of the inherent attribute of the material, the coherence-divergence duality of "Qual", while the philogeny is the criticism of the divergence aspect.

REFERENCES — IRODALOM

ARISZTOTELÉSZ 1959: Metafizika. — Tankönyvkiadó, Budapest.
CSÁNYI, V. 1979: Az evolúció általános elmélete. — Akadémiai Kiadó, Budapest.
CSÁNYI, V.—KAMPIS, GY. 1984: Autogenezis. Önszervező rendszerek evolúciója. Biológia, 32, 3—23.
DETRE, CS. 1976: Rétegtan és fejlődés. — Földtani Közlöny, 106, 30—41.
DETRE, CS. 1979: Az elidegenedés és alkalmazkodás dialektikája. — Biológia, 27, 185—187.
DETRE, CS. 1982a: On the dynamics of evolution. — In: V. J. A. NOVÁK, J. MILKOVSKY (eds.): Evolution and environment, 455—459, Praha, CSAV.
DETRE, CS. 1982b: Adaptáció — dezadaptáció — readaptáció. — Földt. Int. Évi Jel. 1980-ról: 566—568.
DETRE, CS. 1985: Morphological criteria of the uniqueness of progressive evolution. — In: J. MILOVSKY—V. J. A. NOVÁK (eds.): Evolution and Morphogenesis. Praha, Academia, 235—239.
DETRE, CS. 1985a: A monizmus: az egyetlen és genetikailag egységes világ felismerése. — Biológia, 33., 171—174.
DETRE, CS. 1985b: Az élővilág monisztikus evolúciós törzsfája. — Biológia 33., 175—182.
DETRE, CS. 1986: Az egység, sokaság, mindenség dinamikus egysége: a fejlődés. — Magyar Filozófiai Szemle, 1986/3—4., 463—464.
HAECKEL, E. (1917): Kristallseelen. — Alfred Körner Verl., Leipzig.
HAMBARCUMJÁN, V. A. 1980: Az Univerzum kutatásának filozófiai kérdései. — Gondolat, Budapest.
MATURANA, H. R. 1981: Autopoiesis. — In: ZELENY M. (ed.): Autopoieses North-Holland, New York, 21.
MATURANA, H. R. and VARELA F. J. 1980: Autopoieses and cognition. — Boston Studies in the Philosophy of Science. vol. 42. D. Riedel, Boston.
RUNDKVISZT, D. B. 1965: Od odnoj zahonomernosztyi geol. jablenyii. — Nyedra, Leningrád.
SZATHMÁRY, EÖ. 1984: Ez egyedi szerveződés gyökerei. — In: VIDA G. (szerk.) Evolúció Iv. Az evolúció frontvonalai. 37—157. Natura, Budapest.
WEISS, A. 1977: Replication, evolution and differentiation in clay minerals — a model of protolife. In: ROSENQUIST, I. TH. (ed.): Proceedings of the Third European Clay Conference, Oslo.
WEISS, A. 1981: Replikation und Evolution in anorganischen Systemen. — Angew. Chem., 93, 843—854.
WEISSKOPF, V. F. 1976: A tudomány határai és korlátai. — Fizikai szemle 1976/7..

„QUAL" — KOHÉZIÓ — REPLIKÁCIÓ

DETRE CSABA

Magyar Állami Földtani Intézet
Budapest, Stefánia út 14.
H—1143

ETO: 11.1:113:116

Tárgyszavak: kohézió — multiplikáció („Qual"), divergencia, onto-, phylogenezis — replikáció.

Az evolúciótannak rejtélyes problémája az első „replikációra" képes struktúrák, önreprodukáló molekulák létrejötte. Általános az a nézet, hogy éppen ez az a tulajdonság, amely az élőt az élettelentől elválasztja.

Bármely anyagi rendszer attribútuma az egészen általános értelemben vett kohézió és rezisztencia, azaz olyan alapvető konzisztenciális attribútum, amely létét biztosítja. Ez lehet az a tulajdonság, amelyet JAKOB BÖHME a „Qual"-lal azonosít. Az önfenntartó kohézió a különféle destruktív hatásokkal szemben úgy nyilvánul meg, hogy a „megtámadott" rendszer szétszóródik utódrendszerekre. Ez az utódokra történő szétszóródás ugyanis magában hordozza annak lehetőségét, hogy az egyes utódrendszerek más, különböző körülmények közé kerüljenek, s így védjék ki a destruktív hatásokat. Ez a más-körülmények-közé-kerülés viszont más kölcsönhatási rendszerek kialakulásának lehetőségét hordozza magában, s így az utódrendszer a szülőhöz képest mássá válhat.

Az utódokra történő szétesés nem csupán az élővilág sajátossága! Nagy általánosságban megállapítható, hogy mennél magasabb rendű valamely rendszer, annál inkább képes replikatív módon utódrendszerek létrehozására. A Biosź replikációs mechanizmusa az Anyag önmegtartási attribútumának egy forradalmian új, s tökéletesebb megnyilvánulása.

A kikényszerített replikatív nemzedékekre tagolódás olyan téridő struktúrát hoz létre, amely rugalmasan képes kikerülni a destruktív gátló hatásokat, ezzel fokozva a rendszer inhomogenitását, strukturális bonyolultságát. A kialakult generációk sorozata a replikáció hűségével fordított arányban irreverzibilis folyamatláncot alkotnak. Ezen irreverzibilis, kis mértékben replikatív folyamatok összességükben azok, amelyeket filogenetikus folyamatoknak nevezünk. Tehát a filogenezis az evolúció nonreplikatív komponense, míg az ontogenezis a replikatív folyamat. Még általánosabban: a filogenezis az irreverzibilis folyamatok összessége, míg az ontogenezis a reverzibilis folyamatoké.

E két folyamat látványosan és nyilvánvalóan csak a Biosz organizációs szintjén válik ketté. Például a kőzetek világában csak általában genezis létezik, bár annak legdinamikusabban fejlődő osztályaiban, az üledékes kőzetek között sejthetők olyan jelenségek, amelyeket RUNDKVISZT egyenesen replikatív jellegű ontogenetikus egymásutánoknak tekint.

Az önmegtartást biztosító generációk létrehozása, az időben zajló autopoiézis, azaz a generációk szukcessziója, a szülő rendszer időbeni kinövései, részei. A szukcesszív generációk rugalmas ellenhatást biztosítanak az egész rendszer, mint a generációk összessége számára a destruktív hatásokkal szemben. Az evolúció szempontjából jelentős destruktív hatások nem olyan gyorsak, amelyek egy-egy generációt veszélyeztetnek csupán, hanem generációk hosszú során érvényesülnek.

Az egyes rendszerek — a legeklatánsabban a legmagasabbrendű alapvető organizációs szinten, a biológiain és társadalmin — több önálló létre képes részre, s a produktorhoz hasonló „autoonra" történő szétszóródásukkal, generációkra tagolódásukkal tudják biztosítani azt, hogy a rendszer a részeiben továbbéljen. Ezzel megnő a rendszer impulzus-abszorbeáló felülete a destruktív hatásokkal szemben. A destrukcióval szembeni szétszóródás és multiplikáció ugyanakkor megnöveli a rendszer kölcsönhatási érintkezési felületét is. A megnövekedett és sokrétűbb kölcsönhatási rendszer kialakítása viszont a magasabb rendű organizációs szintre jutást is eredményezi. Ez is bizonyíték ahhoz, hogy az evolúció során minden magasabb szintre lépést a destruktív hatások „törő malmai" kényszerítenek ki.

Ezt a feldarabolódást, szétszóródást, amelyre viszont hat a kohézió, az önmegtartási attribútum replikációs kényszere is, nevezhetjük általános értelemben vett nemzedékváltásnak. A nemzedékekre történő feldarabolódást egy időben elnyúló, s szelvényezett, s a szelvények között rugalmas csuklókkal ellátott rendszerrel lehet modellezni. Az ilyen időben elhúzódó rendszerek menete, azaz fejlődése sokkal rugalmasabbá válik a szelvényezetlenekhez képest, könnyebben át tud bujkálni a destruktív gátak résein. Azaz, megnő az adaptációs készség.

A nemzedékekre tagolódás, az időbeni szelvényezettség egyben magában hordozza a szelektív megváltozás lehetőségét is: a nemzedékek különböző körülmények között különféle kölcsönhatási rendszerek eredményeként differenciálódnak. Az időbeni tagolódás és a térbeni tagolódás tehát egymástól elválaszthatatlan.

Az „Aufheben", a megőrizve megszűnés az egymást követő progresszív generációk egymásközti viszonyában erőteljesebbé válik. A generációk egyre hasonlatosabbá válnak, de ugyanakkor mindinkább elkülönülnek is. A progresszív fejlődés iránya éppen az olyan nagyobb minőségbeni diverzitás kifejlődésének iránya, amely egyre inkább egységes rendszert alkot. Autogenezis, ontogenezis az Anyag inherens attributumának, a „Qual" koherencia—divergencia kettősségének a koherencia felőli aspektusai, míg a filogenezis a divergencia-aspektus ítélete.

EARLY GEOLOGICAL MAPS PUBLISHED INDEPENDENTLY OR AS INSERTED IN BOOKS OF THE HUNGARIAN GEOLOGICAL INSTITUTE 1920—1944

GYÖRGY VITÁLIS

Hungarian Geological Survey
Budapest, Stefánia út 14.
H-1143

UDC: 55(084.3)"1920/1944"

Keywords: mapping, geological maps, Hungary

The present study renders an account of the maps published by the Hungarian (formerly Royal Hungarian) Geological Institute between 1920—1944, dealing also with the mapping activity of our survey geologists.

This is a continuation of the series of studies written by the same author (1991, 1992) on maps surveyed and plotted by staff members of the Hungarian Geological Institute, and published also by the Institute between 1920 and 1944 (FÜLÖP, J. 1969, JÁMBOR, Á. 1989, VITÁLIS, GY.—KUTI, L. 1989).

Geological maps published by the Institute

Following World War I and the Trianon Tresty there was a great recession also in the map publishing activity of the Institute. As it can also be read in the list of publication (Annual Report of the Royal Hungarian Geological Institute, Volume II) the following maps were published in the period concerned.

By the financial aid of the Hungarian General Coal Mining Corporation (MÁK) and the Esztergom—Szászvár Coal Mining Corporation the Institute was able to publish the "Mining geological map of the Esztergom Coal Mine Region, scale 1:7500" by P. ROZLOZSNIK, K. TELEGDI-ROTH and Z. SCHRÉTER in 1922, with coloured representation of 16 types of geological formations. Also a financial aid was granted by MÁK for the publication in 1924 of the "Mining Geological Map of the Tatabánya Coal Basin" (P. ROZLOZSNIK) on a scale of 1:12 500 showing 22 geological formations in colour (Fig. 1).

The coloured print of the south-eastern part of the "Geological Map of Hungary and the neighbouring regions scale 1:500 000 was published under the directorship of F. NOPCSA in 1928 distinguishing 64 kinds of rock units on the basis of all the survey data collected previously. The "Geological and tectonic map of Hunyad Country and its environs", on a 1: 200 000 scale, was published by English and Hungarian versions in 1929. It comprises 21 geological units, showing also faults, anticlinal folds synclines and thrust faults. Explanation was given by F. NOPCSA on the map sheet.

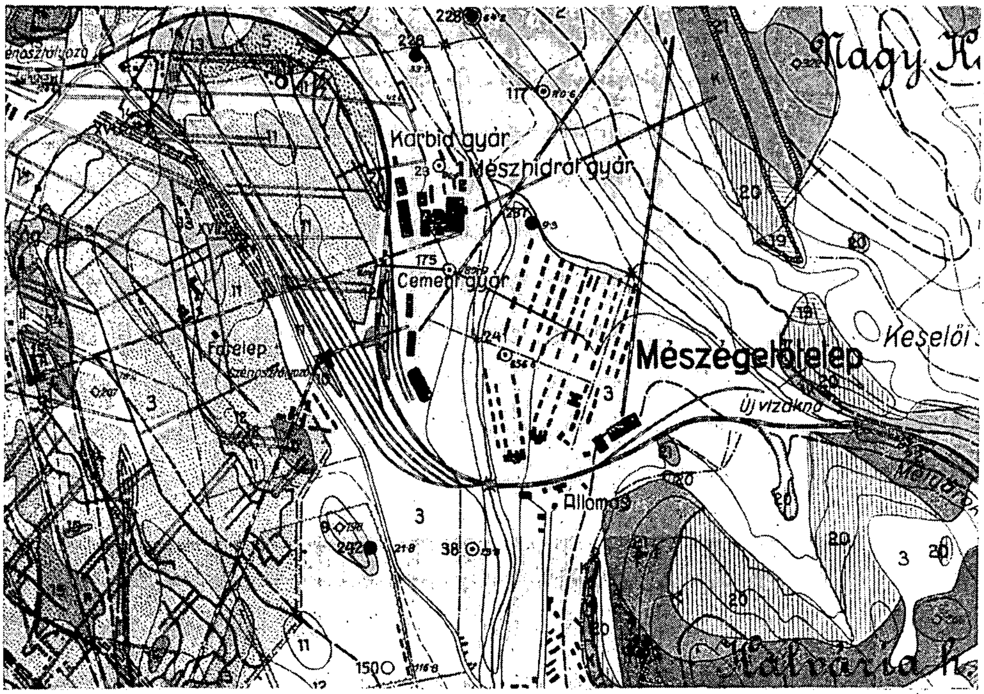


Fig. 1. Extract from the mining-geological map of the Tatabánya Coal Basin (Original scale: 1:12 500), after P. ROZLOZSNIK, 1924

1. ábra. A tatabányai szénmedence, eredetiben 1:12 500 ma. bányaföldtani térképrészlete (ROZLOZSNIK, P., 1924 után)

Among the economic-geological map types I call attention to the "Map of the areas and quarries of limestone in Hungary (Scale 1:550 000, 1928)" that features also the roads and railways, and shows the rocks in a threefold division: older and hard, compact limestones; compact carvable freshwater limestones and coarse limestones. The hachured of "Saline soils of soils of mutilated Hungary with the drivers well network for groundwater observation" (scale 1: 750 000) was published in 1934. Here argillaceous-imperrious, sandy and sulphuric-saline areas are depicted by also giving the existing and planned driver wells or well groups for groundwater checking.

The reference map showing the distribution of quadrangles surveyed for different purposes till 1944 (L. LÓCZY JR., 1945) demonstrates the geographic location of areas surveyed for hydrocarbons, ores and coal, and the position of areas where a search for kaolin, rock salt, refractory clay was done, and also indicates the zones of scientific agrogeological studies. Just for the sake of completeness, we should also mention that the progress of soil surveys, and the map series on a scale of 1:25 000 are also shown on the index map of the director's report for 1943 (L. LÓCZY JR.). Their titles, in details, are enumerated in the list of publications of the Institute (Annual Report for the

Years 1936—1938, Vol. 2) and in the annual reports of the relevant years. Here, however, these reports will not be discussed.

Geological maps published as inserted in the bulletins of the Institute

Several maps of great importance were also published as inserts in an article or as annexes. The publications of the Royal Hungarian Geological Institute, namely the Yearbook, the Annual Report, the Report on the Debates (from 1942), the series „Geologica Hungarica" (from 1929), the Geology of Hungarian Regions (from1935), and the practical and occasional publications generally contain coloured maps or maps hachured with one colour or hachured maps related to geology.

The maps included in the different publications can be divided practically into three groups according to their date of publication and topics. In the period between 1920—1928 mining geological maps were published for all the coal basins in Hungary. The majority of the maps issued between 1932—1938 deal with the structure-geological setting of areas built of Tertiary sedimentary rocks in N Hungary giving guidance to the then planned hydrocarbon explorations. In the period between 1939—1943 the maps depicting the megatectonic structure of the NE Carpathians and the natural gas occurrences in Transsylvania are dominating.

