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Vadose Diagenetic Carbonates (Caliches) in the Sarmatian (Miocene) of Hungary

By GYÖRGY LELKES*)

With 1 Text-Figure and 6 Plates

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Österreich
Ungarn
Pannonisches Becken
Miozän
Sarmat
Diagenese
Caliche-Fazies

Inhalt

Vados-diagenetische Karbonate (Caliches) im Sarmat (Miozän) von Ungarn

Zusammenfassung

Das mikrofazielle Studium von Dünnschliffen sarmatischer Karbonatgesteine aus Kernbohrungen von verschiedenen Lokalitäten Ungarns erbrachte den Nachweis von pedogenetischer Caliche-Fazies. An typischen Mikrogefügen konnten Rhizolithen (Wurzelabdrücke), Wurzelschläuche, Wurzelsteinkerne) und alveolare Gefüge, Microcodium, kalzitisierte Insekteneier, Caliche-Kügelchen sowie verschiedene Typen pedogenetischer Hohlräume (gekrümmte Risse, zirkum- und intergranulare Risse und Kanäle in „verkreidetem" peloidalem Mikrit) nachgewiesen werden.

Folgende petrographische Caliche-Typen können unterschieden werden: rhizolitisch, glaebular, massiv, laminiert, pisolithisch und „verkreidet". Die Häufigkeit und weite Verbreitung dieser Gefüge legt es nahe, daß sich Caliche-Fazies nicht nur auf karbonatischen Substraten, die einer subaerischen Erosion ausgesetzt waren und mit Bodenbildung assoziiert werden können, entwickelten, sondern daß sie während des Sarmats im Pannonischen Becken generell häufig entwickelt waren.

Vadózus diagenetikus karbonátok (caliche) a magyarországi szarmatában

Összefoglalás

A magyarországi szarmata karbonátos fúrásminták jelentős része vékonycsiszolatos mikrofácies vizsgálatok szerint caliche fáciesűnek minősíthető a különféle rhizolitok, alveoláris textúrák, microcodiumok, megkövesült rovarlárvák, caliche-glaebulák és különböző pedogén repedéstípusok (a caliche fácies diagnosztikus bélyegei) jelenléte alapján. Kőzettanilag rhizolitos, glaebuláris, masszív, laminált, pizolitos és csomós caliche-típusok különíthetők el. A fenti bélyegek gyakorisága és széles földrajzi elterjedése arra utal, hogy a sekélytengeri, zárt platform fáciesű karbonátos szubsztrátumon kifejlődő és a szubaerikus környezetet, illetve pedogenezist egyértelműen jelző caliche a szarmatában a Pannon Medence gyakori fáciese volt.

*) Author's address: Dr. GYÖRGY LELKES, Geological Institute of Hungary, Stefánia út 14, H-1442 Budapest, Hungary.

Abstract

Thin section microfacies studies on Sarmatian carbonate borehole samples from various parts of Hungary have revealed petrographic evidences for pedogenic caliche facies. The diagnostic features identified are rhizoliths (root moulds, root casts, root tubules, rhizocretions and root petrifactions), alveolar textures, *Microcodium*, calcified insect eggs, caliche glaebules and various types of pedogenic voids (curved fractures, circumgranular and intergranular cracks and channels in clotted, peloidal micrite).

The following petrographic types of caliche can be differentiated: rhizolitic, glaebular, massive, laminated, pisolitic and clotted. The abundance and widespread geographic distribution of features mentioned above suggests that caliche facies not only developed on carbonate substrates indicating subaerial exposure and pedogenesis but also must have been common in the Pannonian Basin in Sarmatian times.

1. Introduction

Sarmatian carbonate formations are widespread in Hungary. JÁMBOR (1971, Table 1) mentions their presence in 11 geographic areas of the country of a total 19. Based on his megascopic observations, the main carbonate lithologies are limestones, oolitic and cryptocrystalline limestones and calcareous marls, and these are considered to represent littoral, sublittoral and neritic depositional environments.

In the mid eighties, thin-section carbonate microfacies studies led me to conclude that the general environment of Sarmatian deposition was a restricted platform (sensu WILSON, 1975) subjected to cryptalgal sedimentation, leading mainly to gastropod and miliolid-bearing microoncoidal grainstone/packstone rock-types (LELKES, 1985). To avoid uncertainties concerning the exact nature of "microoncoids", I now prefer to use the more descriptive term "peloidal" sedimentation for these carbonates, leaving unchanged the reconstruction of the depositional environment as a restricted platform. Thin-section examination of Sarmatian carbonate deposits has also revealed fairly abundant features that can be interpreted as pedogenic textures, characteristic of caliche/calcrete profiles in the upper vadose zone of the meteoric diagenetic environment. The aim of this paper is the preliminary documentation of these hitherto unpublished features found so frequently in Sarmatian (and other) carbonates in Hungary.

2. Sampling Points and Previous Works

The samples on which this study is based are from twenty-seven borehole sections. Their geographic location is shown in Text-Figure 1.

