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SOME BAUXITIC TEXTURES AND THEIR GENETIC INTERPRETATION

(*Figs. 28*)

A b s t r a c t: Most important micromorphological features of karst-bauxites of Hungary are discussed with special emphasize on elementary processes of bauxite formation and the individual textures and structures produces by them (primary sedimentary structures, structures assigned to the mechanical effect of paraautochtonous reworking, structures assigned to the chemical effect of early- and late-diagenetic chemical processes, structures of prelithification compaction and epigenetic structures formed after the deposition of the coverbeds on reaction with descending solutions).

Р е з ю м е: В статье дискутированы самые важные микроморфологические черты карстовых бокситов Венгрии образовывающихся при всех основных процессах их формирования и для них типичные текстуры и структуры (первичные осадочные структуры, структуры механической переработки параавтохтона, раннедиагенетические и позднедиагенетические структуры, структуры литификационные и структуры возникающие во время эпигенетического процесса нисходящими растворами).

Karst bauxites — although undoubtedly belonging to the group of metalliferous raw materials — are generally omitted from handbooks of ore-microscopy. Reasons for this omission are quite understandable. Bauxites do not polish well and — except for hematite — the absorptionreflection properties of their main constituents are generally insufficient for being studied under the reflected-light microscope. Since by grain-size they are generally considered as "pelitic", conventional petrographical microscopy is likewise troublesome in most cases. This is why the role of micropetrography became subordinated to other more up-todate method of investigation of bauxites.

It was only a small number of authors, namely N i c o l a s (1968), V a l e t o n (1972), A u g u s t i t h i s (1978) and partly also B á r d o s s y (1977) who realized that no rockforming process, not even bauxitization can be adeqately traced when neglecting the information contained by the structure and texture i. e. the "micromorphology" of the material in question.

There were two important conclusions emerging from the few but outstanding results of the above mentioned authors, namely that No 1. the microtextures accessible by the normal petrographic microscope are immensely rich in genetic information, but No 2. at the level of our present knowledge this information is sometimes hard — if not impossible — to decipher and translate into the terms of petrogenesis.

Genetic interpretation of structures and textures always needs some adequate classification of the phenomena.

The first attempts to set up a textural system for bauxites in general were those of V a l e t o n (1973) and B á r d o s s y — N i c o l a s (1973), the latter

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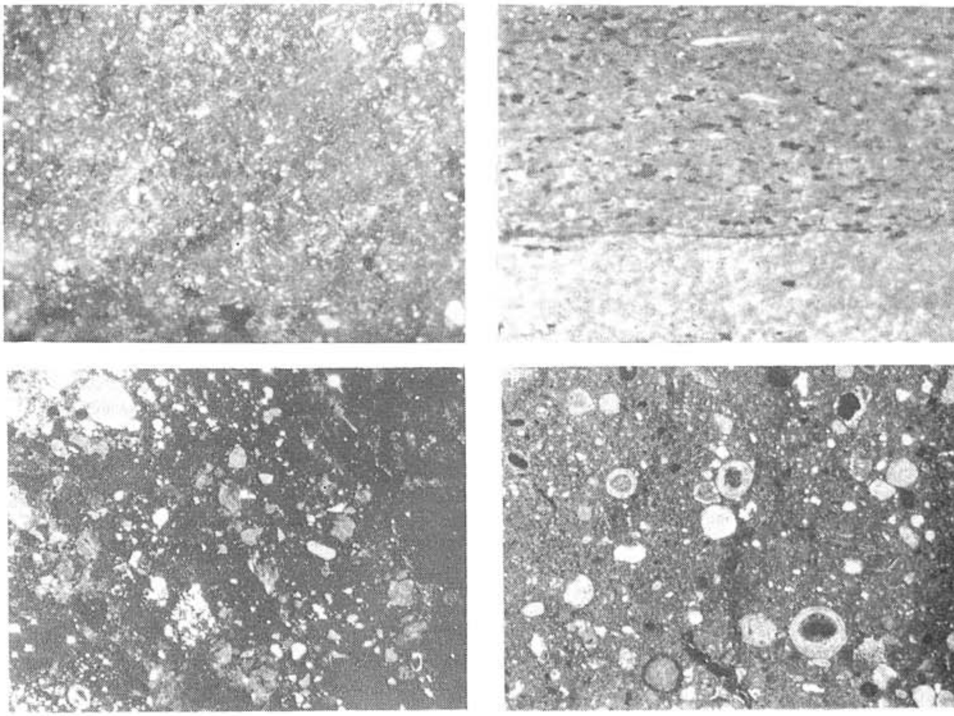


Fig. 1. Fine-grained microclastic matrix of pelitomorphous bauxite (Gánt.) Magn. 200 ×, crossed polars.