In the volumes XXVI—XXXVI of the Yearbook of the Royal Hungarian Geological Institute, pertaining to the period,

15 geological maps (1:20 000—1:5 000 000 scale),
5 tectonic-morphological maps (1:200 000—1:625 000,
1 geological-tectonic map (1:20 800),
1 tectonic map (1:900 000),
1 economic-geological map (1:16 000 000) and
1 morphological map (1:270 000), i.e. altogether 24 map sections or map supplements were published.

In the Annual Reports and the related series "Report on the Debates" altogether 243 maps (scale 1:1000—412 000 000) were published in the following distribution:

164 geological maps (1:1000—1:11 250 000 scale),
28 geological-tectonic maps (1:3700—1:434 000),
17 tectonic maps (1:16 000—1:1780 000),
10 paleogeographical maps (1:312 000—1:412 000 000),
6 hydrogeological maps (1:5000—1:172 000),
5 economic-geological maps (1:37 000—1:1315 000),
4 pedological maps (1:16 700—1:50 000),
4 paleontological maps (1:37 500—1:500 000),
3 mining-geological maps (1:1900—1:16 900), and
2 geophysical maps (1:60 000—1:1 000 000).

The series "Geologica Hungarica" included

26 geological maps (1:1600—1:344 000),
9 tectonic maps (1:75 000—1:31 000 000),
2 morphological maps (1:200 000—1:900 000),
1 hydrogeological map (1:450 000) and
1 geophysical map (1:770 000), i.e. altogether 39 maps and map sections (scale 1:1600—1:31 000 000) were published in this series.

In the "Geology of Hungarian Regions" series

11 geological maps (1:10 000—1:4 166 000),
3 tectonic maps 1:25 000—1:3 125 000) and
1 pedological map 1:200 000), that is altogether
15 maps (1:10 000—1:4 166 000) can be found.

In the "Practical and Occasional Publications"

38 geological maps (1:5600—1:98 000 000),
14 mining-geological maps (1:2200—1:90 000),
1 tectonic map (1:40 000),
1 map for geology and mineral deposits (1:100 000),
1 morphological (1:400 000) and
1 pedological map (1:3 000 000, i.e. altogether 56 (1:5600—1:98 000 000) map sections or map appendices were published.

Summarizing and evaluating the maps published in the Yearbooks, Annual Reports, Report on the Debates and in the series Geologica Hungarica we can conclude that they, according to the requirements of the age, as the result of the work of the geologists of the Royal Hungarian Geological Institute, largely contributed to the geological understanding of the country, of course, according to the given possibilities. Some characteristic examples that reflect the geological mapping method of the period, and also its development are shown in figs. 2—8.

Fig. 2. In the Table I of Part 3 of the vol. XXXVI of the Hungarian Geological Institute the "geological map (1:20 000) of the western part of the Veszprém plateau" prepared by J. ERDÉLYI FAZEKAS certain geological formations are emphasized by a rather demonstrative way of hachuring. The map published in 1943 depicts 19 geological formations.

Fig. 3. In vol. IV of the Annual Report of the Royal Hungarian Geological Institute for 1933—1935 further on Ann. Rep. (GY. VIGH—F. HORUSITZKY, among others published also the light-brown-hachured geological and tectonic map of the Sas Hill, scale 1:3700, that shows precisely the extent of 10 geological formations and the observed tectonic phenomena.

Fig. 4. F. PÁVAI VAJNA in his the Geological and Tectonic Map of the Rákoscsaba—Pécel—Ecser Anticline (scale 1:47 600) (Ann. Rep. 1936—1938, Vol. I.) represents besides 4 geological formations the supposed anticlinal struc-

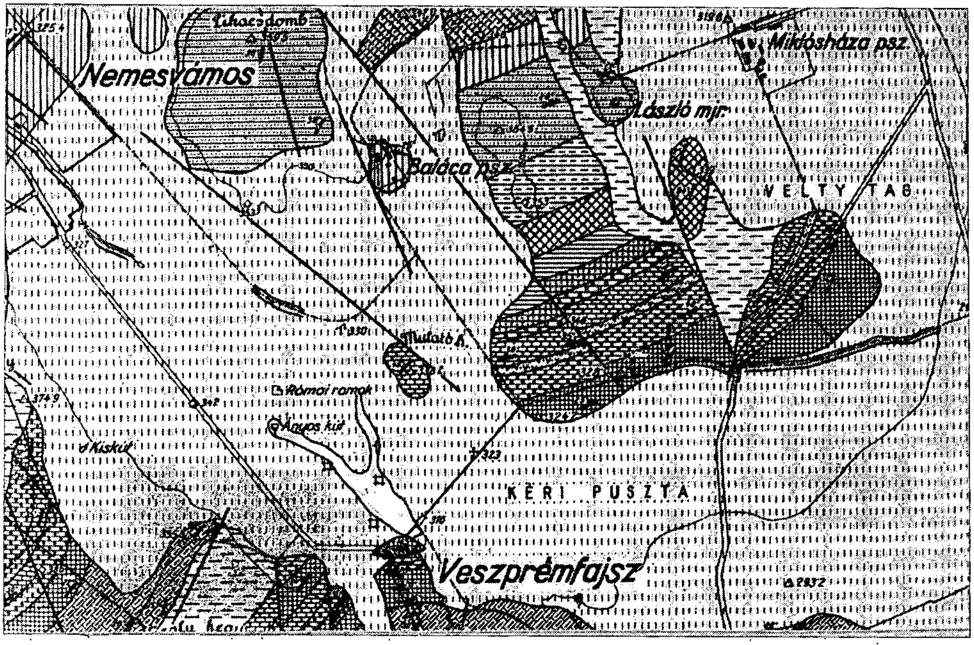


Fig. 2. Extract from the geological map of the western half of the Veszprém Plateau (original scale: 1:20 000), after J. ERDÉLYI FAZEKAS, 1943

2. ábra. A veszprémi fennsík nyugati felének eredetiben 1:20 000 ma. geológiai térképrészlete (ERDÉLYI FAZEKAS, J., 1943 után)

ture upon strike and dip reading (continous lines) and the trends of synclines (dotted lines).

Fig. 5. G. TELEKI on his tectonic map of the Felsőörs zone (scale: 1:35 700) (Ann. Rep. 1936—1938, Vol. I), besides 22 geological units depicted by hachures shows faults with continuous lines, downward displacements with pecked lines and the thrust faults with cogged lines.

Fig. 6. F. HORUSITZKY's "Geological map of the Bér—Buják elevation, scale: 1:50 000" (Ann. Rep. 1936—1938, Vol. II) including 13 geological units, also well illustrates the typical faults of the Cserhát Mts area and, consequently, the contact of the different rocks.

Fig. 7. S. JASKÓ's hachured geological sketch map of the so-called Bicske Gulf, scale: 1:150 000, contains 9 geological units (Ann. Rep. 1939—1940, Vol. I), summarizes all the features that can be observed at all in an area so poorly exposed (Fig. 7). Dots indicate the uplifted and dotted lines the subsided ranges.

Fig. 8. Rather expressive is Z. SCHRÉTER's geological map published in the "Report on the Debates, Vol. 5, 1943", scale 1:71 000, reflecting also the folded structures of the Bükk Mts. Besides depicting 17 geological units, this map also illustrates the tectonic elements.

Figs. 9—10. A new colour appeared in the map publication activity of the institute by the introduction of the coloured geological map enclosures, plotted

Fig. 3. Part of the geological and tectonic map of Sashegy (original scale: 1:3700), after GY. VIGH—F. HORUSITZKY, 1940

3. ábra. A Sashegy eredetiben 1:3700 ma. földtani és hegyszerkezeti térképrészlete (VIGH, GY.—HORUSITZKY, F., 1940 után)

on a correct topographic basis, published within the series "Geology of the Hungarian Regions". From them we have selected Z. SCHRÉTER's geological map of the Nagybátony region (scale 1:25 000), displaying 17 geological units (Fig. 9), and J. NOSZKY's geological map of the Cserhát Mts scale: 1:75 000, with 21 units (Fig. 10). In the present study one detail of each of the above maps are published. On the map section from the Nagybátony region with double-dotted line also the Nagybátony anticline is shown (Fig. 9), while the extract map from Cserhát calls attention to the varied geological structure of the Danube Bend and the of the Nagyszál near Vác (Fig. 10).

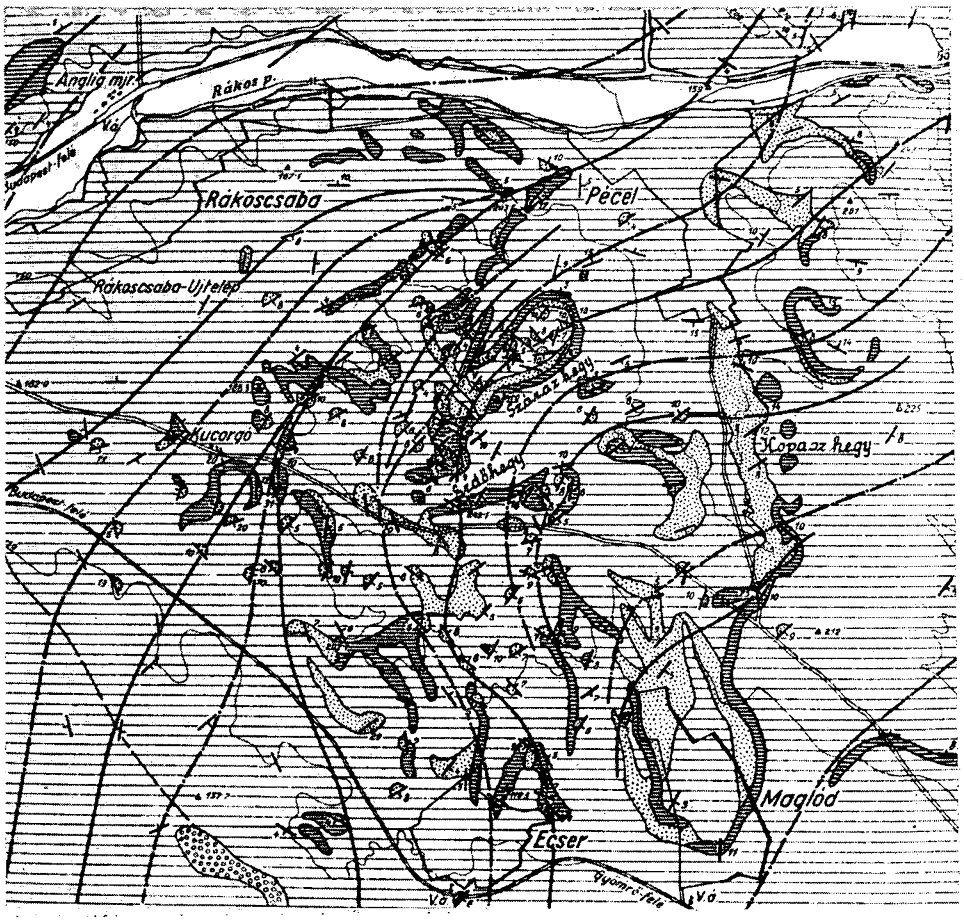


Fig. 4. Extract map showing a part of the geological and tectonic map of the Rákoscsaba—Pécel—Ecser anticline (original scale: 1:47 600), after F. PÁVAI VAJNA, 1941

4. ábra. A rákoscsaba—pécel—ecseri felboltozódás eredetiben 1:47 600 ma. földtani és hegyszerkezeti térképrészlete (PÁVAI VAJNA, F., 1941 után)

The practical and occasional publications of the Institute include predominantly geological and mining geological maps.

Figs. 11—12. Of these a sketch map published in F. SCHAFARZIK—A.VENDL: Geological Excursions in the vicinity of Budapest (1929) is selected showing the geological makeup of the Pesterzsébet—Budafok area by 9 geological units on a 1:66 000 scale (Fig. 11). The authors of this map attempted to depict the rock types supposed to be present in the bed of River Danube.

From M. PÁLFY's monograph, entitled "Geological conditions and mining production of Hungary's gold and silver mines" (1929) the Telkibánya mining district is shown scale 1:21 000 with 7 geological units (Fig. 12). This, besides the geological units, shows also the dikes, bedplates and shafts important for the precious metal production.

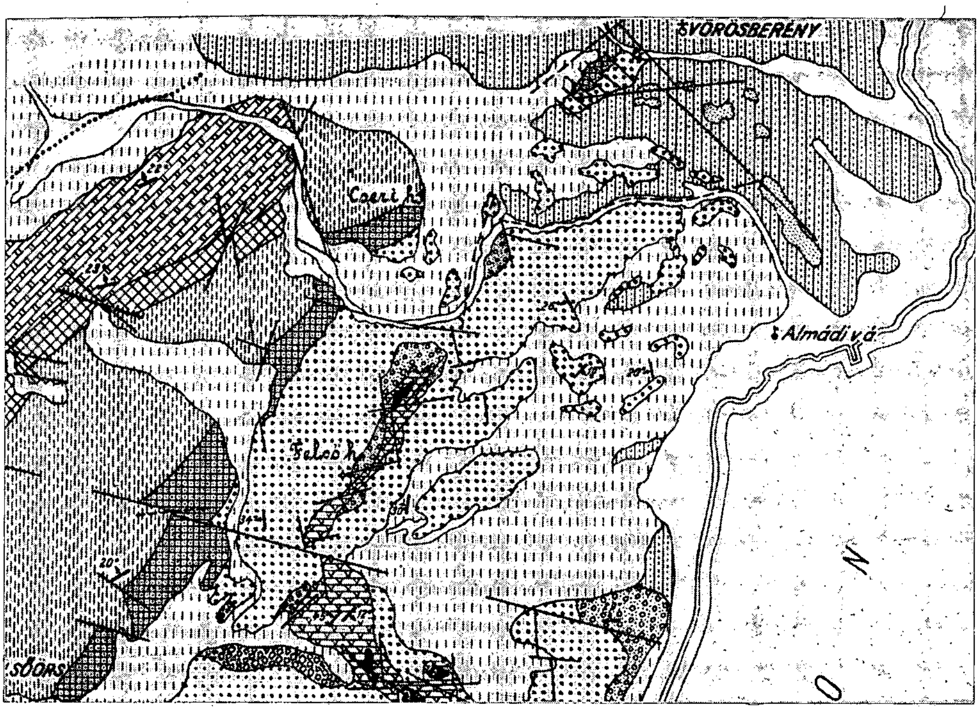


Fig. 5. Extract from the tectonic map of the Felsőörs region (original scale: 1:35 700), after G. TELEKI, 1941

5. ábra. Felsőörs környékének eredetiben 1:35 700 ma. tektonikai térképrészlete (TELEKI, G., 1941 után)

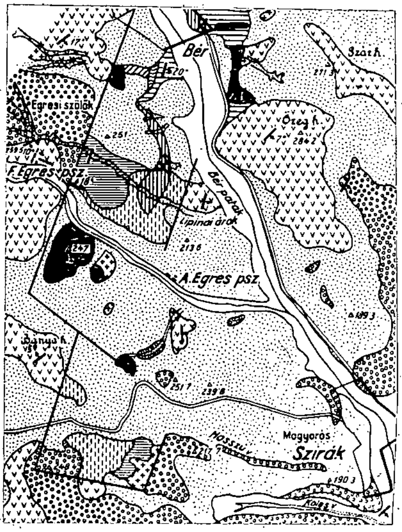


Fig. 6. Part of the geological map of the Bér—Buják elevation (original scale: 1:50 000), after F. HORUSITZKY, 1942

6. ábra. A bér—bujáki kiemelkedés eredetiben 1:50 000 ma. földtani térképrészlete (HORUSITZKY, F., 1942 után)

The maps published by the Institute between 1920 and 1944 independently or as atteched to textual publications reflect the creative spirit of our survey geologists. These maps are worth studying even today because of their pleasing appearance and exemplary delineation technique. For the excellent reproduction of the figures, the author is highly indebted to Margit Pellérdy.