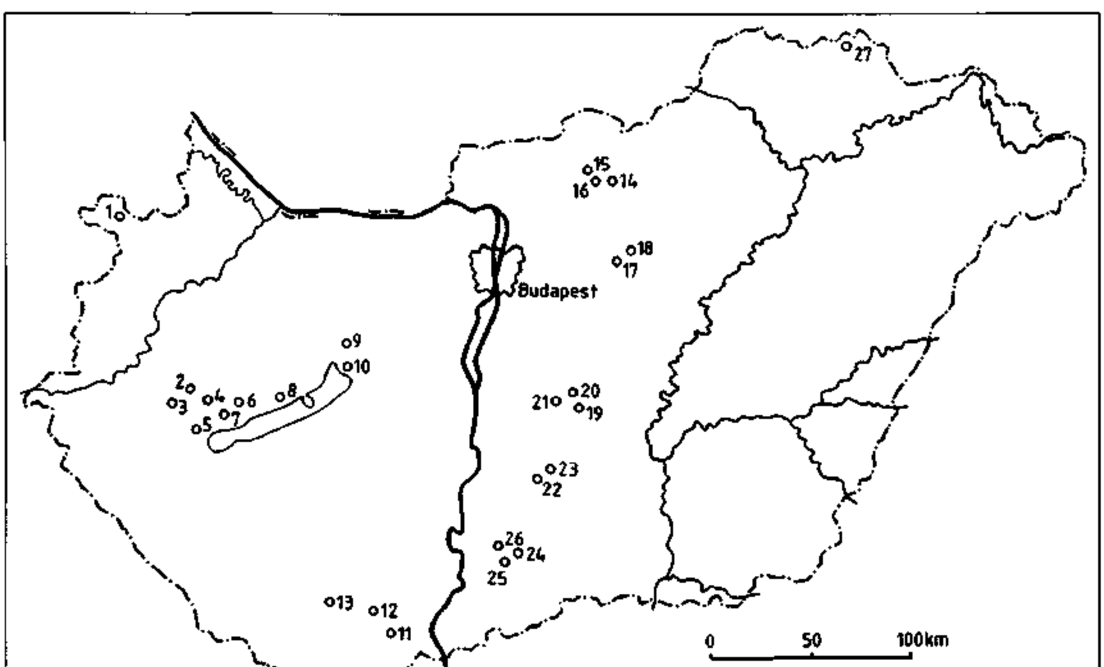
Concise information on lithological, palaeontological and stratigraphical aspects of various Sarmatian formations is given by JAMBOR (1971, 1975). BODA (1971, 1974) developed the subdivision of the Sarmatian stage on the basis of invertebrate fauna (molluscs, foraminifera) and described the stratotypes of the Sarmatian in Hungary.

3. General Considerations

The vadose environment of the meteoric diagenetic realm may be divided into two zones: an upper vadose soil or caliche zone at the air-sediment or rock interface; and a lower vadose zone, which includes the capillary fringe just above the water table (MOORE, 1989, p. 177).

According to the definition by ESTEBAN & KLAPPA (1983, p. 15)

> *"... Caliche is a vertically zoned, subhorizontal to horizontal carbonate deposit, developed normally with four rock-types: (1) massive-chalky, (2) nodular-crumbly, (3) platy or sheet-like, and (4) compact crust or hardpan. The position and development of these rock-types in a vertical sequence (profile) is highly vairable ... "*



Text-Figure 1.

Location of boreholes from which samples have been analysed.

1 = Fertőrákos 21/a; 2 = Zalaszántó 3; 3 = Zalaszentlászló 1; 1; 4 = Várvölgy 1; 5 = Hévíz 6; 6 = Tapolca 3; 7 = Tapolca 5; 8 = Balatonakali 40; 9 = Berhida 4; 10 = Balatonkenese 1; 11 = Bóly 1; 12 = Máriakéménd 3; 13 = Nagykozár 2; 14 = Mátraszőlős 6; 15 = Alsótold 1; 16 = Alsótold 2; 17 = Tóalmás 1; 18 = Tóalmás 2; 19 = Kerekegyháza 1; 20 = Kerekegyháza 2; 21 = Kerekegyháza 5; 22 = Soltvadkert 4; 23 = Soltvadkert 10; 24 = Érsekcsanád 1; 25 = Érsekcsanád 2; 26 = Érsekcsanád 5; 27 = Hidasnémeti 1.

The term "caliche profile" means the complete vertical succession of morphologically distinct horizons. An idealized caliche profile of 2–3 m in thickness can, from top to bottom, be made up of a zone of active soil, a laminated hardpan, a platy, nodular and chalky caliche, a transitional horizon and finally the host material (ESTEBAN & KLAPPA, 1983; MOORE, 1989). Besides the characteristic macrofeatures these horizons contain distinctive petrographic textures I, seen in thin-section. They are summarized by KLAPPA (1980), ESTEBAN and KLAPPA (1983) and SCOFFIN (1987). A number of them were observed in the Sarmatian carbonates and are discussed below.

4. Observations

The following petrographic textures were identified in the samples studied. The definitions are used after KLAPPA (1980), ESTEBAN & KLAPPA (1983) and SCOFFIN (1987):

1) Rhizoliths or rhizoids (organosedimentary structures resulting in the preservation of roots of higher plants, or remains thereof, in mineral matter) with the following basic types (sensu KLAPPA, 1980):
   A) Root moulds and/or borings (cylindrical pores left after root decay); fairly common (Plate 1, Figs. 1,2).
   B) Root casts (sediment- or cement-filled root moulds); fairly common (Plate 1, Figs. 3,4).
   C) Root tubules (cemented cylinders around root moulds); rare (Plate 2, Fig. 1).
   D) Root concretions or rhizocretions (pedodiagenetic mineral accumulations around living or decaying roots); fairly common (Plate 2, Figs. 2,3,4).
   E) Root petrifactions (mineral encrustations, impregnations or replacements of organic materials whereby anatomical root features are partly or totally preserved); rare (Plate 3, Figs. 1,2).
2) Alveolar textures (cylindrical to irregular pores, which may or may not be filled with calcite cement, separated by a netwok of anastomosing micrite walls); common (Plate 3, Figs. 3,4).
3) *Microcodium* (elongate, petal-shaped calcite prisms or ellipsoids, grouped in spherical, sheet- or bell-like clusters); rare (Plate 4, Figs. 1,2,3,4).
4) Calcified cocoons (ovoid to spherical, 1–3 cm diameter cases of calcified puparia of soil-dwelling insects); rare (Plate 5, Fig. 1).
5) Caliche glaebules (undifferentiated to concentric structures, silt to pebble in size, commonly found in caliche facies including caliche ooids, pseudooids, ooliths, peloids, pellets, pelletoids, coated particles, nodules, concentric structures and concretions); frequent (Plate 5, Figs. 2,3,4).
6) Curved fractures, circumgranular and intergranular cracks and channels in clotted, peloidal micrite (the clotted texture results from crumby fracture of dense micrite and the cracking results from repeated wetting and drying); rare (Plate 6, Figs. 1,2,3).