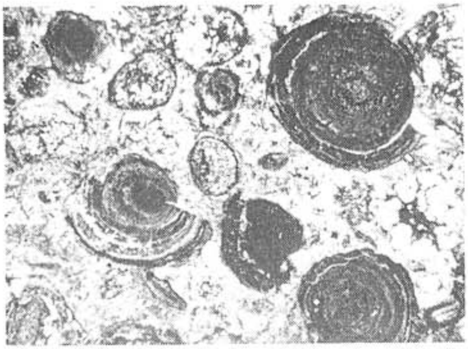
Fig. 2. Alternating laminae of pelitomorphous and microbrecciated bauxite (Nagytárkány). Magn. 200 ×.

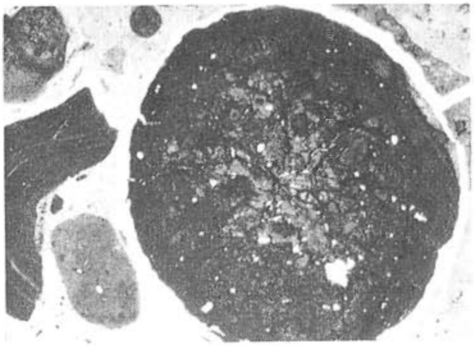
Fig. 3. Clastic structure resulted by early diagenic "parautochtonous" redeposition (Fenyöfö). Magn. 20 × (with courtesy of Mrs É. Tóth-Gecse).

Fig. 4. Diagenic-clastic ooid-bearing bauxite consisting of fine-grained kaoliniticboehmitic matrix with scattered patches of coarse-crystalline gibbsite (Dudar). Magn. 20 ×, crossed polars.

of which was officially accepted in the same year by the International Committe for studies of Bauxites Alumina and Aluminium (ICSOBA). As to lateritic bauxites this system was modified in 1978 by the present author in Athens (Greece) and in 1980 by the IGCP No 129 Laterite seminar in Triwandrum (India). As to karst bauxites no substantial attempt to modify or fill out the Bárdossy – Nicolas system has been published up to now.

Since during the last ten years in Hungary the micromorphology of bauxites became an intensely cultivated field of research (Hidasi, 1978; Hidasi – Mensáros, 1976; Mindszenty, 1976; Gecse – Mindszenty, 1979), the aim of setting up a new comprehensive genetic system of bauxitic textures seemed to be something quite plausible. At the same time it was quite obvious, however, that the work could be completed gradually, in at least three successive stages only, so that:





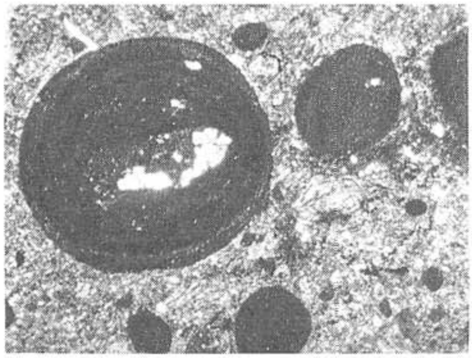


Fig. 5. Diagenic-clastic ooid-bearing bauxite with broken ooids of the segregation-type and with traces of late-diagenic rearrangement of sesquioxides in the groundmass (Iharkút). Magn. 35 ×.

Fig. 6. Rounded bauxite-pebbles and iron-rich ooid-fragments cemented by a diagenetically recrystallized kaolinitic-crandallitic? matrix (Gánt). Magn. 20 ×, crossed polars.