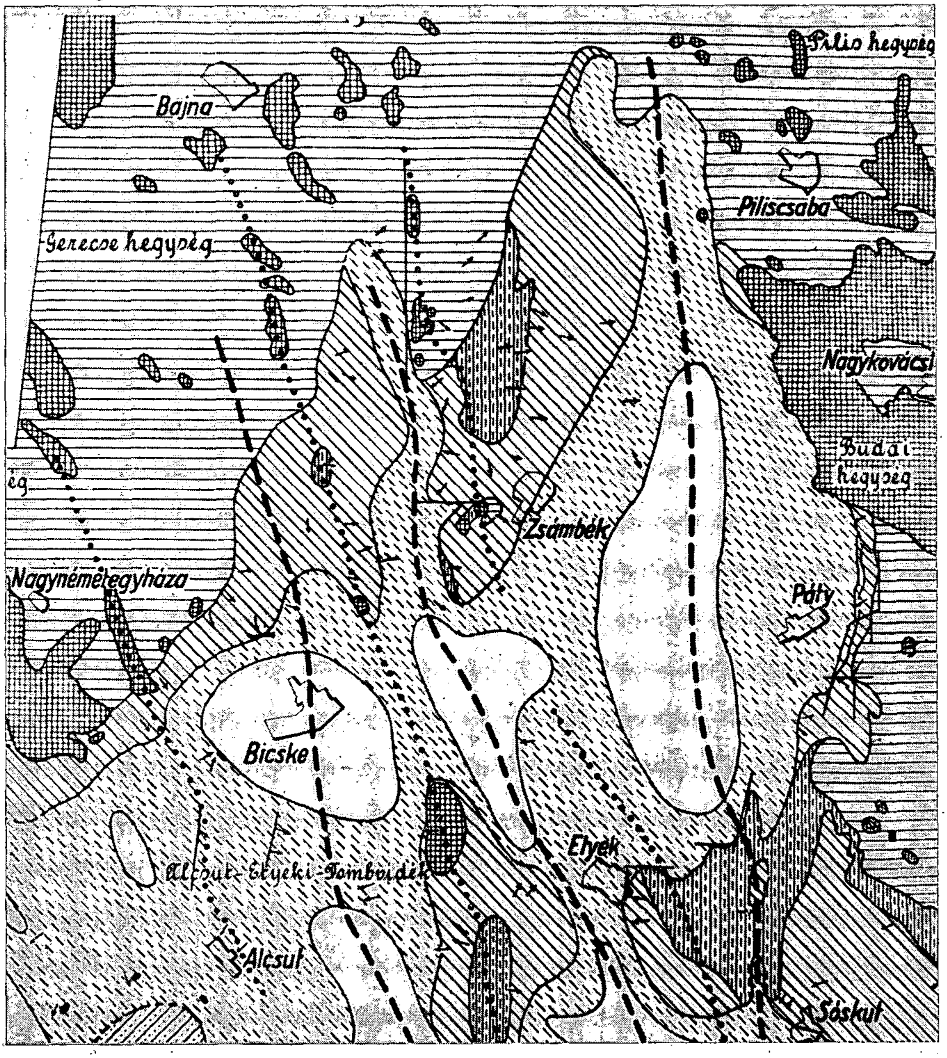


Fig. 7. Part of the geological sketch map of the "Bicske Gulf" (original scale: 1:150 000), after S. JASKÓ, 1943

7. ábra. A bicskei öböl eredetiben 1:150 000 ma. geológiai térképvázlat részlete (JASKÓ, S., 1943 után)

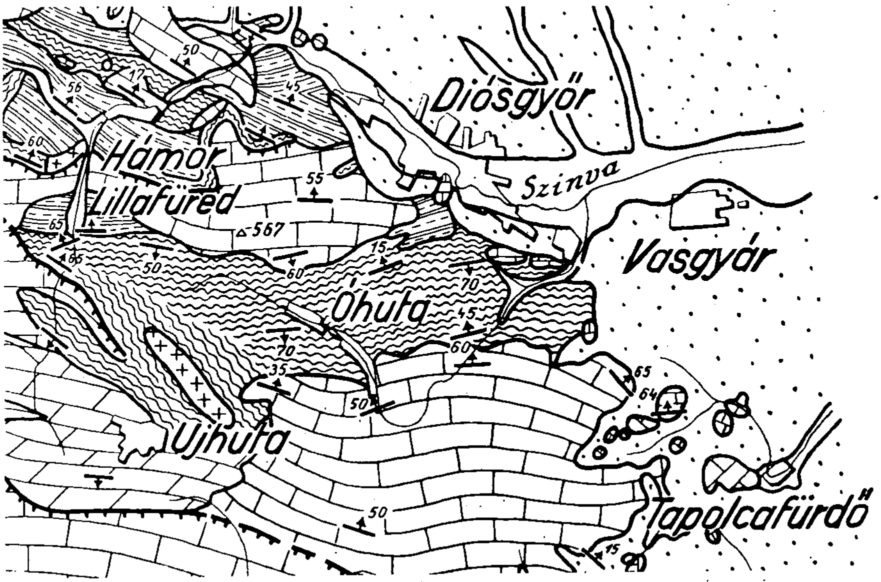


Fig. 8. Extract from the small-scale geological map of the Bükk Mts (original scale: 1:71 000), after Z. SCHRÉTER, 1943

8. ábra. A Bükk-hegység eredetiben 1:71 000 ma. átnézetes földtani térképrészlete (SCHRÉTER, Z., 1943 után)

Fig. 9. Extract from the geological map of the Nagybátony area (original scale: 1:25 000), after Z. SCHRÉTER, 1940

9. ábra. Nagybátony környékének eredetiben 1:25 000 ma. földtani térképrészlete (SCHRÉTER, Z., 1940 után)

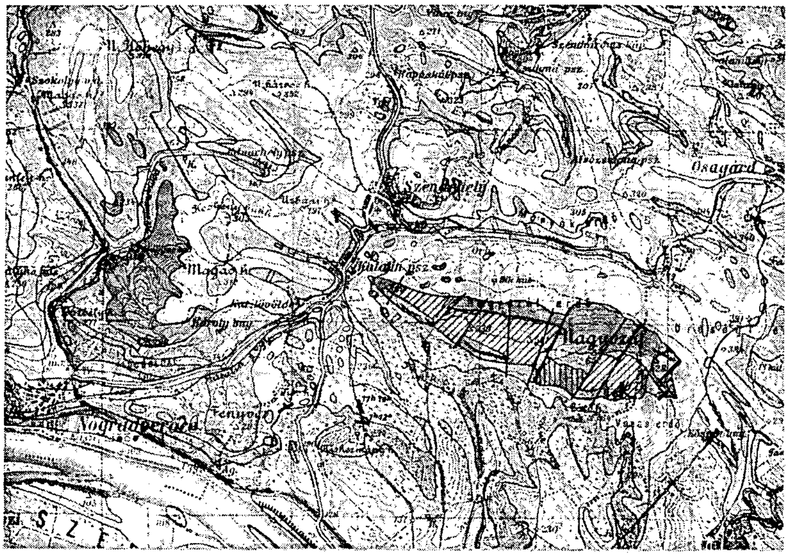


Fig. 10. Extract from the geological map of the Cserhát Mts (original scale: 1:75 000), after J. NOSZKY, 1940

10. ábra. A Cserhát-hegység eredetiben 1:75 000 ma. földtani térképrészlete (NOSZKY, J., 1940 után)

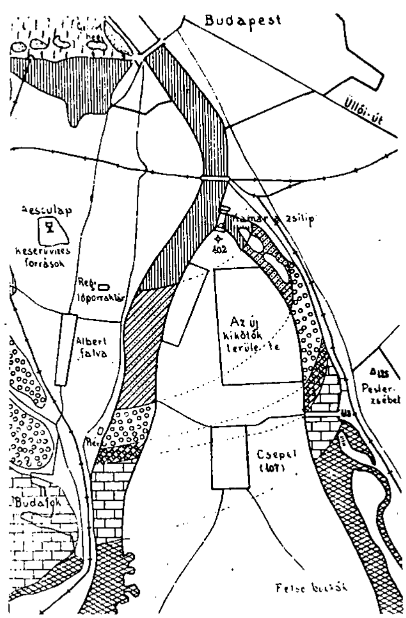


Fig. 11. Sketch map showing the geological conditions of the Pesterzsébet—Budafok area (original scale 1:66 000) after F. SCHAFARZIK—A. VENDL 1929

11. ábra. Pesterzsébet—Budafok geológiai viszonyainak eredetiben 1:66 000 ma. vázlata (SCHAFARZIK, F.—VENDL, A. 1929 után)

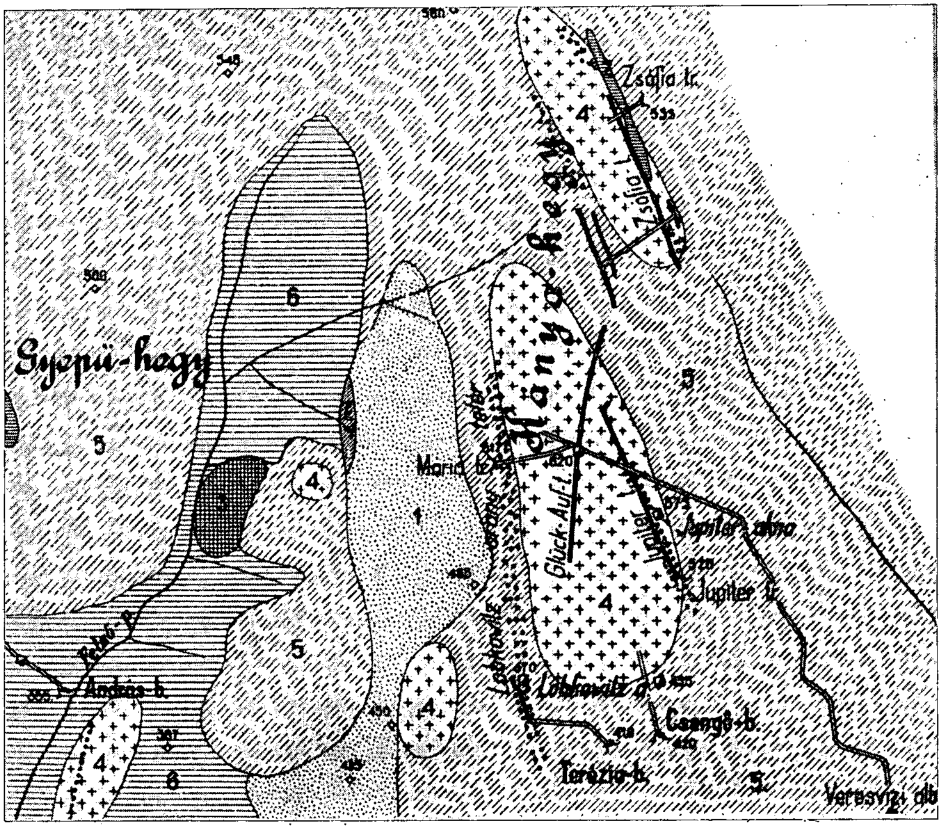


Fig. 12. Part of the geological map of the Telkibánya mining district (original scale: 1:21 000), after M. PÁLFY, 1929

12. ábra. A telekibányai bányaterület eredetiben 1:21 000 ma. geológiai térképvázlata (PÁLFY, M., 1929 után)

REFERENCES — IRODALOM

FÜLÖP, J. 1969: Geological Mapping in Hungary: Past, Presence and Future. — In: Fülöp, J.— Tasnádi Kubacska, A. ed.: One Hundred Years of the Hungarian Geological Institute, Budapest: 86—107.

JÁMBOR, Á. 1989: Geological Forecast maps of Hungary. — In: Csáti, E. ed.: Hungarian Cartographical Studies — 1989. 14th World Conference International Cartographic Association. Hungarian National Committe, Budapest: 171—183.

LÓCZY, L. 1945: Igazgatói jelentés a m. kir. Földtani Intézet 1943 évi müködéséről. — Direktionsbericht über die Tätigkeit des Kön. Ung. Geologischen Anstalt im Jahre 1943. — Földt. Int. Évi Jel. 1943-ről I.: 1—94.

VITÁLIS, GY. 1991: Old geological maps published in the edition of the Hungarian Geological Institute or published as insets within the issues of the Institute 1869—1919. In: Vitális, Gy.—Kecskeméti, T. ed.: Museums and Collections in the History of Mineralogy, Geology and Paleontology in Hungary. On the occasions of the 16th International Symposium of INHIGEO Dresden, Germany, 1991. Hungarian Geological Survey — Hungarian Geological Society, Budapest: 229—242.

VITÁLIS, GY. 1992: A Magyar Állami Földtani Intézet kiadásában és kiadványaiban megjelent archiv földtani térképek 1869—1919. — Földt. Int. Évi Jel. 1990-ről: sajtó alatt.

VITÁLIS, GY.—KUTI, L. 1989: Geological Maps of the Hungarian Geological Institute. — In: Csáti, E. ed.: Hungarian Cartographical Studies — 1989. 14th World Conference International Cartographic Association. Hungarian National Committe, Budapest: 161—169.

A MAGYAR ÁLLAMI FÖLDTANI INTÉZET KIADÁSÁBAN ÉS KIADVÁNYAIBAN MEGJELENT ARCHÍV FÖLDTANI TÉRKÉPEK 1920—1944

VITÁLIS GYÖRGY

Magyar Állami Földtani Intézet
Budapest, Stefánia út 14.
H-1143

ETO: 55(0843)„1920/1944"

A tanulmány az INHIGEO kötetben angol nyelven megjelent közlemény (VITÁLIS GY. 1991) és a MÁFI Évi Jelentésében (VITÁLIS GY. 1992) közzétett hasonló című tanulmány folytatásaként, a Földtani Intézet geológusai által készített geológiai felvételek alapján az Intézet kiadásában és kiadványaiban az 1920—1944. évek között nyomtatásban megjelent geológiai térképeket tekinti át, és egyúttal az Intézet térképezési tevékenységébe is bepillantást nyújt.Az Intézet által a tárgyidőszakban kiadott jelentősebb térképek közül 2 db 1:7500—1:12 500 ma. bányaföldtani, 1 db 1:200 000 ma. földtani és tektonikai, 1 db 1:500 000 ma. földtani és 2 db 1:550 000—1:750 000 ma. gazdaságföldtani térképet ismertet.

A tárgyidőszakban kiadott talajismereti térképekkel a tanulmány nem foglalkozik.

Az Intézet kiadványai közül a Magyar Királyi Földtani Intézet Évkönyvében, a Magyar Királyi Földtani Intézet Évi Jelentésében, a Beszámoló a Vitaülésekről, a Geologica Hungaricaban, a Magyar Tájak Földtani Leírásában, valamint a gyakorlati és az alkalmi kiadványokban:

254 db 1:1000—1:98 000 000 ma. földtani,
31 db 1:16 000—1:31 000 000 ma. tektonikai,
29 db 1:3700—1:434 000 ma. földtani és tektonikai,
17 db 1:1900—1:90 000 ma. bányaföldtani,
10 db 1:312 000—1:412 000 000 ma. ősföldrajzi,
7 db 1:5000—1:450 000 ma. vízföldtani,
6 db 1:37 000—1:16 000 000 ma. gazdaságföldtani,
6 db 1:16 700—1:3 000 000 ma. talajtani,

5 db 1:200 000—1:625 000 ma. tektonikai és morfológiai,
4 db 1:200 000—1:900 000 ma. morfológiai,
4 db 1:37 500—1:500 000 ma. őslénytani,
3 db 1:60 000—1:1 000 000 ma. geofizikai és
1 db 1:100 000 ma. földtan-teleptani térkép, illetve térképrészlet látott napvilágot.