All of the above samples have come from boreholes from depths of several tens to several hundreds of meters where the Sarmatian beds are overlain by younger formations. Undoubtedly, these subaerial surfaces developed on carbonate substrata and are true fossil caliche horizons.

5. Conclusions

❶ The petrographic textures documented above are diagnostic features of caliche facies. Tthis is the first record of caliche from the Miocene of Hungary.

❷ The following petrographic types of caliche can be differentiated: rhizolitic, glaebular, massive, laminated, pisolitic, clotted.

❸ Rhizolitic structures (root moulds and casts), hitherto usually misinterpreted or overlooked, are especially frequent.

❹ Caliche facies definitely indicate subaerial exposure. This compliments the palaeogeographical picture: sedimentation on a shallow marine, restricted carbonate platform was interrupted by subaerial periods and pedogenesis in Sarmatian times.

Acknowledgements

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Plate 1

Photomicrographs illustrating root moulds and root casts.

Some of the fossils and other components mentioned here and on the following plates can be seen in the thin-sections of the rocks concerned, but are not necessarily within the fields of view of the photomicrographs.

Fig. 1: Root moulds in a fossiliferous, foraminifer- and ostracod-bearing micritic mudstone.
Balatonkenese-1; 209,5 m.

Fig. 2: Root moulds in a calichified hostrock containing a few foraminifers, ostracod and mollusc shell fragments and abundant caliche glaebules.
Balatonkenese-1; 217,0 m.

Fig. 3: Root cast (root mould filled mainly with micritic material and partly with sparite) in a calichified hostrock with foraminifers, ostracods, mollusc shell fragments and very abundant caliche glaebules.
Kerekegyháza-2; 816,0-821,0 m.

Fig. 4. Root cast (root mould filled with very finely crystalline sparite) in a calichified hostrock with abundant quartz grains and caliche glaebules, less frequent sponge spicules and a few foraminifers and mollusc shell fragments.
Alsótold-2; 88,0-89,2 m.

Thin-sections, plane polarized light.

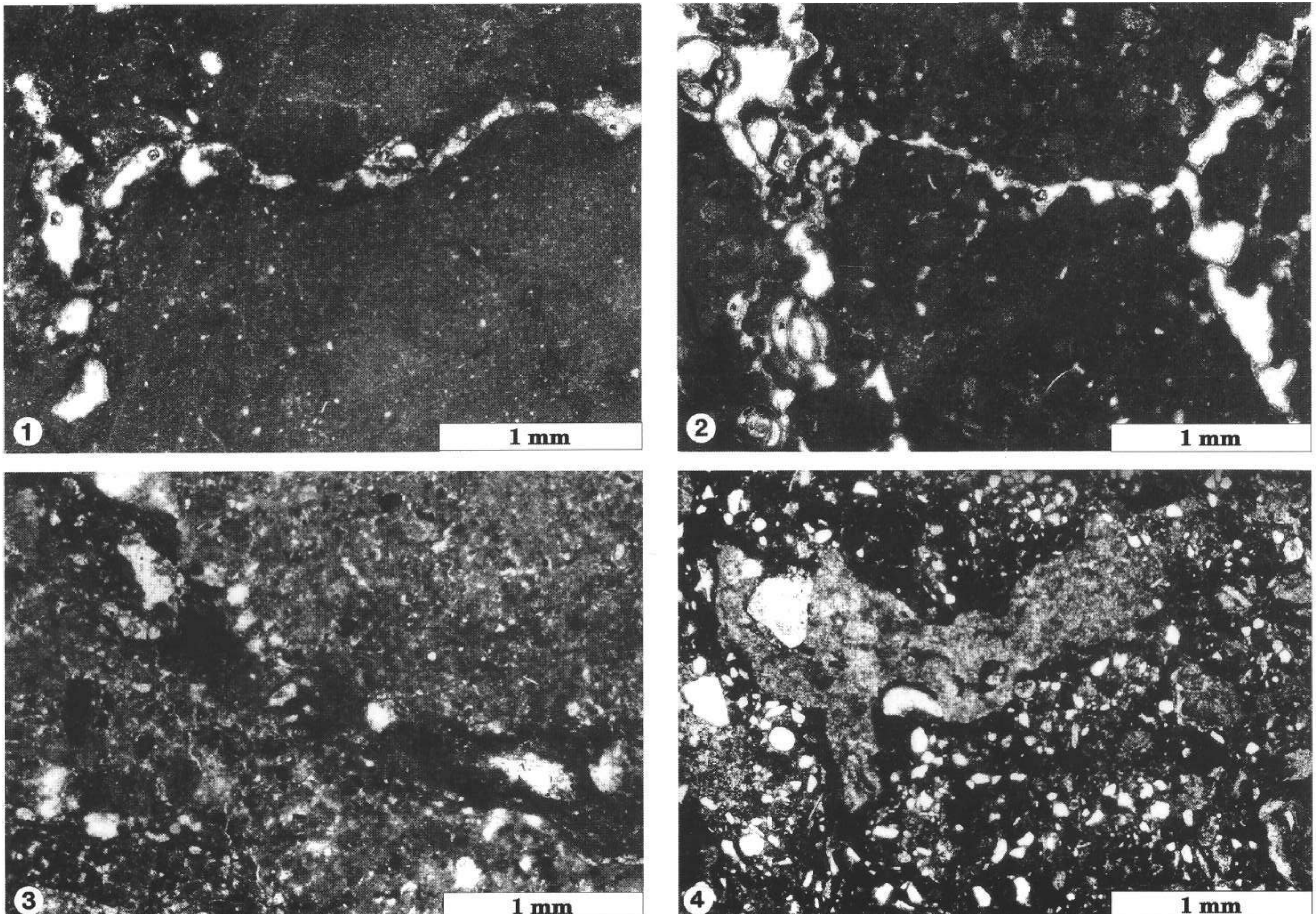
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Plate 2