E térképek híven tükrözik és gazdag tárházát adják az intézeti geológusok alkotó szellemének, ezért tanulmányozásukat a ma kutatói számára is melegen ajánljuk, mert mind kivitelezésükben, mind ábrázolástechnikai megoldásaikban például és mintául szolgálnak.

GEOLOGICAL REPORTS OF SCIENCE-HISTORICAL IMPORTANCE OF THE NATIONAL GEOLOGICAL ARCHIVES IN HUNGARY (1938—1944)

ISTVÁN SZENTIRMAI

Hungarian Geological Survey
Budapest, Stefánia út 14.
H-1143

UDC: 061.68:55(439)
55(091)(439)

Keywords: National Geological Archives (Hungary), Hungarian Geological Survey, manuscript reports, history of sciences

The present paper is the sixth part of a series methodologically summarizing the publications based on the study of the materials of the Archives. In this case a historically shorter period that, however, is rich in results of geological investigations will be summed up.

The National Geological Archives as a department of the Hungarian Geological Survey, in accordance with its basic function collects, systematically processes and evaluates the manuscript geological reports. One of the results of this evaluation is the series describing the main trends of geological investigations for predetermined periods as reflected by the holdings of the National Geological Archives. This series of studies began by a paper written by GY. VITÁLIS (1988, 1989, 1990) then it was continued by I. SZENTIRMAI (1991, 1992), and we strongly hope that it is interesting for the professional circles (E. ERDÉLYI-TÓTH 1991). The cited reports are mentioned within the text with their archival number of registration in brackets. For this reason they are not included in the "References" of this paper.

The territory of the country during the period referred to was increased. The investigations were concentrated, first of all, on the newly reannexed regions but the exploration in the "original" country was not neglected either. The locality of the sites mentioned in the reports of exploration for mineral resources are shown in Fig. 1.

The investigations carried out by the staff of the Royal Hungarian Geological Institute (today Hungarian Geological Survey) in the given period are well summarized in the "Director's reports" issued by L. LÓCZY JR. (T 5775; Ált. 11; T 1407; T 1408; Ált. 12; T 1686; Ált. 13). These contain the annual work of investigation of the Institute. These reports reflect the fact that beside the systematic geological mapping economic-geological investigations were also carried out. Like in the previous period the Institute kept hands on all the state-financed investigations and was a consulting organization for controlling private and concessional explorations.

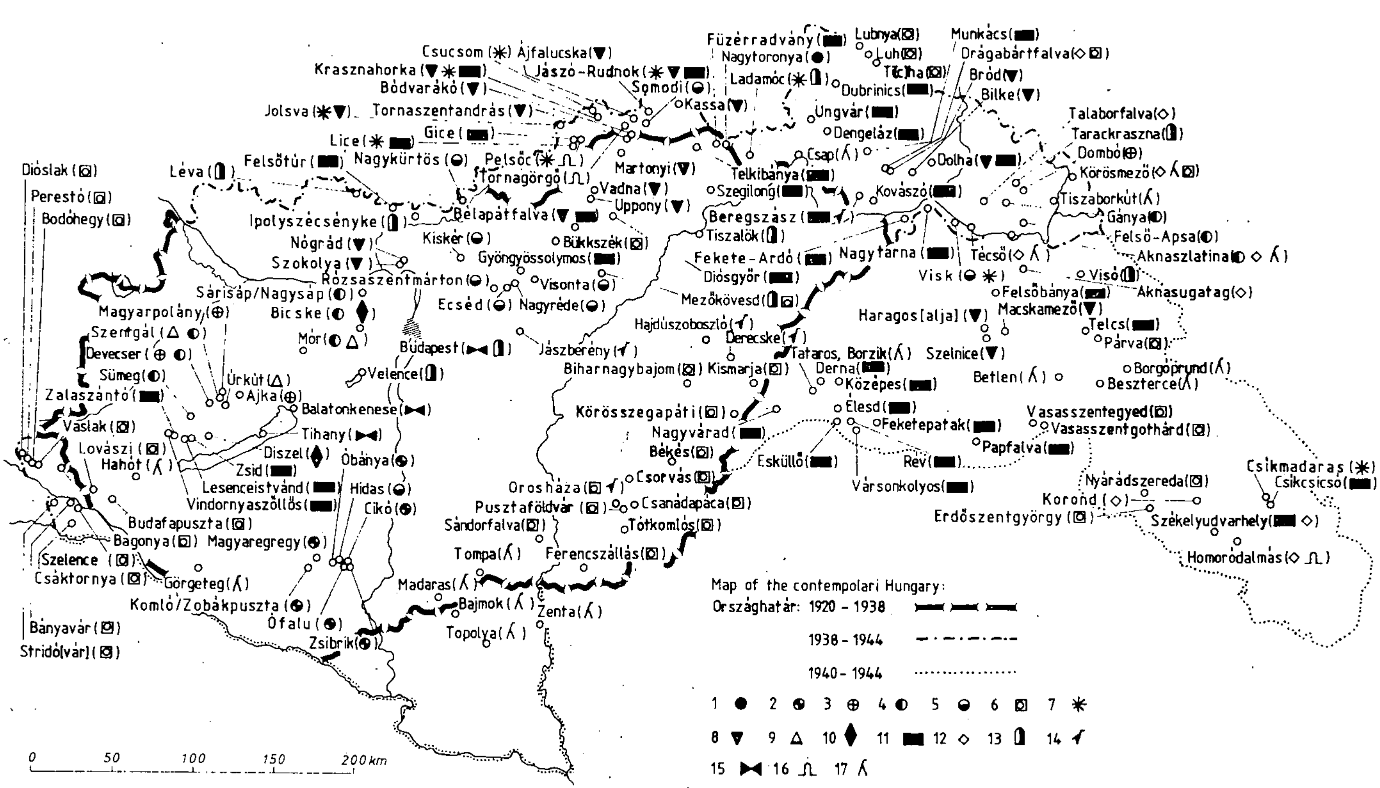


Fig. 1. Location map showing places that are referred to in the areal reports from 1938—1944, stored at the National Geological Archives, and the sites of mineralization considered therein

1. Carboniferous, *2.* Jurassic, *3.* Cretaceous, *4.* Paleogene (Eocene, Oligocene), *5.* Neogene: black coal; brown coal and lignite, *6.* hydrocarbon (petroleum and natural gas), *7.* non-ferrous mineral ores (precious matals and sulphidic ores), *8.* iron ore, *9.* manganese ore, *10.* bauxite; *11.* nonmetallic minerals, *12.* rock salt, *13.* hydrogeology, hydrology, *14.* agrogeology (soil science), *15.* engineering geology: *16.* speleology, *17.* geophysics

1. ábra. Az Országos Földtani Adattár 1938—1944. évek közötti területi jelentései és a bennük ismertetett nyersanyagok földrajzi elhelyezkedése

1. karbon, *2.* jura, *3.* kréta, *4.* paleogén (eocén, oligocén), *5.* neogén: feketekőszén, barnakőszén, illetve lignit, *6.* kőolaj és földgáz, *7.* színesérc (nemesfém- és szulfidos érc), *8.* vasérc, *9.* mangánérc, *10.* bauxit, *11.* vegyesásvány, *12.* kősó, *13.* hidrogeológia—hidrológia, *14.* agrogeológia (talajtan), *15.* mérnökgeológia (építésföldtan), *16.* barlangkutatás, *17.* geofizika

Coal exploration, due to the increased energy demands of World War II, was continued. All over the country including the temporarily re-attached parts, besides the general surveys, the exploration for Carboniferous coal deposits was going on. According to I. FERENCZI (Ált. 12; 1940) the coal deposits had to be explored, due to the deposition a features by horizontal and inclined shafts instead of drilling. Unfortunately, this coal occurrence represented only a matter of geological interest.

The Jurassic coal deposits of the Mecsek Mts, were studied in this period, first of all along the northern margins of the local coal range area by the Salgótarján Coal Mines Co. that had an interest in the business. On the area of complicated tectonics and geological setting S. VITÁLIS prepared two unpublished reports about the Ófalu—Zsibrik region in 1942 and 1943 (M.X.42; and M.X.48) respectively. In 1938 P. ROZLOZSNIK compiled a manuscript report entitled Coal 52 (Szén 52) concerning "the coal deposits of Magyaregregy". Here it was concluded that the existence of coal fields of a greater extent is out of question. In a study of 1941 entitled "Report on the geological exploration of the area between Zobákpuszta and Komló" (M.X.20) S. VITÁLIS mentioned the 800.07-m-deep borehole Zobákpuszta III. In his opinion "the results achieved by deep drilling are practically of minor significance". The thickness of the exploitable coal deposit cut across in a depth interval of 572 m was estimated by him as 6.0—6.6 m.

I. VITÁLIS, in two reports prepared in 1942 (M.X.21; M.X.22) proposed to the Salgótarján Coal Mines Co. to obtain the mining rights of the (Mecsek) Jánosi—(Kis)Battyán—(Mecsekfa)Budafa area. As an illustration for his proposal he attached to his report a geological profile shown in Fig. 2.

The areal extent of the Cretaceous coal deposit according to I. VITÁLIS's report prepared in 1939 (B.X.30) entitled "Report on the coal deposits of Ajka" may be 10—12 km^2 with ca. 26 million tons of resource. He thought, however, that "by making the most of the rock pressure even 30—35 million tons might be mined."

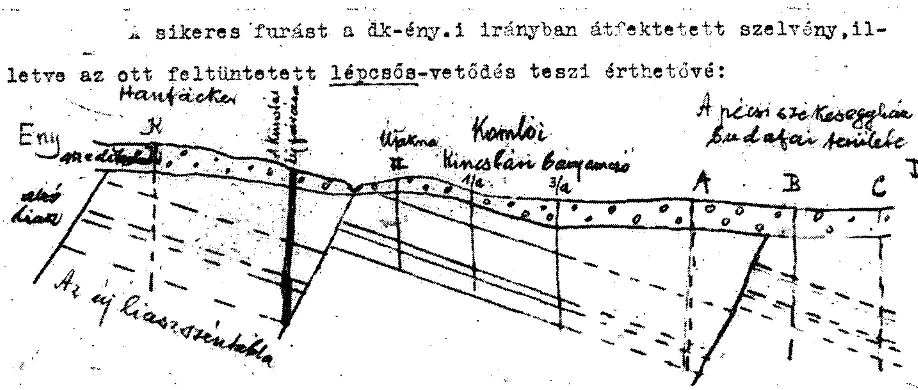


Fig. 2. I. VITÁLIS's interpreting geological section set up across the Komló area

2. ábra. VITÁLIS I. értelmező földtani szelvényvázlata Komló környékéről

In his paper "Report on the coal deposits at Bódé (B.x. 28; 1939) I. VITÁLIS writes that ".... the borehole to be deepened could offer some information... on the Eocene coal deposits of the Paleogene Basin, and perhaps on the continuation of the Cretaceous coal deposit in the Ajka region." In another report (B.X.35; 1941), through drillings he expects the discovery of Eocene and Cretaceous coal deposits in the Magyarpolány-(Tósok)Berénd—Devecser estate of the Zirc Abbey.

Concerning the Eocene coal J. NOSZKY JR. in his report "A survey of the area between Antalhegy and Csókahegy near Mór" (Szén 51, 1934) came to the conclusion that coal cannot be expected to have been present, however, significant amounts of Mn ore are previsible. On the "drillings of the prospective coal region" of Sárisáp—Nagysáp, a report of S. VITÁLIS (Szén 54; 1940) gives an account. He emphasized the importance of detailed geological mapping because in this way "conclusion can be drawn in advance concerning the expected depth of the boreholes i.e. of the coal deposits".

Of the several reports concerning the younger coal deposits the "Mining expert's opinion about the Kiskér coal mining owned by the Royal Pázmány Péter University of Sciences" can be mentioned (Szén 65/k; 1943). The detailed geological, mining and economic expertise prepared by mining engineers L. SCHMIDT and J. POLLNER can be used as an instrumental example even by the today's generation.

GY. VIGH, in his report "An appraisal of the lignite deposits in the Mátra foreland region" (Szén 53; 1939) predicts that the exploitable reserves of the Pannonian "earthy-ligneous" coal deposit might be amounting to 215 million tons. In the report "A geological checking-up of the estimate of lignite resources in the foreland to the Mátra Mts" (Szén 56; 1940) Z. SCHRÉTER prepared a study for the so far explored total area that can be worked by the given mining techniques (deep mining) and the water inrush hazards.

The industrial contractors were greatly interested in the fuel reserves and their workability of the re-attached regions. I. VITÁLIS related to this problem wrote the report "...on the explored and explorable coal deposits of Upper Northern Hungary" (C.VI.34; 1938). Just to mention a few localities, he expects the existence of workable coal deposits in the zone of Csákányháza, Fülek, Párkány, Zsély and in the vicinities of Toronya, Regmec, Ungvár, Munkács and Huszt.

Upon governmental request the Institute started a detailed geological mapping in the reannexed regions. In their reports F. SZENTES (T 1408/a) and GY. KULHAY (T. 1408/b; 1939) mention Cretaceous-(?)Paleogene, Middle Miocene and Sarmatian coal deposits from the environs of Kalinfalva—Dombó, Neresznyice—Gánya, Visk—Velejte. The chief result of this work remained purely geological, since the coal found either was not workable or the shortness of the period of possessing these regions did not allow Hungarian venturers to take the necessary measures for opening mines.

The war conditions raised a special interest in petroleum and natural gas, and thus their exploration was carried out with a proper intensity. During this period, on assignments by the Treasury, the Royal Hungarian Geological Institute and private companies, moreover the legal successors of EUROGASCO possessing the concession earlier, MAORT (Hungarian—American Oil Company) and MANÁT (Hungarian—German Petroleum Company) did exploratory work.

The state explorations were performed on the basis of the previous concepts elaborated by the Royal Hungarian Geological Institute, parallel with the systematic geological mapping of the country. L. MAJZON's study "The deep boreholes in the area of Bükkszék" (Gáz 32; 1939) is worth mentioning as having summarized the results of the micropaleontological study of 51 hydrocarbon exploratory deep borehole sections around Bükkszék.

A comprehensive study was compiled by L. LÓCZY JR. "Geologischen Gutachten über die Kohlenwasserstoffmöglichkeiten des südöstlichen Teilen des Alföld in Rumpfungarn" (T 82; 1939)in which an account was given of the gas deposits and their types at Pusztaföldvár, Békés, Csorvás and Csanádapáca. Regarding the same author, the following study of his is also noteworthy: "An account of the main conclusions of the visit to the Geological Institute in Berlin and to the petroleum fields in Germany and proposal for the transferring the licences for the hydrocarbon exploration and production" (Ált. 58; 1939) that from the aspects of the Institute has still preserved its actuality.

MAORT was exploring and producing in S Transdanubia. An anonymous report (Gáz 34; 1938—1941) published 69 figured and descriptive profiles of the Budafa deep borehole. Another, also MAORT report (Gáz 35; ? 1940) includes the profiles of seven deep boreholes at Lovászi. In the Vend region (T 91; 1941) and in Muraköz (T 92; 1942) mapping was carried out by L. STRAUSZ definitely for the foundation and preparation of further petroleum explorations.

MANÁT, in 1943—1944, studied the SSE frontier zone of the present-day national borders of the country. An anonymous report deals with the complete stratigraphical sequences, the oil-, gas condition and geophysical well-logging data of 29 boreholes deepened in the zone of Kismarja, Biharnagybajom, Körösszegapáti, Tótkomlós, Sándorfalva, Ferencszállás (Gáz 39/a). At the same time, upon the invitation of MANÁT, the Roland Eötvös Geophysical Institute carried out geophysical measurements in the Bajmok—Topolya—Zenta—Madaras—Tompa—Sándorfalva—Ferencszállás area. The drilling of the discovered structures was, however, hindered by the war conditions. Of the investigations I. BASSÓ in his report "Bericht über der Resultate der Drehwaagenmessungen ausgeführt von dem Königl. Ung. Baron LORAND EÖTVÖS Geophysikalischen Institut im Jahre 1942 im Bácska im Auftrage der Ungarisch—Deutschen Erdölwerke GMBH" (Cf 81:, 1942) gave an account.

In the reannexed territories hydrocarbon exploration were carried our simultaneously with the geological mapping. F. HORUSITZKY, GY. WEIN (T 1407/6; 1939) and F. SZENTES (T. 1407/7; 1939) reported on the petroleum indications of Lubnya-Loh-Ti/c/ha and Kőrösmező, L. MAJZON, in his report "State-sponsored deep drilling activities in Transylvania" (Gáz 38/a; 1940—

1944) wrote on his Foraminifera studies of 31 borehole sections largely contributing to the determination of the stratigraphical conditions that was important as orientating the elaboration of the model of investigations.

For the investigation of the petroleum-bearing structures a gravity survey by torsion balance and gravimetric measurements were also carried out in the region. Of the results I. BRASSÓ, T. DOMBAI and GY. BANAI reported (Cf. 45, 81, 83, 85, 86; 1939—1944). An anonymous author discussed the subject "Mining products and mineral exploration possibilities in the areas reannexed as a result of the revision of the borders of Czechoslovakia" (Ált. 10; 1938—1939) dealing, first of all, with ore exploration. From the margin of the Gömör—Szepes Ore Mountains, from the neighbourhood of Csucsom, Jászó and Krasznahorkaváralja the report mentioned the occurrance of antimony, manganese and copper ores. For the area of Jolsva and Pelsőc (ardó) the presence of vein-type zinc, lead and chromite ore deposits are mentioned. From Ladamóc, copper ore is described by F. SZENTES (T. 81; 1939). In the Hargita, A. FÖLDVÁRI made a search for mercury ore, and in Csíkmadaras he found cinnabar with evidences of ancient mining (Ált. 13; 1943). The exploration of non-ferrous ores did not result in reserves of industrial size.

In the territory of the present-day Hungary, in order to supply the iron works with ore, explorations were renewed time and again. In 1942 I. VITÁLIS compiled a whole series of reports on the iron ore occurrences of Szokolya—Nógrád (Fe 22—27). The explorations following the traces of old mining operations finally brought no results. Fig. 3 shows the extent of the exploration area. The report prepared by P. ROZLOZSNIK (Fe 19b; 1938) speaks of "...the possibilities of the iron ore occurrence at Bodvarákó and Tornaszentandrás". The report concludes that "No workable mineral resources can be granted through a simple field survey in Hungary. Therefore every mining venturer should run the risks of investing money in exploration." S. VITÁLIS's report (Fe 21; 1941) deals with the Martony locality almost totally exploited by that time. In the reannexed territories of the country J. NOSZKY JR. did mapping and searched for iron ore deposits in the S part of the Szepes—Gömör Ore Mts around Ájfalucska, Jászó, Jolsva and Krasznahorka (Fe 19a; 1939). On the hematitic iron ore occurrence found near Kassa, A. FÖLDVÁRI reported (T 85; 1939) emphasizing that the mining of this deposit can be started at once by continuing the former works done there. From the Bilke and Bród areas GY. KULHAY (Fe 20a; 1939) mentions limonitic ore stating that it can be found in tuff deposited in water. The iron ore occurrences of Dolha, Zárnya and Gyilalja were studied by F. PAPP writing two reports (T 81, T 1407/4; 1939). One of his ore samples, according to the analysis contained 64.7% Fe_2O_3, i.e. 45.25% iron. In 1943 mapping was carried out by Z. SCHRÉTER in the timely reannexed Transylvanian territories. It is documented by the report pair "... on the geological study of the iron ore occurrences in the surroundings of Óharagos and Haragosalja" (Fe 28 and 72; 1943). A thin magnetite deposit was found in the area the geological of which are shown in Fig. 4.

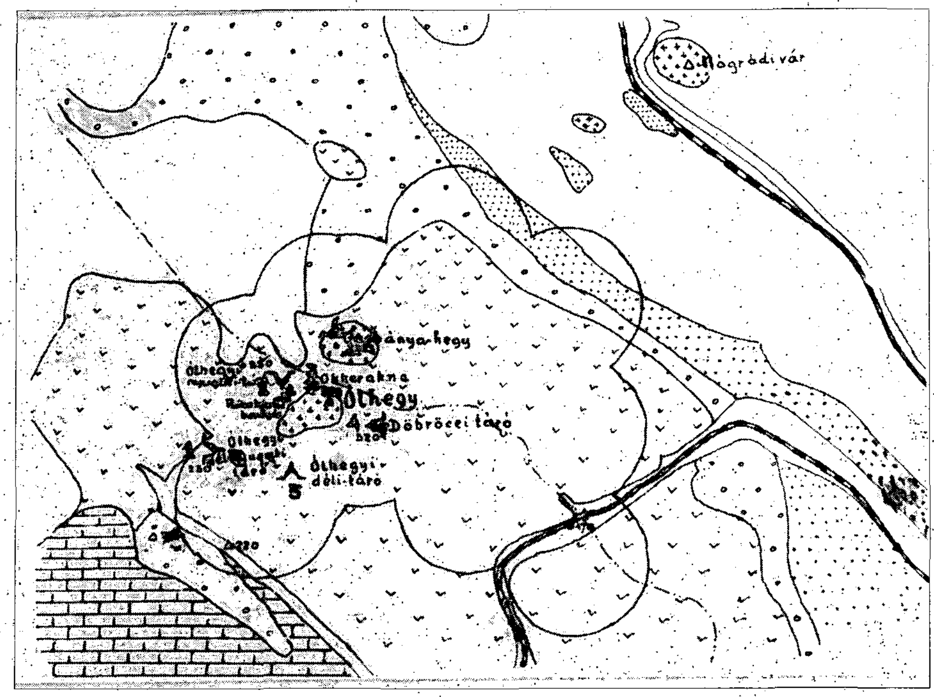


Fig. 3. Iron ore occurrences of Szokolya and Nógrád (after I. VITÁLIS, original scale: 1:75 000)
3. ábra. Szokolya és Nógrád környékének vasérc előfordulásai, VITÁLIS I. szerint (eredeti M= 1:75 000)

In this period the demands for manganese ore were also increased. Beside the already known and operated localities new sites were also studied. Manganese ore occurrences were also known from the Eger environment and it came into the foreground of interest in this period. Upon requests of the Ministry of Industries the area was investigated by M. VENDL (Mangán 15; 1938). In the same year I. VITÁLIS wrote a preliminary report "Manganese ore occurrence in the Eger region" (Mangán 10; 1938). Then, as a continuation, I. VITÁLIS in his reports (Mangán 11, 12, 13; 1938) described the schedule and results of the investigations. Finally, due to the capricious mode of occurrence and poor quality of the ore the area was abandoned.

Several bauxite localities had already been known and operated but the increasing demands required further investigations. The report compiled in the first period was written by GY. VIGH. "Report on the bauxite and basalts of the Kovács major area owned by the English—Hungarian Bank near Diszel" (Bu 7; 1938) in which he concludes that both the basalt and the bauxite to be found here are of poor quality. P. ROZLOZSNIK (Bu 8; 1939) and I. VITÁLIS (Bu 9; 1939) wrote on the Nyirád and Perepuszta bauxite of Magyar Bauxite Mines Co. The first an estimation of the mineral resources was prepared, and the second accounted for the necessity of a more precise reserve estimation

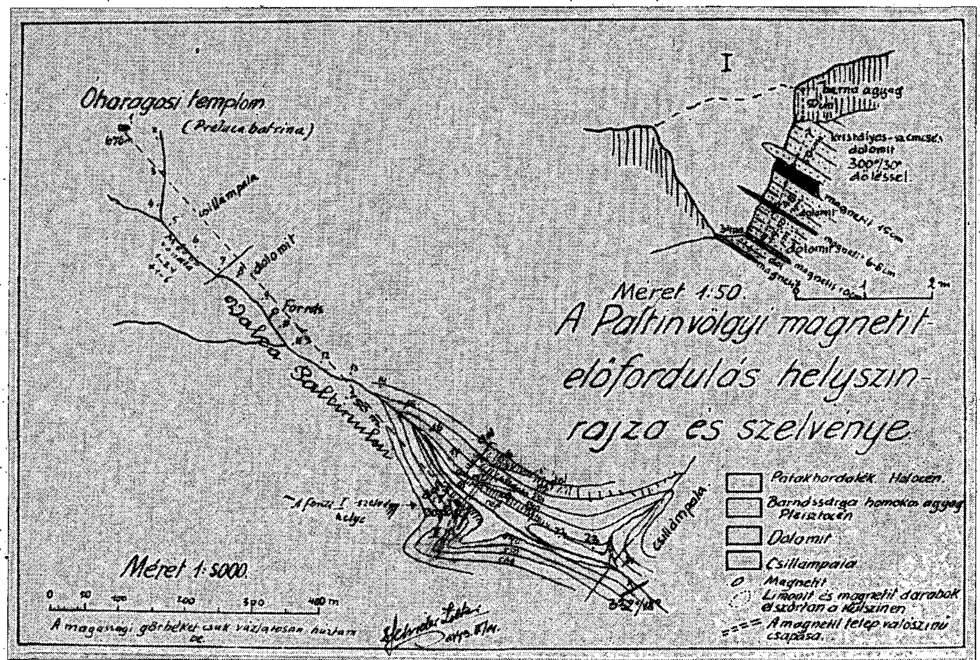


Fig. 4. Geological sketch map and profile of Paltinvölgy by Óharagos (after Z. SCHRÉTER)
4. ábra. Az Óharagos környéki Paltinvölgy földtani térképvázlata és szelvénye, SCHRÉTER Z. szerint

and for the better determination of the ore quality with a detailed plan for drilling.

The documents dealing with the exploration and production of the "Félix" mine at Diszel and the required permissions issued by the Inspection of the Mines are noteworthy and instructional for us even now (Bu 13; 1940).

Related to the investigations of nonmetallic minerals, I. VITÁLIS prepared an expert opinion for the Hungarian Chemical Works Co. dealing with refractory clay exploration (Tü.a. 7; 1938 and Tü.a. 8; 1941). In them he summarized the localities within the country and then those in the reannexed regions. Within the borders of the country, I. FERENCZI (Kaolin 11; 1938) and A. FÖLDVÁRI (Kaolin 12; 1938) made a prospecting on the kaolin deposit of Füzérradvány. A. FÖLDVÁRI gave also outlines for the further investigations required by reserve estimation. S. VITÁLIS (Kaolin 14; 1939) described the geological condition of the kaolin occurrence of Szegi. By the assignment of the Ministry of Industries, G. SZUROVY carried out mining-geological surveying necessary for a forthcoming exploration of the ore and kaolin deposits of Gyöngyössomlyó. He concluded that neither the ore nor the kaolin were workable in the region (Kaolin 16; 1940).

In the reannexed parts of the country, A. LIFFA studied some kaolin and refractory clay occurrences (Kaolin 15; 1940). The geological and mining geological conditions of the kaolin and refractory clay occurrences of Dubrinics (Bercsényifalva) are shown on Figs. 5 and 6.

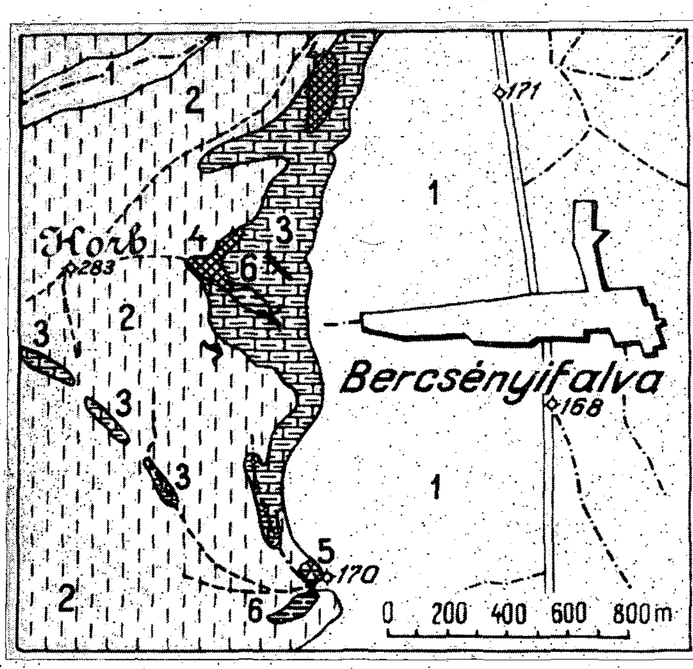


Fig. 5. Geological sketch map of the vicinity of Dubrinics (Bercsényifalva) (plotted by A. LIFFA)

5. *ábra.* Dubrinics (Bercsényifalva) környékének földtani térképvázlata, felvette: LIFFA A.

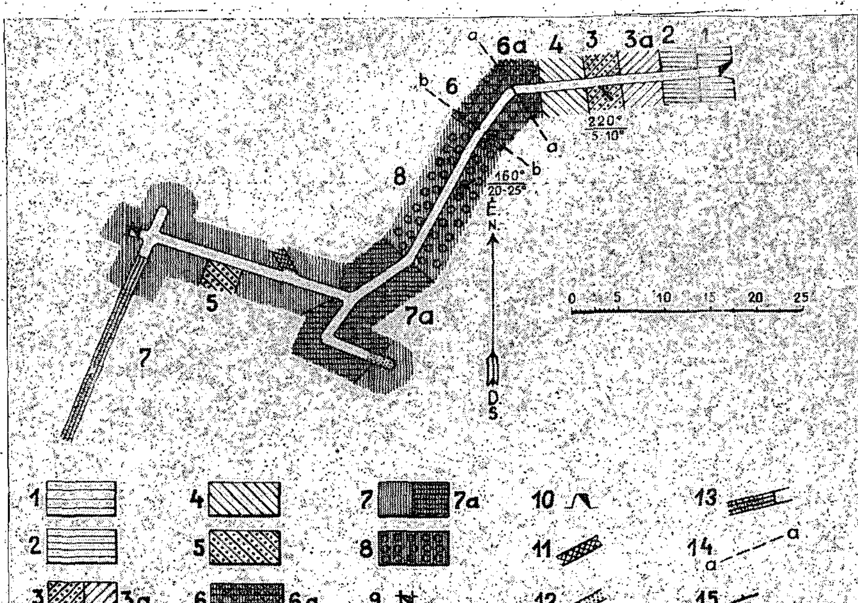


Fig. 6. Mining-geological map of the kaolin exposure at Dubrinics (Bercsényifalva) (after A. LIFFA)

6. *ábra.* A dubrinicsi (Bercsényifalva) kaolin feltárás bányaföldtani térképe, LIFFA A. szerint

In post-Trianon Hungary no rock salt deposits have remained to be ex-ploited. As in the case of other minerals, a search for rock salt was introduced, hoping also for the presence of oil around the salt domes in Transylvania and Sub-Carpathia. A rock salt occurrence near Drágabártfalva was described by GY. KULHAY and T. SZALAI (Ált. 12; 1940) and by F. SZENTES (T 81; 1939) regarding Talaborfalva. T. SZALAI (T 85; 1940) dealt with the Körösmező occurrence. In the director's report L. LÓCZY JR. (Ált. 13; 1943) the rock salt areas of Aknaszlatina and Aknasugatag were described.