Photomicrographs illustrating root tubule and rhizocretions.

Fig. 1: Root tubule (right side of the picture) in a fossiliferous (ostracod-, foraminifer- and mollusc-bearing) micritic mudstone.
Balatonkenese-1, 212,2 m.

Fig. 2: Rhizocretion in a molluscan-foraminiferal grainstone.
Tóalmás-1, 1040,0-1042,5 m.

Fig. 3: Rhizocretion in a calichified, mollusc-, foraminifer- and ostracod-bearing micrite with abundant caliche glaebules.
Kerekegyháza-1, 849,0-852,0 m.

Fig. 4. Rhizocretions in a calichified, foraminifer-, ostracod- and mollusc-bearing hostrock with very abundant caliche glaebules.
Kerekegyháza-2, 816,0-821,0 m.

Thin-sections, plane polarized light.

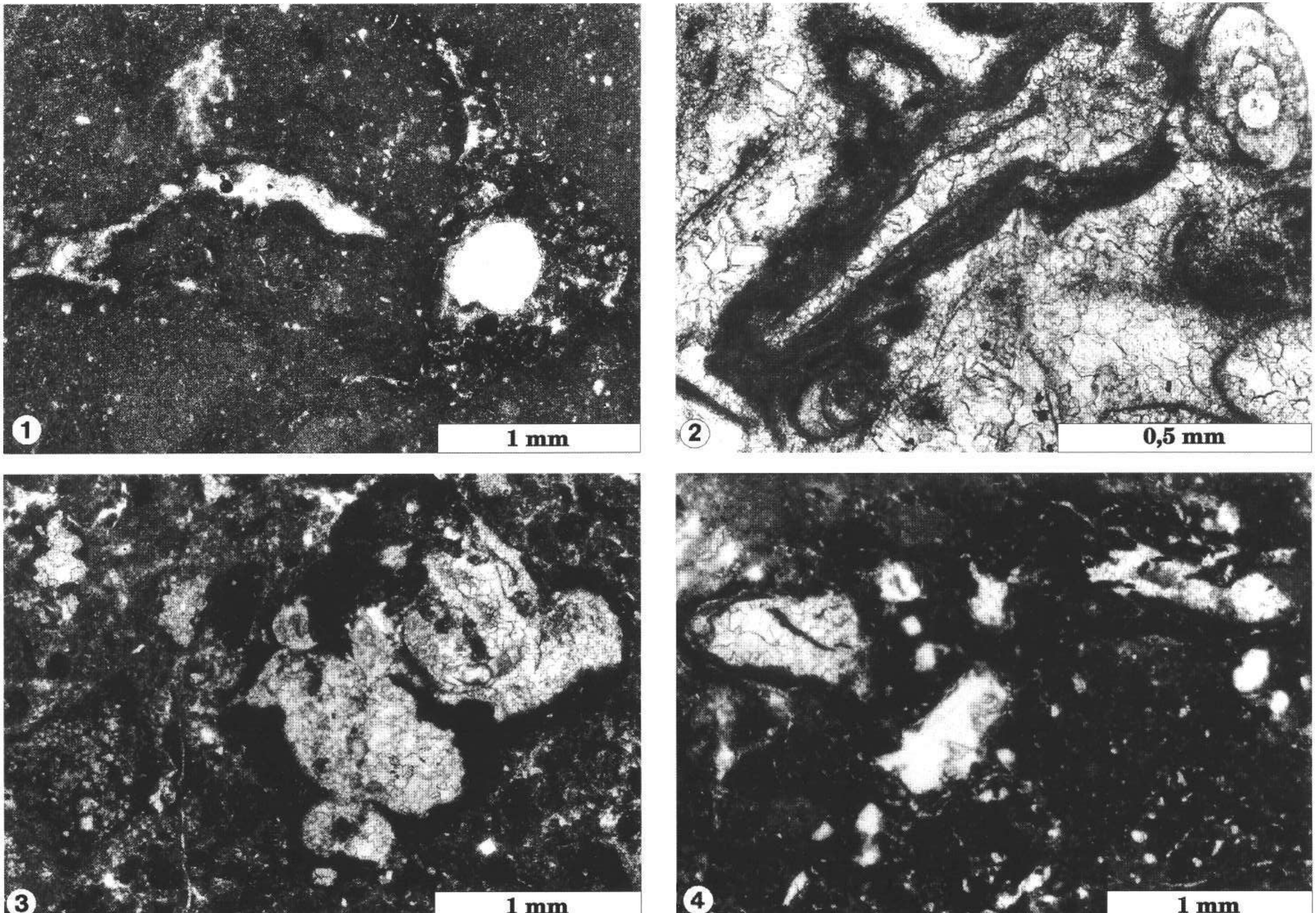
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Plate 3

Photomicrographs illustrating root petrifaction and alveolar textures.

Fig. 1: Root petrifactions in a calichified, mollusc- and foraminifer-bearing micrite hostrock.
Bóly-1; 529,0-530,7 m.

Fig. 2: Root petrifaction (upper right corner) in a fossilferous (foraminifer-, ostracod- and mollusc-bearing) micrite.
Hévíz-6; 171,8 m.

Fig. 3: Alveolar texture in a calichified hostrock containing a few mollusc shell fragments and foraminifers and very abundant caliche glaebules. The picture shows a network of micrite walls, completely filled by mosaic sparite.
Soltvadkert-10; 1174,0-1180,0 m.

Fig. 4. Another type of alveolar texture. The network of micrite walls is largely empty.
Bóly-1; 553,8-555,8 m.

Thin-sections, plane polarized light.

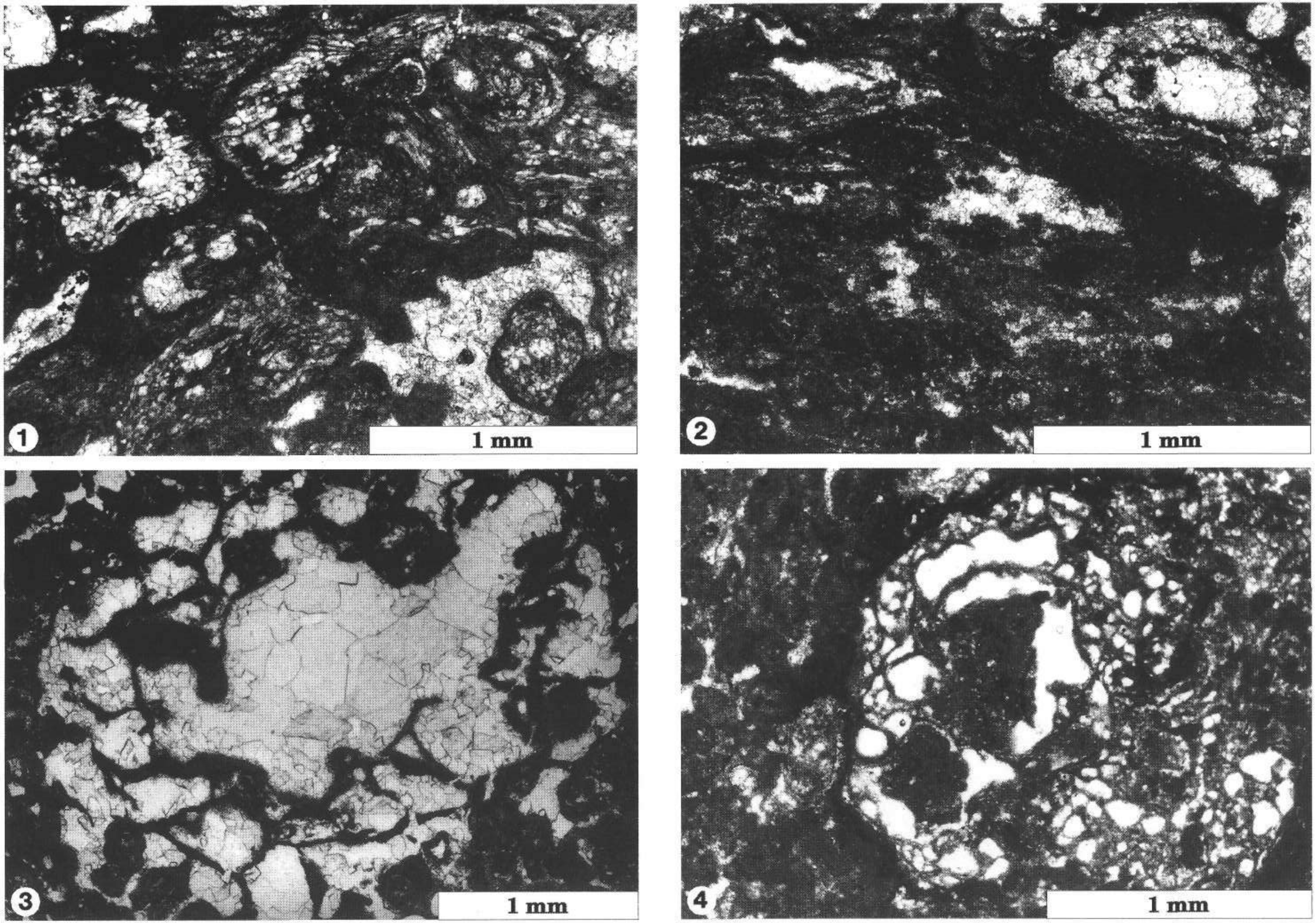
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Plate 4

Photomicrographs illustrating *Microcodium*.

Fig. 1: *Microcodium* in a coarse-grained, gastropod- and foraminifer-bearing grainstone.
Soltvadkert-4; 1123,0-1128,0 m.

Fig. 2: *Microcodium*. Detail of Fig. 1.
Soltvadkert-4; 1123,0-1128,0 m.