The Department of Hydrogeology was perhaps the busiest section of the Institute playing an important role in obtaining a sounder knowledge of the hydrogeology of the country. L. MARZSÓ carried out studies of artesian wells in Szekszárd and in its broader vicinity and also in Muraköz (T 1686; 1943). The gaseous artesian wells of Tiszántúl (The Trans-Tisza Region) were examined by E. R. SCHMIDT (Ált. 11; 1939). All these works contributed to the completion of the artesian well register of the country. In his expertise "Thermal water heating of the City Hall" L. LÓCZY JR. (T13868; 1943) described the geological conditions and the water law problems rising therefrom. In the course of the geological mapping hydrogeological observations were also made. I. FERENCZI mentions salty and sulphuric springs from Ladamóc, and F. PÁVAI VAJNA speaks of salty springs in the Léva-Ipolyszécsényke area (T 81; 1939). Finding oil indications was the practical purpose of these observations.

Reports related to hydraulic construction can be also found in the Archives. In his expert's opinion E. SCHERF (T 88; 1939) gives an account "... of the geological investigations performed in the region of the Tarackraszna barrage", and in another expert opinion of his (Ált. 13; 1944) he speaks of the proposed location of the water dam at Visóvölgy. The idea of the constructing a dam by Tiszalök arose simultaneously. Of the related work J. SÜMEGHY prepared a report. He called also the attention to the necessity of investigating carefully the expectable environmental impacts (T 76; 1938). The location of the planned objects is shown in Fig. 7.

In the concerned period also the soil-scientific mapping was accelerated. The reports of L. KREYBIG (T 5077; 1941) and L. LÓCZY's JR. "Reports of the Director" serve with the respective information.

Among the Institute's work for practical purposes those belonging to the engineering geology should also be mentioned. Among these, G. TELEKI's (Egyéb 15; 1938) "Geological expert's report on the touristic utilization of the monks' lodgings in Tihany" should be first mentioned. Referring to the land-slide hazards of the high banks he emphasized that the costs of the rescue operation of uncertain result might by far exceed the expected profit coming from tourism. It is well compleneted by L. LÓCZY JR. seems to have shared the former opinion in his "geological study" demanding that "the railway line and public road endangered by landslide hazard by Balatonkenese—Fűzfő shall be replaced into the lake". In this case, instead of the construction of the technically almost unrealizable, extremely costly protected works, he suggested

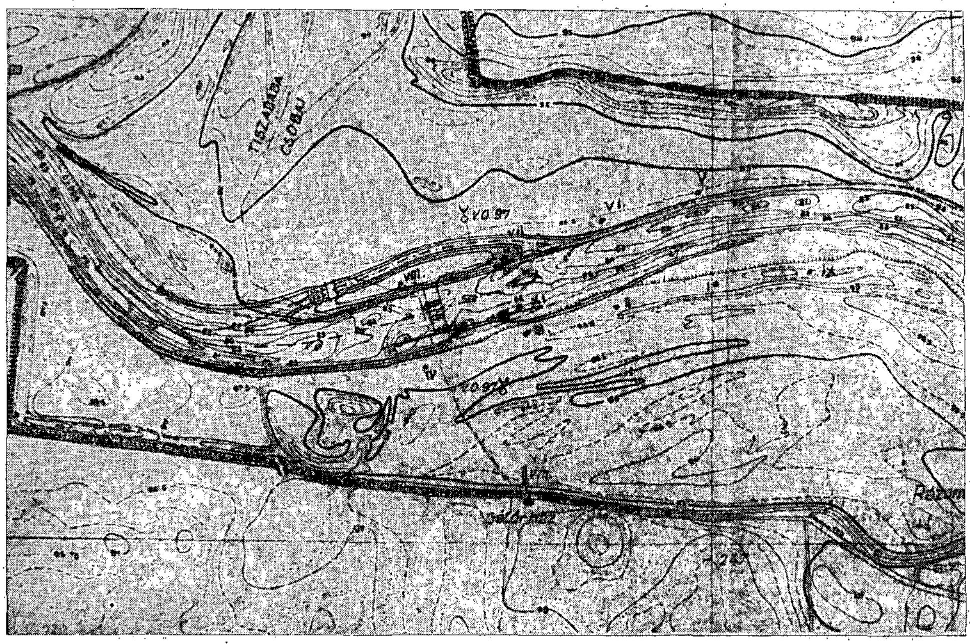


Fig. 7. Lay out map of the objects of the Tiszalök Water Dam and its immediate surroundings, from Report T 76 (Original scale: 1:10 000)

7. ábra A tiszalöki viztározó duzzasztó-műtárgyának és szűkebb környezetének helyszínrajza, a T 76 sz. jelentéséből (eredeti M=1:10 000)

applying a "passive defense". The sliding of the high banks in 1942 is well shown in Fig. 8 (Fsz. 13; 1943).

As a special idea, S. JASKÓ's proposal (Egyéb 21; 1944) should be mentioned here entitled as "Geological expert's report on the utilization of the Mátyás-hegy (Mátyás Hill) caves as shelters against the bombings of air raids" with the description and map of the cave system (Fig. 9).

Speleological investigations are also interesting. Ördög-lyuk (the Devil's Hole) at Tornagörgő and Csengőlyuk at Pelsőc were studied by H. KESSLER in the Gömör-Torna karst region. Some 33 caves of the Homoródalmás ravine were investigated by J. KEREKES. In six caves he found phosphatic clay and bat guano in a quantity that is worth mining. Both of these investigations are recorded in the report (Ált. 13; 1943).

The reproductions of Figs. 2—9 in this study praises the work of M. PELLÉRDY and the author here would like to expressed his warmest thanks to her.

Fig. 8. The railway line section between Balatonkenese and Fűzfő damaged by the landslide of 1942, and a view of the zone of sliding by sections 419—421 (after L. LÓCZY JR.)

8. ábra. Az 1942-ben Balatonkenese és Fűzfő között bekövetkezett hegyomlástól megrongált pályaszakasz és csuszamlás látképe a 419—421 szelvényeknél, if. LÓCZY L. felvétele

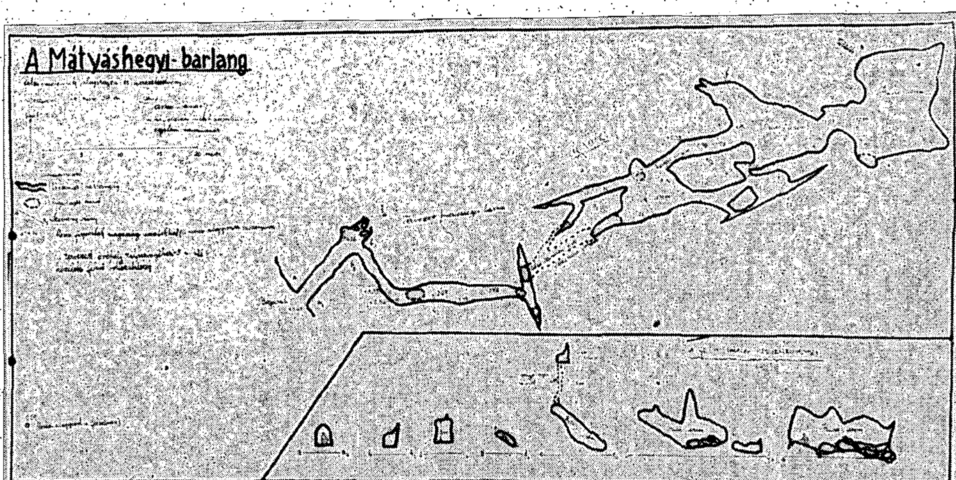


Fig. 9. Map of the Mátyáshegy cave system, and the typical cross section of its caves (after S. JASKÓ)

9. ábra. A Mátyáshegyi-barlang térképe és üregeinek jellegzetes keresztmetszete, JASKÓ S. szerint

REFERENCES — IRODALOM

ERDÉLYI-TÓTH, E. 1991: The collection of early reports and experts' opinions in the National Geological Data Base 1839—1950. — Ann. of the Hist. of Hung. Geol. Spec. is. 3. (ser. ed. G. CSÍKY, eds. GY. VITÁLIS and T. KECSKEMÉTI) Budapest, 215—228.

SZENTIRMAI, I. 1991: Manuscript reports of science-historical value in the National Geological Database 1920—1929. — Földt. Int. Évi Jel. 1989-ről: 641—658.

SZENTIRMAI, I. 1992: Manuscript reports of science-historical value in the National Geological Database 1930—1937. — Földt. Int. Évi Jel. 1990-ről, Budapest.

VITÁLIS, GY. 1988: History of earth sciences as represented by Geological Survey Reports stored in the files of the National Geological Data Base 1839—1899. — Földt. Int. Évi Jel 1986-ról,: 613—626.

VITÁLIS, GY. 1989: Manuscript regional reports of science-historical value dated 1900—1909, in the National Geological Archive. — Földt. Int. Évi Jel. 1987-ről: 487—504.

VITÁLIS, GY. 1990: Survey reports of science-historical importance stored in the national Geological Data Base of Hungary 1910—1919. — Földt. Int. Évi Jel. 1988-ról: 407—423.

AZ ORSZÁGOS FÖLDTANI ADATTÁR TUDOMÁNYTÖRTÉNETI ÉRTÉKŰ KÉZIRATOS TERÜLETI JELENTÉSEI 1938—1944

SZENTIRMAI ISTVÁN

Magyar Állami Földtani Intézet
Budapest, Stefánia út 14.
H-1143

ETO: 061.68:55(439)55(091)439)

Tárgyszavak: Területi kutatási jelentés, tudománytörténet, adattár

Ez a cikk a hatodik tagja az e tárgyban VITÁLIS GY. (1988; 1989; 1990) által indított újszerű, majd SZENTIRMAI I. (1991; 1992) által folytatott módszeres adattári feltáró munkából származó közleményeknek.

Ez esetben egy történelmileg szűkre szabott, de a földtani kutatásban gazdag időszak fontosabb jelentéseit tekintjük át.

Az állami és magántőke érdeklődése a megnagyobbodott országterület ásványkincsei iránt a visszatért részeken intenzív tudományos és gyakorlati munkára ösztönözte a földtan művelőit.

Mindamellett a mai Magyarország területének kutatását sem hanyagolták el. A válogatott jelentésekből és a válogatáshoz szükségképpen tanulmányozott jelentésanyagból világosan kitűnik, hogy a mai határokon belül a ma is rendelkezésre álló energiahordozókat és nyersanyagokat egyaránt kutatták. A visszacsatolt országrészek viszonylagos ismeretlensége nagyobb reményekkel kecsegtetett, ezért ott a kutatás intenzívebb volt.

THE COLLECTION OF MINERALS AND ORES OF THE HUNGARIAN GEOLOGICAL SURVEY TAKING CHARGE OF KEEPING SCIENTIFIC MATERIALS AND PROVIDING RELEVANT INFORMATION

by

ORSOLYA KÁKAY-SZABÓ

Hungarian Geological Survey
Budapest, Stefánia út 14.
H–1143

UDC: 069.5

Keywords: Museum, history, collections, exhibitions, development

The Collection of Minerals and Ores of the Hungarian Geological Institute preserving the scientific materials of the search for minerals since 1868 became one of the greatest collections of this kind in the Carpathian Basin. Its second period of intensive enrichment began in 1950, when the exploitation of ore mines within the reduced national borders started. The collection has continued to be enriched and is divided into three parts which are as follows: a Collection of Minerals and Ores; a Collection of Minerals from Hungary; a Collection of Standards. All data associated with these collections can be retrieved, for the time being, according to the name and locality of minerals. A computer-based database program is being developed making feasible the retrieval of the materials of the Collection according to several aspects.

The history of collection begins with the history of the Hungarian Geological Institute in the year 1868, when the Hungarian Geological Department was set up within the framework of the Ministry of Agriculture. The members of the Hungarian Geological Department, namely, M. HANTKEN, K. HOFMANN, B. WINKLER, J. BÖCKH and A. KOCH, immediately started to survey the geology of the environs of Budapest, Transdanubia and the stern margin of the Great Hungarian Plain. Mineral samples collected during these investigations were the first to incorporate into the collection.

A year later, Minister of Agriculture I. Gorove made a proposal to sovereign FRANCIS JOSEPH for the establishment of the independent Royal Hungarian Geological Institute. The consent thereto was given by sovereign FRANCIS JOSEPH on the 11th June, 1869. The first Director of the Institute, M. HANTKEN specified, in the Deed of Foundation, all duties related to the collection and issued orders of practical approach clearly showing how to store, document and study the mineral samples and how to apply the pertaining data in the research.

Starting from 1879, particularly from the time when a large-sized geological investigation of the NE Carpathians and the Transylvanian Basin began, the collection became richer and richer from year to year.

However, the samples collected were stored in packing-cases located in cellars.

Despite the fact that the geological research went on excellently in regard to economy, the expert staff of the Institute were accommodated in an area of 5 to 6 rooms of flats even 13 years after the time the Institute had been established.

In the year 1882, after 13 years'directorship, M. HANTKEN had to left his office so that there was no hope for ensuring an independent building for the Institute.

In the year 1882 J. BÖCKH was appointed director of the Institute. At this time he focused not only on research but on the necessity to create a home for the Geological Institute.

As a first step, in 1887 the Institute was moved from a number of flats to the new building of the Ministry of Agriculture where a space of 512 sq.m. was provided for the Institute. During the geological surveys that started in 1883, a great number of samples from Selmecbánya, Körmöcbánya, Nagybánya, Felsőbánya, Kapnikbánya, the gold deposits in the Erdélyi Érchegység (Transylvanian Ore Mts) and the Szepes-Gömöri Érchegység (Szepes-Gömör Ore Mts) were collected and incorporated into the collection. These samples provided a basis for the mining-geological collection. Using this rich collection, J. BÖCKH organized representative exhibitions on mining and mineral resources prospecting. As a result, both the industrial and the commercial spheres got knowledge, all of a sudden, of the large-scale geological research including its practical significance. In the year 1896, at an exhibition organized in line with the millenary celebrations of Hungary, the Institute achieved a great professional success by showing its scientific, practical and industrial activities. However, a great astonishment was caused by the manifestation of the poor working conditions of the experts. Inspired by this unacceptable situation, Minister of Agriculture I. DARÁNYI submitted a petition to the National Assembly to provide a financial basis for the establishment of a building ensuring a proper accommodation for the Geological Institute. Starting from the time of being appointed director of the Institute, J. BÖCKH urged, from year to year, the acceptance of this petition. After the petition had been approved by the National Assembly, the metropolitan leadership contributed an area of 2000 square fathoms and a sum of 800 000 gold crowns, whereas the Great Hungarian Maecenas A. SEMSEY contributed by 50 000 gold crowns to the establishment of the new building of the Geological Institute. The building was constructed with an incredible speed, over a period of two years.

In the year 1899 J. BÖCKH inaugurated a most beautiful secessionist building designed by Ö. LECHNER that has even today accommodated the Hungarian Geological Institute. In this building an area of 1470 sq.m. was provided for the Collections.

This event put an end to a 17 years' heroic era of J. BÖCKH's directorship and, at the same time, to the most revolutionary and most active period of geological research in Hungary.

During the hard times of 30 years the expert staff of the Geological Institute provided a firm basis that has so far been relied upon, even by today's Hungarian geologists. During the aforesaid period one-fourth of Hungary covering, at that time, the entire Carpathian Basin, was surveyed and samples of mineral resources, rocks and fossils were collected therefrom. As a result of these active years of work, such a large amount of material was collected that it filled ten huge rooms, on the second floor of the building. Documents of several decades' work, samples from the abundant mineral resources, rocks and fossils encountered in Hungary, the comparative material needed for research and the soil samples used for practical purposes were accommodated in beautiful storage cabinets matching the secessionist style of the building of the Hungarian Geological Institute (Fig. 1).