Fig. 3: Colonies of *Microcodium* consisting of elongate calcite prisms grouped in spherical clusters.
Soltvadkert-4, 1129,5-1134,5 m.

Fig. 4: Transverse section through *Microcodium* colonies: note the elongate calcite prisms and the central canals filled with mosaic sparite.
Soltvadkert-4, 1129,5-1134,5 m.

Thin-sections, plane polarized light.

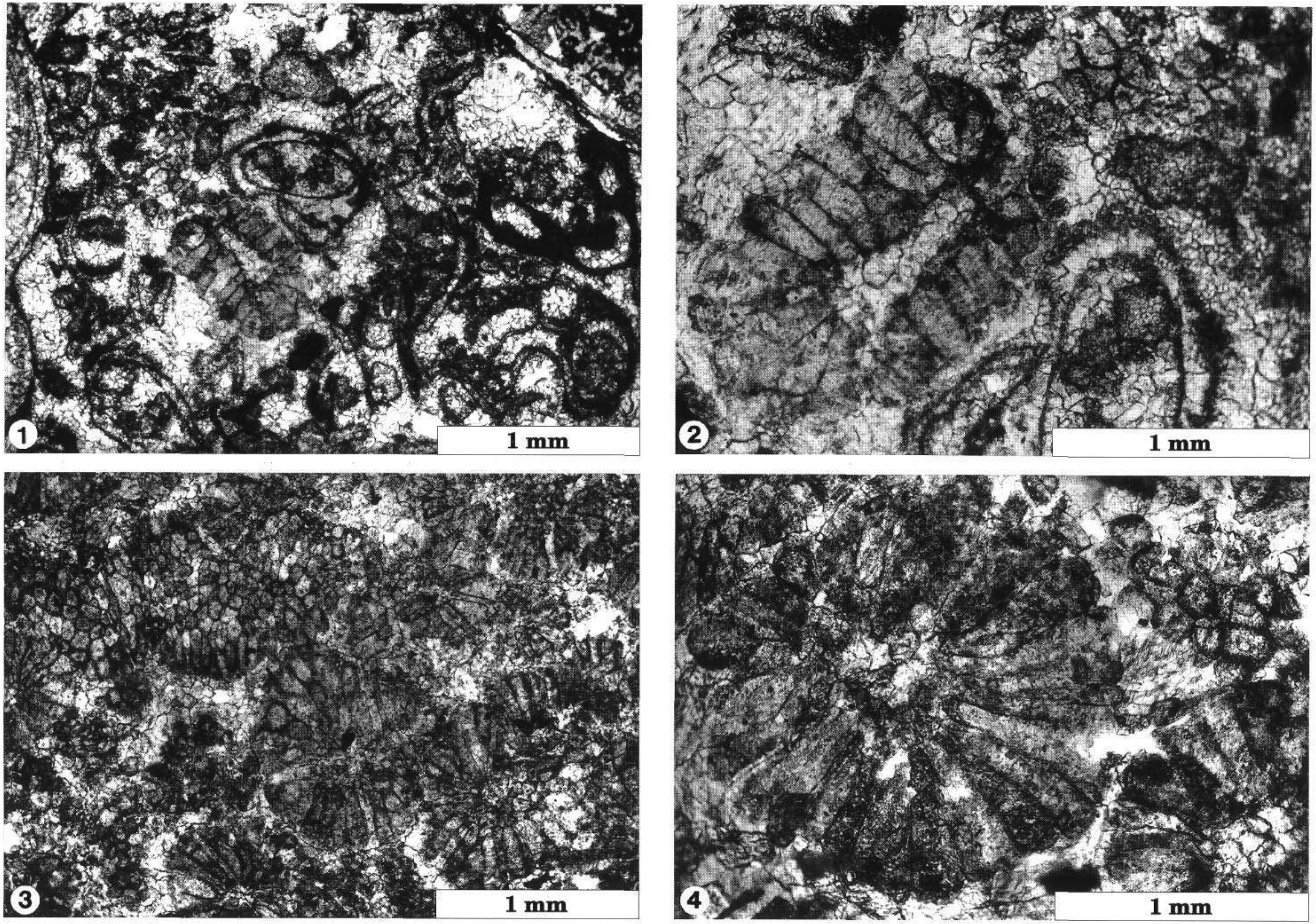

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Plate 5

Photomicrographs illustrating calcified insect eggs and various types of caliche glaebules.

Fig. 1: Abundant spheres measuring mainly 0,06-0,2 mm in diameter, filled with very finely crystalline sparite in a homogeneous micrite. These spheres might be calcified insect eggs (see also FREYTET and PLAZIAT, 1982, p. 139, Plate 12D).
Balatonkenese-1, 220,8 m.

Fig. 2: Very abundant caliche glaebules (undifferentiated caliche peloids) in a foraminifer- and mollusc-bearing hostrock: note the difference in size and shape of caliche peloids.
Bóly-1, 511,4-513,6 m.

Fig. 3: Abundant caliche glaebules (mainly undifferentiated caliche peloids and a few pseudooids showing a faint concentric structure) in a micritic hostrock containing foraminifers and mollusc shell fragments.
Bóly-1; 541,4–542,4 m.

Fig. 4: Caliche glaebules of different character: sand-sized coated particles exhibiting concentrical laminations.
Balatonakali-40; 15,5 m.

Thin-sections, plane polarized light.

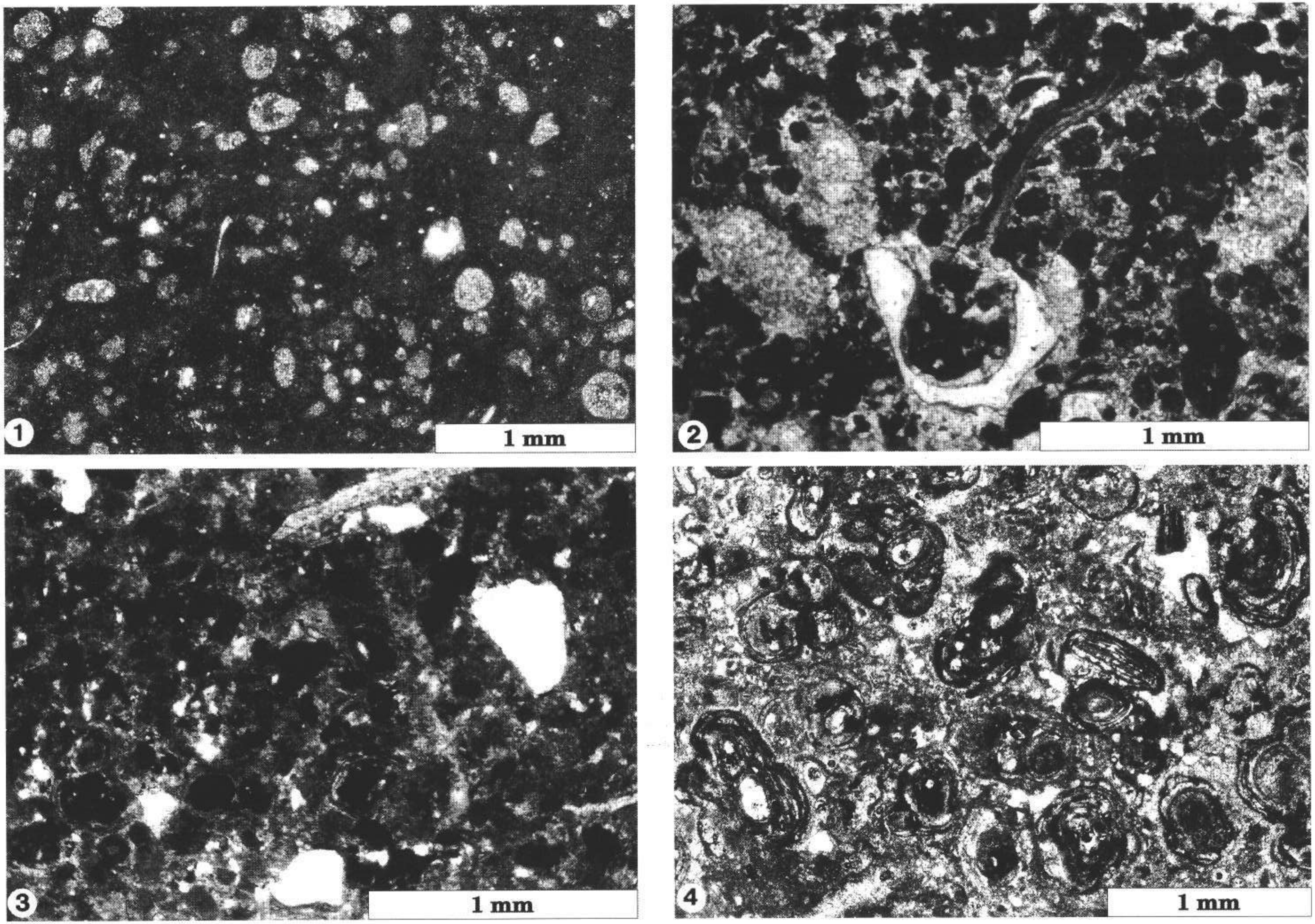
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Plate 6

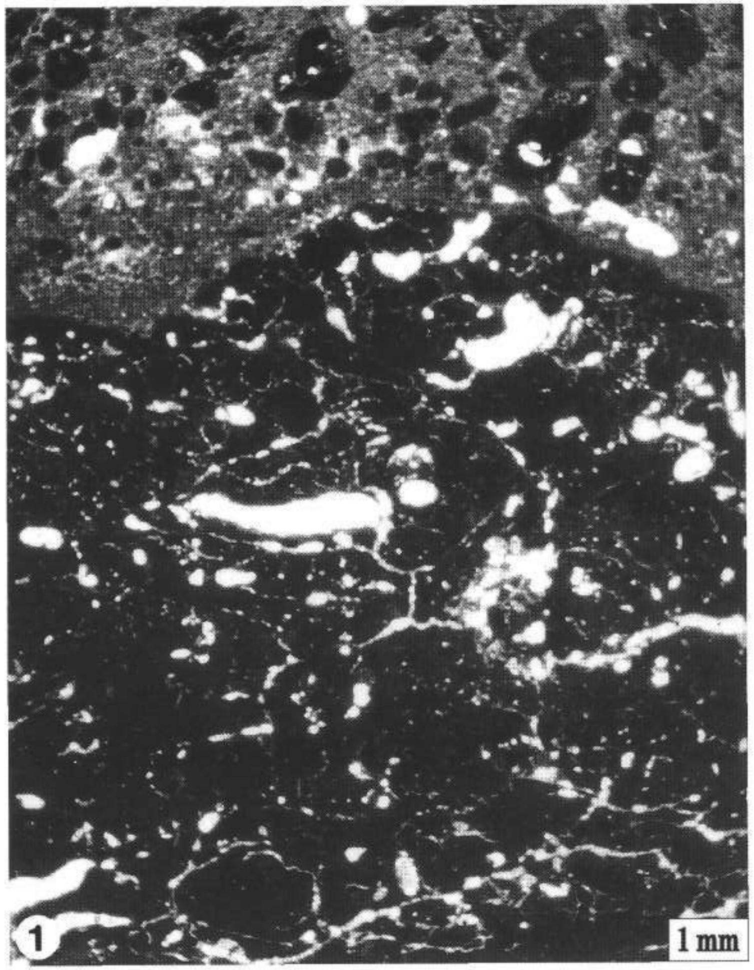
Photomicrographs illustrating pedogenetic voids.