Fig. 1. Early cabinets for the storage of the Collection of Minerals and Ores (Photo: M. PELLÉRDY)

1. ábra. Az ásvány- teleptani gyűjtemény első tárolószekrényei (Fotó: PELLÉRDYNÉ)

The collection was enriched by geologists as well as collectors who were friends of geology, and by the greatest patron of sciences in Hungary, A. SEMSEY. That is how one of the greatest geological collection in the Carpathian

Basin was formed by the turn of the century. In the year 1900 a well-educated student of J. KRENNER, namely, A. LIFFA (Fig. 2) was commissioned to set up the Collection of Minerals and Ores. Using the samples of ore and mineral resources, A. LIFFA established a Mining-geological Collection and a Collection of Comparative Materials.

Fig. 2. A. LIFFA, the establisher of the Collection of Minerals and Ores (Photo: M. PELLÉRDY)
2. ábra. LIFFA AURÉL, az ásvány- teleptani gyűjtemény felállítója (Fotó: PELLÉRDYNÉ)

The Collection of Minerals and Ores embraced five major fields of research, namely, ore mining, coal mining in general, petroleum exploration, coking coal mining and opal mining. Samples of minerals and industrial resources of various mining regions were grouped according to their localities.

The collection of ore minerals covered the Small and NE Carpathians, the Szepes-Gömöri Érchegység (Szepes-Gömör Ore Mts), the Vihorlát-Gutin Mts, the ore dykes in Mátra Mts, the Erdélyi Érchegység (Transylvanian Ore Mts), the iron ore range in Hunyad county and the Krassó-Szörény Ore Mts. The major part of this collection of samples from ore mining are considered as the most valuable pieces of our collection of standards even today. A number of mineral species were first described from these fields of research. Included in them are sylvanite first encountered at Offenbánya, semseyite first found at Felsőbánya, and andorite named after the great Hungarian patron of sciences and described by J. KRENNER in 1881 and 1882, as well as krennerite described and named after KRENNER by RATH in 1877. Moreover, nagyágite, rézbányite, libethenite, kapnikite, úrvölgyite and dillnite are also included.

The Comparative Collection consisting of three parts was for use in comparing rocks, construction rocks, ornamental stones and precious stones of various purposes with rocks found in Hungary, and suitable for any of the aforesaid purposes.

The collection of artificial and construction rock samples from Austria, Germany, France, Sweden, Norway, Serbia and Greece were collected by T. SZONTAGH and F. SCHAFARZIK.

The collection of precious stone and ornamental stones included ornamental objects made of agate, onyx and carnelian mainly from Brazil, donated to the Museum by A. SEMSEY in 1896.

The part of the collection representing precious stones and ornamental pieces from the Hungarian Empire was intended to demonstrate rocks and minerals that were suitable for use in preparing precious stones and ornamental pieces.

By the time the collection of the Museum became, during a period of four decades, the most complete collection in the Carpathian Basin, J. BÖCKH, after 26 years' directorship, was followed by L. LÓCZY, a prominent scientist of international reputation in geology and geography. In May, 1909 after his plans had been completely implemented, J. BÖCKH died.

On the 18th of July, 1909 L. LÓCZY had a bulletin titled Vezető (Guide) published to the 40 anniversary of the Geological Institute. This bulletin represents the first summary of the 40 years' history of the Royal Hungarian Geological Institute, including the first description of the collections of the Museum in which a description of the Collection of Minerals and Ores by A. LIFFA was also included, The paper gives a clear description of the geological setting of mining districts in the Carpathian Basin and is illustrated with photos showing the typical mineral species from each mining area. For instance, the gold plate shown here (Fig. 3) represents a historical piece of great importance for our collection of standards even today.

World War I caused the continuous progress of the Geological Institute and the Museum to interrupt. As a result of the varying political conditions, the working conditions and performances also showed fluctuations. In the year 1919 L. LÓCZY retired on a pension and in May of the following year he died. After he had left the Geological Institute, hard times, transitional years came in the lives of the Institute and the Museum alike. As a result of changes in the national borders, the research fields considerably reduced, too. Research plans and options also changed. As a result of subsequent reorganizations, the inefficient management of deputy directors, the progress of the Museum stopped and became neglected.

L. LÓCZY as director was followed five years later, in 1925, by F. NOPCSA, a world-wide famed paleontologist, then in the year 1929 by an expert of

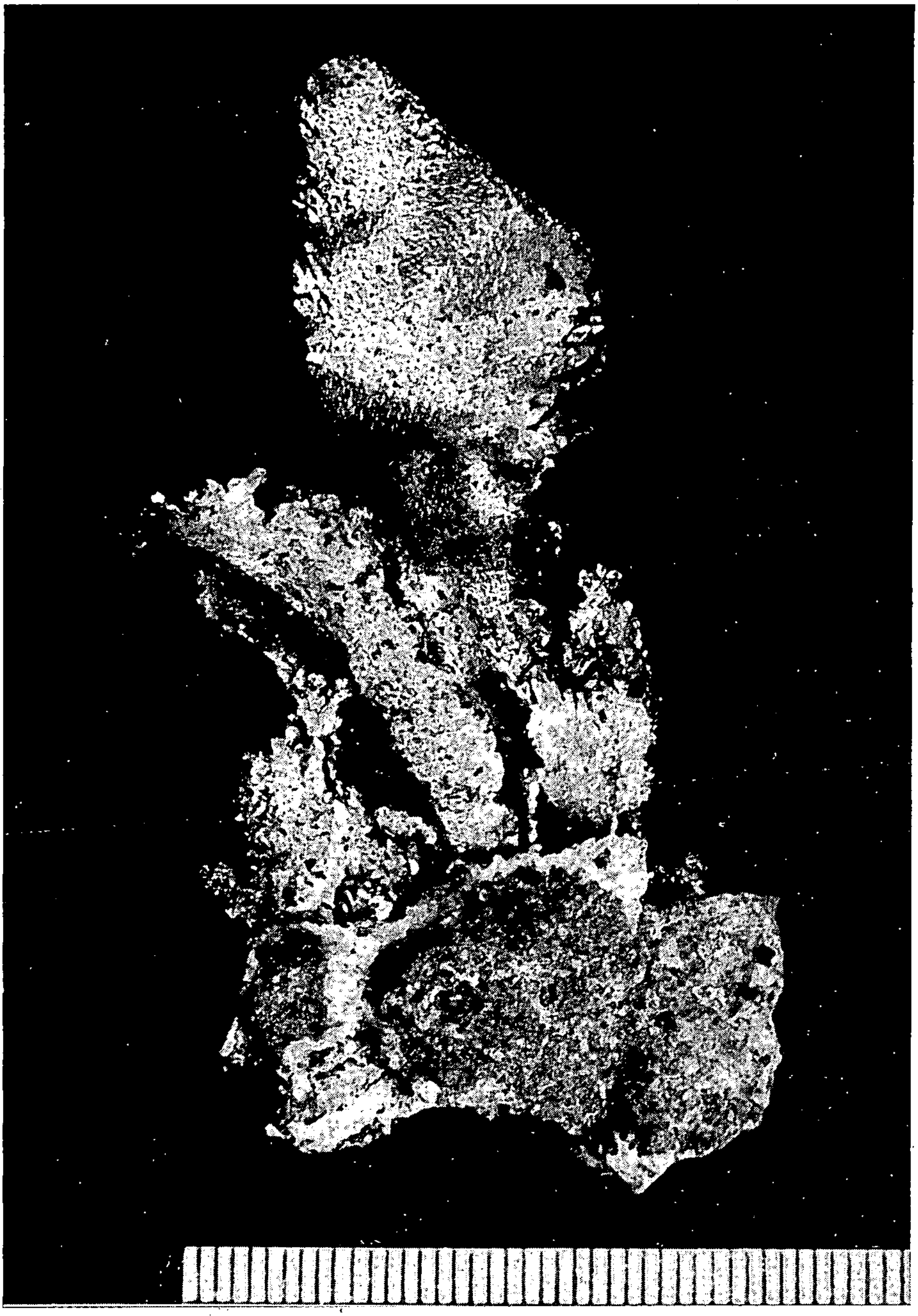


Fig. 3. A gold plate from Verespatak, representing an ancient piece of the Collection of Minerals and Ores (Photo: M. PELLÉRDY)

3. ábra. Aranylemez Verespatakról, az ásvány- teleptani gyűjtemény ősi darabja (Fotó: PELLÉRDYNÉ) hydrocarbon explorations, H. BÖCKH, who had an excellent practical sense. However, H. BÖCKH died young, in the year 1931.

In 1932 L. LÓCZY JR. was appointed Director of the Geological Institute. According to his own governing principle he focused on the research of resources for practical purposes. As a result, in the second half of the 30s ore geological explorations started in the region of Gyöngyösoroszi and Recsk, in the Velence Mts, in the vicinity of Szabadbattyán, in the Uppony Mts and the Rudabánya Mts, in the region of the Bakony Mts and in the Tokaj Mountains. However, the explorations were suspended during World War Two. Only a number of documentary samples associated with these investigations were incorporated into the Collection, for lack of proper leading experts. Due to the war, chaos and incertainty became dominant again. L. LÓCZY JR. did not return home from his expert trip to Turkey in 1946, and, finally, he officially resigned from his post in the Geological Institute in 1948. From 1946 to 1950 the Institute was temporarily directed by a famed geologist, T. SZALAI. In the first half of 1950 S. VITÁLIS, later a professor of Applied Geology at the Eötvös University was appointed Director of the Geological Institute. During this period he organized the geological research organizations. As a result, departments of applied geology were set up. Between 1950 and 1958, directors followed one another at intervals of half a year, one year or two years, including L. MAJZON, K. BALOGH, J. NOSZKY JR., M. KRETZOI. Meanwhile, in accordance with the Government's central conception of developing heavy industries in the country, ore production in mines opened around 1937 was resumed. This rapid progress also gave an impetus to the reorganization of the Collection.

In November, 1950, a new era started for the Collection, when a former General Director of the National Museum of Natural Sciences, A. TASNÁDI KUBACSKA (Fig. 4) was appointed Head of the Museum of the Geological Institute by director L. MAJZON. A. TASNÁDI KUBACSKA was an outstanding paleontologist with a wide intellectual horizon who established the science of paleopathology, created a school for the "artistical" keeping of museums for natural sciences, and excelled in propagating the knowledge of natural sciences in public spheres, established the Science-Historical Collection of the Geological Institute, and was the first Hungarian representative of INHIGEO. He was able to revive the Museum that had been established by great predecessors but neglected due to political storms sweeping through the country over a period of a few decades. Being a good organizer of dynamic personality, he worked out modern and comprehensive plans on a uniform basis for the development of the stratigraphic, mineralogical and petrological units of the Museum, and appointed experts to lead these collections.

Included in the essential tasks were to documentary materials of new research areas within the reduced borders and to sort materials from former surveying carried out in these areas. The arrangement of scientific exhibitions for the general public and the collecting comparative samples from other countries were not included any longer in the mission of the Museum, and the materials

Fig. 4. A. TASNÁDI KUBACSKA, Head of the Museum of the Geological Institute (Photo: M. PELLÉRDY)

4. ábra. TASNÁDI KUBACSKA ANDRÁS, a Földtani Intézet Múzeumának vezetője (Fotó: PELLÉRDYNÉ)

suitable for these purposes were transferred to the relevant specialized collections of the Museum of Natural Sciences and the universities.

Till 1950 the fundament of the Mineral and Ore Collection consisted mainly of mineral samples collected in the Carpathian Basin until 1920. Within the reduced territory of the country the exploitation of ore deposits started in 1951. Parallel with the mining operations, a systematic collecting action of mineral and ore samples also began. As a result, a second period of enrichment was initiated for the Mineral and Ore Collection. The main goal was to give a perfect description of ore and mineral samples from the mines, including type minerals and mineral rarities. In the 50s the first samples were collected in an oxidation zone overlying the Rudabánya iron ore deposit. Native copper of rare quality, in a great variety, is most valuable in our Collection even today. A native copper skeleton crystal that is unique in the world in regard to its quality (Fig. 5) was also collected during this period. In addition, the lead and zinc deposits in the Mátra Mts and the bauxite and manganese deposits in the Bakony Mts were also exploited. The major part of specimens incorporated into the Collection were collected by geologists involved in the exploration of the ore deposits, namely, G. PANTÓ, B. JANTSKY, A. VIDACS and GY. BÁRDOSSY, together with A. TASNÁDI KUBACSKA.

In January, 1957 J. ERDÉLYI, a talented mineralogist working for the Hungarian National Museum was appointed keeper of the Collection of Minerals and Ores. He rearranged the Collection according to a new conception and performed a partial development thereof, under the guidance of A. TASNÁDI KUBACSKA. The Collection of Ores and Minerals was divided into three major parts, namely, the collection of ore deposits according to ore deposit localities,

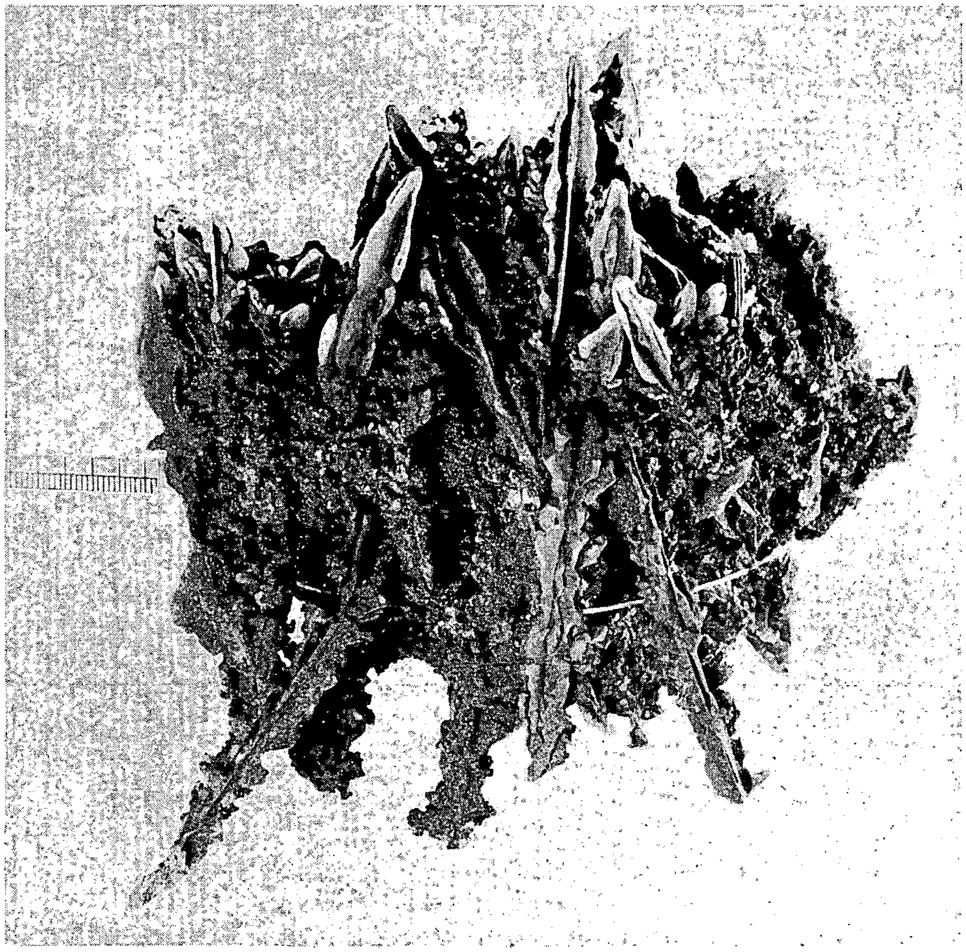


Fig. 5. Native copper skeleton crystal with malachite coating, from Rudabánya (Photo: M.-PELLÉRDY)

5. ábra. Termésréz vázkristály malachit bevonattal Rudabányáról (Fotó: PELLÉRDYNÉ)

a collection of minerals collected in Hungary, grouped in a systematic order of minerals, and finally, a collection of mineral standards for comparison, arranged in alphabetical order according to mineral names. Since that time the

Collection has been kept according to this system. J. ERDÉLYI was involved not only in the development of the Collection of Mineral Samples but also in enriching the Collection with samples from zeolite and serpentinite localities in Hungary. In addition, ha also made a number of new statements concerning the detailed structure of the aforesaid minerals.