Fig. 1: Curved fractures together with intergranular cracks and channels in a slightly fossiliferous (foraminifer-, ostracod- and molusc-bearing) micritic mudstone. The upper part of the photograph shows the broken pieces of this fossiliferous micrite embedded in a matrix consisting mainly of silt-sized, light-coloured caliche glaebules.
Berhida-4; 155,7 m.

Fig. 2: Desiccation cracs and channels developed as circumgranular cracks around foraminifers in a slightly fossiliferous micritic mudstone showing locally clotted texture.
Berhida-4; 155,7 m.

Fig. 3: Circumgranular crack around a foraminifer. Detail of Fig. 2.
Berhida-4; 155,7 m.

Thin sections, plane polarized light.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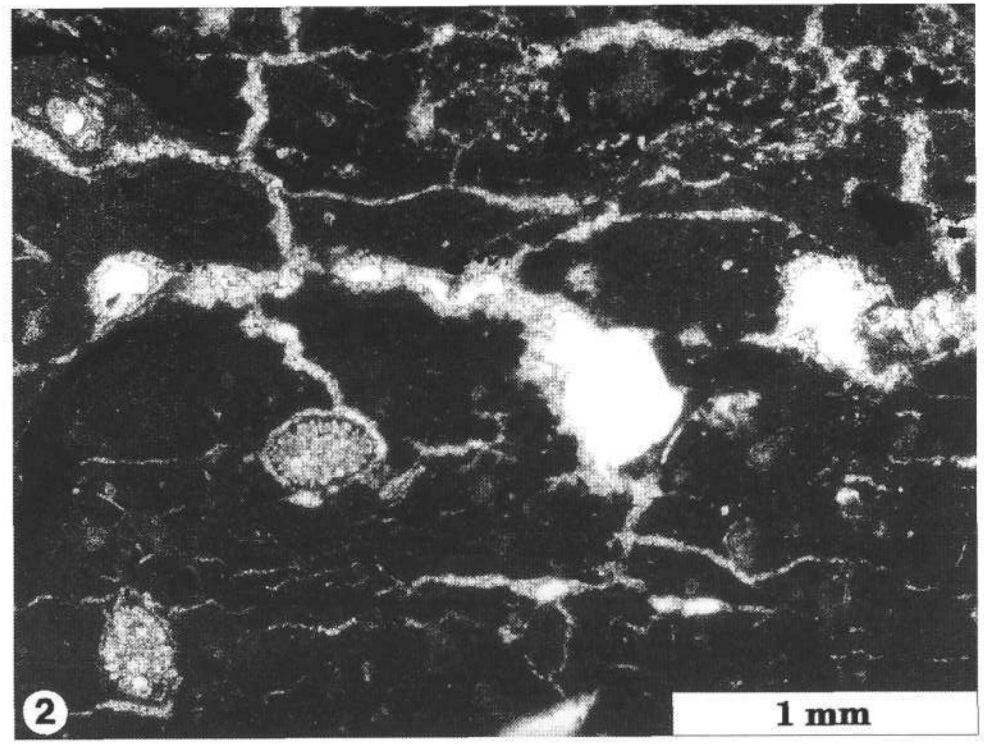
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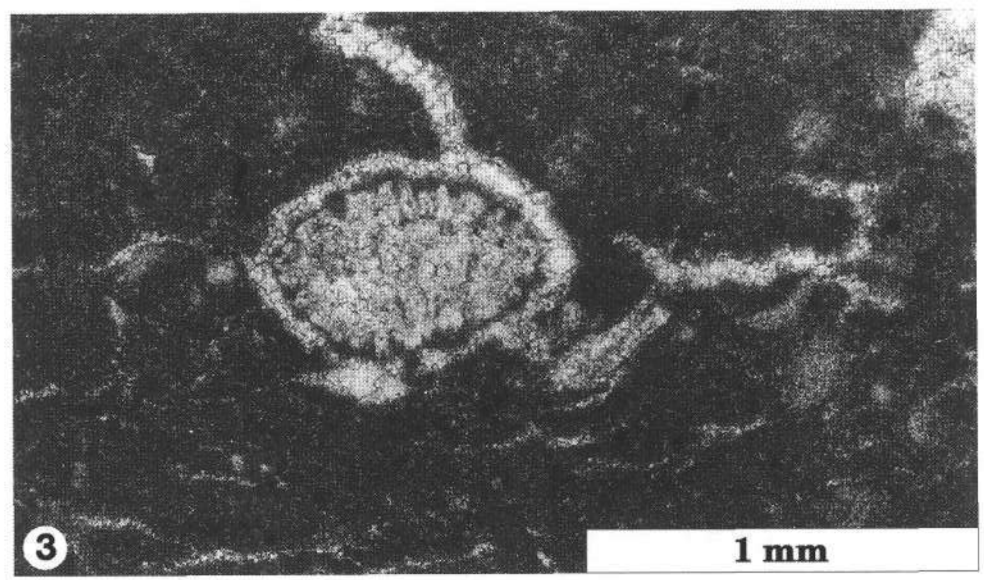
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