In the year of 1958, a young geologist J. FÜLÖP, the newly appointed Director of the Geological Institute recognized the problems with the accommodation of the materials of the Collection and took measures to commute the old-fashioned cases for new oak cabinets with drawers of high storage capacity and suitable for a safe keeping of the materials concerned (Fig. 6.) The finan-

Fig. 6. Oak cabinets for the storage of the Collection (Photo: M. PELLÉRDY)
6. ábra. A gyűjtemény tölgyfa tárolószekrényei (Fotó: PELLÉRDYNÉ)

cial coverage needed to by the cabinets was ensured over a period of years by V. BESE, General Director of National Oil and Gas trust at that time. By 1968 both wings of the Museum were filled with the 350 new cabinets comprising a total of 17 000 drawers. By 1969, when an international congress was held on the occasion of the 100th anniversary of the Institute, the entire collection was arranged according to the new conceptions and was ready to show the scientific materials of the previous 100 years to foreign and Hungarian visitors alike.

In 1967 A. TASNÁDI KUBACSKA was commissioned to arrange an exhibition showing the Institute's history during the previous one hundred years, using the mineral and ore samples and stratigraphic materials of the Collection, including a representation of the work results achieved during this period, at the Centenary Celebrations of the Institute. When starting the work, A. TASNÁDI KUBACSKA assessed the material representing the mines and came to realize that the assemblage of samples from orebodies in Hungary was deficient and poor in minerals suitable for demonstration. To make up it, he organized regular trips to mines operating at full capacity at that time. O. KÁKAY-SZABÓ, a student of S. KOCH, Professor of Mineralogy at the University of Szeged, was employed, after her graduation in 1968, for this job. Since the time J. ERDÉLYI retired in 1968, O. KÁKAY-SZABÓ has been the keeper of the Collection. A. TASNÁDI KUBACSKA, in association with her, started to accomplish a combined task of collecting samples and arranging the exhibition. The collecting trips proved to be successful. The most beautiful and most valuable mineral samples from the mines became the representative pieces of the Collection.

Fig. 7. A showcase used to demonstrate the Gyöngyösoroszi ore deposit at the centenary exhibition (Photo: M. PELLÉRDY)

7. ábra. Gyöngyösoroszi érctelep centenáriumi kiállítási szekrénye (Fotó: PELLÉRDYNÉ)

Each mining area was demonstrated in a separate vitrine, including samples from orebodies of Rudabánya, Recsk, Mátraszentimre, Gyöngyösoroszi (Fig. 7), the Velence Mts, the oxide and carbonate manganese ore deposits at Urkút and Eplény, the coal seams in the Mecsek Mts, and the type localities of bauxite in Hungary and all over the world (the latter collected and arranged by GY. BÁRDOSSY). These vitrines show results from research of decades even today in the corridor of the geological Institute. The only change is that the major part of ore and mineral samples from the demonstrated mines are now regarded as "relics" that are to be carefully preserved because they are of inestimable value and irreplaceable.

In 1970, after the centenary celebrations, director J. FÜLÖP was replaced by J. KONDA who led the Institute till 1979.

After the centenary, A. TASNÁDI KUBACSKA published a book titled Láthatatlan bánya (The invisible mine) describing the history of the one-and-a-half-a year-long collecting trips. This work published in 1973 has been regarded as a swan-song of A. TASNÁDI KUBACSKA, also giving a review of the history of mines that were operational at that time. In the year 1973 A. TASNÁDI KUBACSKA as leader of the Museum was replaced by I. NAGY, and died in 1977. His successor followed the already established tendency of developing the collections.

In addition to mineral samples from old mines, from 1971, the collection of mineral specimens from the deep-level polymetallic ore deposit of Recsk have also has contributed to a continuous enrichment of the Collection. In-

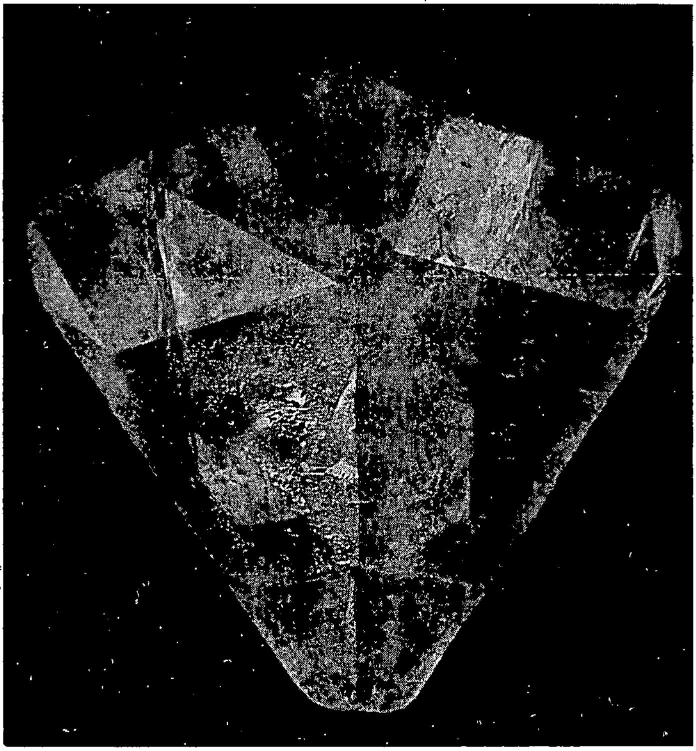


Fig. 8. One of the largest heart-shaped twin crystal of whewellite ($CaC_2O_4 \cdot H_2O$) in the world; Recsk; level: -900; 5.5x5.5 cm (Photo: M. PELLÉRDY)

8. ábra. A világ egyik legnagyobb whewellit ($CaC_2O_4 \cdot H_2O$) szívalakú ikerkristálya, Recsk, -900szint (5,5x5,5 cm) (Fotó: PELLÉRDYNÉ) cluded in these specimens is a heart-shaped whewellite twin crystal (Fig. 8) representing one of the largest, 5.5 by 5.5 cm, calcium-oxalate organic mineral in the world. The Collection of Mineral Samples from Hungary was also made richer by the incorporation of rare mineral samples from Erdőbénye and Felső petény and with the mineral samples from minor localities such as Csordakút, yielding a large benzol-hexacarbonic acid organic mineral also regarded as a rarity in the world, the crystal druse of mellite (Fig. 9).

Fig. 9. A crystal druse of mellit ($Al_2C_{12}O_{12}\cdot18H_2O$) from Csordakút (dimensions: 17.5x9.5x10 cm); (Photo: M. PELLÉRDY)

9. ábra. Mellit ($Al_2C_{12}O_{12}\cdot18H_2O$) kristálydruza, Csordakútról (17,5x9,5x10 cm) (Fotó: PELLÉRDYNÉ)

In 1979 G. HÁMOR took over the directorship of the Geological Institute. As a first step he organized to from a mezzanine structure in the Museum in order to enlarge the space provided for the research associates and to allow the research staff to have been increased. This work implied that the collections of the Museum were moved and rearranged several times. At the beginning of the 80s' I. NAGY was responsible for organizing and directing this major job. The samples of the collection were places into small fixed or rolling storage cabinets (Fig. 10). A part of the material of the Collection of Minerals and Ores stored in 49 oak cabinets was moved into 101 brand-new cabinets and, due to a restricted storage capacity, the bauxite, iron ore, brown coal and petroleum samples were transferred into our depository at Rákóczi-telep.

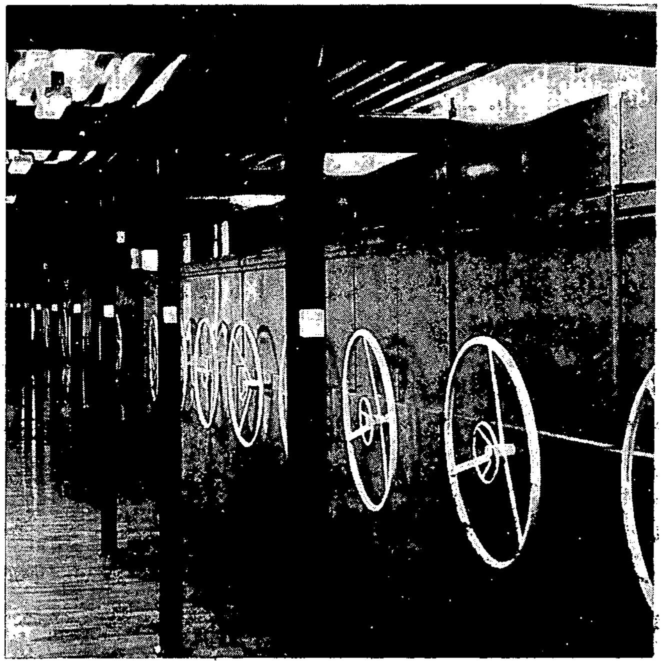


Fig. 10. Massive cabinets for the storage of the Collection (Photo: M. PELLÉRDY)
10. ábra. A gyűjtemény tömör tárolószekrényei (Fotó: PELLÉRDYNÉ)

In the year 1987 L. KORDOS was promoted to Head of the Museum. Since that time he has been involved in this duty. Under his guidance, catalogues for each unit of the Museum have been completed in a regional system setup according to counties that will allow us to introduce a computer-based data processing of the Collection. The establishment of the programme for a computerbased database of the Collection was entered on. This vast amount of data will be available for our researchers through computerized retrieval, according to several aspects, in an easy and rapid way.

All documents and relics of inestimable value associated with geological research preserve the past and they can be instrumental in economizing geological research now and in the future, too.

REFERENCES — IRODALOM

BÖCKH, J.—SZONTHAGH, T. 1900: A Magyar Királyi Földtani Intézet. — Budapest.

BÖCKH, J. 1902: Igazgatósági jelentés. — Magyar Királyi Földtani Intézet. Évi Jel. 1900-ról: 5—39.

FÜLÖP, J.—TASNÁDI KUBACSKA, A. 1969: Száz éves a Magyar Állami Földtani Intézet. — Budapest

KÁKAY-SZABÓ, O. 1991: One hundred and twenty-two years of the Collection of Minerals and Ores of the Hungarian Geological Institute. — Ann. of the Hist. of Hung. Geol. Special ISSUE 3. 16. Symp. of INHIGEO. Dresden, Germany.: 181—196.
LÓCZY, L. 1909: Vezető a Magyar Királyi Földtani Intézet Múzeumában. — Budapest.
MAURITZ, B. 1958: Liffa Aurél emlékezete. — Földt. Közl. LXXXVIII (2): 5—7.
NAGY, I. 1984: A Magyar Állami Földtani Intézet Gyűjteményének és Országos Földtani Adattárának újjáalakítása. Földt. Int Évi Jel. 1982-ről: 67—72.
NAGY, I. 1987: The Plaeontological collection of the Hungarian Geological Institute. — Ann. of the Hist. of Hung. Geol. Special ISSUE. XIII. Symp. of INHIGEO PISA—PADOVA, ITALY.: 161—166.
SZEBÉNYI, L. 1980: Dr. Tasnádi Kubacska András emlékezete — Földt. Int. Évi Jel. 1978-ról: 39—44.
SZTRÓKAY, K. 1980: Dr. Erdélyi János emlékezete. — Földt. Int. Évi Jel. 1978-ról: 29—38.
TASNÁDI KUBACSKA, A. 1964: A Magyar Állami Földtani Intézet Múzeuma. — Földt. Int. Évi Jel. 1961—ről: 91—94.
TASNÁDI KUBACSKA, A. 1969: A Magyar Állami Földtani Intézet gyűjteménye. —Földt. Kut. 10 (1): 28—31.
TASNÁDI KUBACSKA, A. 1973: A láthatatlan bánya. — Móra, Budapest.

A MAGYAR ÁLLAMI FÖLDTANI INTÉZET ÁSVÁNY- ÉS TELEPTANI GYŰJTEMÉNYE, MINT A KUTATÁSOK DOKUMENTÁLÓJA ÉS ADATKÖZLŐJE

KÁKAY-SZABÓ ORSOLYA

Magyar Állami Földtani Intézet
Budapest, Stefánia út 14.
H-1143

ETO: 069.5

T á r g y s z a v a k : Múzeum, történet, gyűjtemények, kiállítások, fejlesztés

A Magyar Állami Földtani Intézet ásvány- és teleptani gyűjteményének első alapító darabjai 1868-ban, a Földművelésügyi Minisztérium keretein belül megindult, Magyar Földtani Osztály első kutatásainak dokumentum anyagaiból származtak. A Magyar Királyi Földtani Intézet megalapításával 1869-ben, az Intézet első igazgatója, máig érvényes módon meghatározta a gyűjtemény feladatait, az Intézet alapító okiratában, az anyagok tárolását, dokumentálását, feldolgozását és adatainak a kutatásban való alkalmazását illetően.

A nagyarányú földtani kutatások megindulásával az ÉK-i Kárpátok, az Erdélyi medence és a DK-i Kárpátok területéről a gyűjtemény anyaga évrőlévre gyarapodott, de 1899-ig, a Földtani Intézet jelenlegi épületének felépüléséig, a gyűjtemény anyagait csak ládákban, pincékben elhelyezve tudták tárolni. 1900-ban nyílt mód először, az Intézet második emeletén, a több mint 30 éves kutatómunka dokumentumainak rendezésére és bemutatására, úgy a szakemberek, mint a nagyközönség számára. A Kárpát-medence egyik legnagyobb ércteleptani anyagát, bányageológiai és összehasonlító gyűjteményegységekbe rendezték. A bányageológiai gyűjtemény felölelte az ércbányászat, petróleum kutatás, kőszén- és opálbányászat ágazatait, lelőhelyek szerint csoportosítva. Az összehasonlító gyűjtemény magába foglalta a külföldi mű- és építőkő-, valamint az ékkő és díszítőkő- és a magyar ékkövek és dísztárgyak készítésére alkalmas ásványokat és kőzeteket. A gyűjtemény töretlen fejlődése az első világháborúval megszakadt. Az országhatárok megváltozásával lecsökkentek a kutatási területek, megváltoztak a kutatási tervek és lehetőségek.

A gyűjtemény második nagy gyarapodási korszaka 1951-ben indult meg, az ércbányászat újraélesztésével. Az ásvány- teleptani gyűjteményt új szempontok szerint, három egységre osztották. Teleptani-, magyarországi ásvány- és etalon gyűjteményre, mely a mai napig ebben a rendszerben működik. A gyűjtemény gyarapítása napjainkig folyamatosan történik az Északi-középhegység, a Dunántúli-középhegység és a Mecsek ipari nyersanyagainak és ásványainak gyűjtésével. A jelen feladata, a több mint egy évszázad dokumentumainak adatközlése, a számítógépes adatbázisok létrehozásával, hogy a múlt adatainak felhasználásával a jelen és a jövő kutatásainak eredményességét elősegítse.