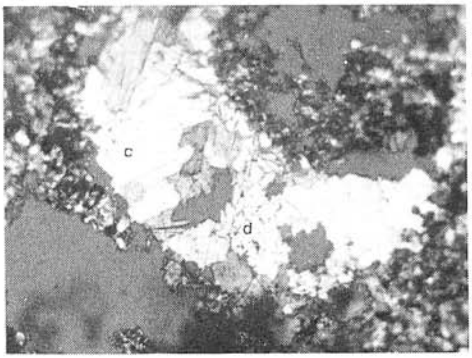
Fig. 7. Iron-rich round-grains and ooids embedded in a fine-grained argillaceous matrix. Note the large accretional ooid on the right formed around a detrital carbonate grain (Iszkaszentgyörgy). Magn. 50 ×, crossed polars.

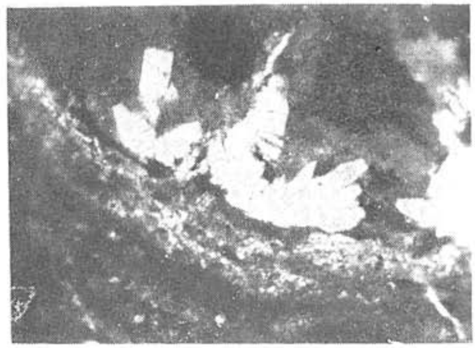
Note: Figs. 1—2 — Primary sedimentary structures
Figs. 3—10 — Diagenic structures
Figs. 3—7 — Early diagenic structures formed by mechanical and chemical processes, characteristic of parautochtonous redeposition

In the first stage all observable textural elements should be precisely described, and correlation of each of them with elementary processes of formation should be established.

In the second stage associations as well as vertical and lateral relation of the above mentioned textural elements should be investigated in detail, and structural and textural microfacies should be established and defined.

In the third stage relation of the individual microfacies to the processes of formation of industrial-grade deposits should be revealed.





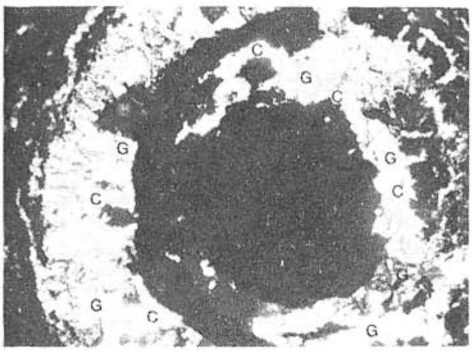


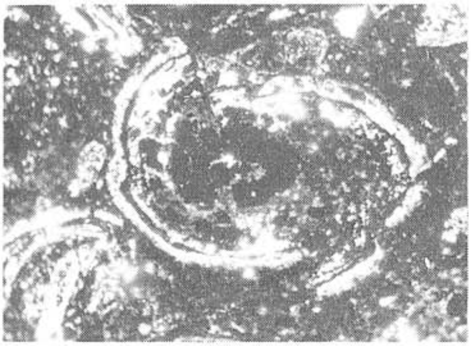
Fig. 8. Pore-space filling of diasporic-calcitic composition (Iharkút). Magn. 300 ×, crossed polars with sens: tint plate.

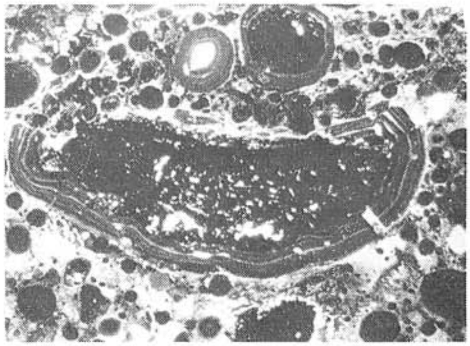
Note: Fig. 8—10 — Late diagenic structures formed mainly by chemical processes.
Fig. 9. Automorphous crystals of boehmite? within an ooid (Iharkút). Magn. 300 ×, crossed polars with sens: tint plate.
Fig. 10. Subconcentric inner structure of an iron-rich ooid with the contraction-spaces filled by late-diagenic (syneretic?) gibbsite (g) and calcite (c) (Iharkút). Magn. 120 ×, crossed polars with sens: tint plate.

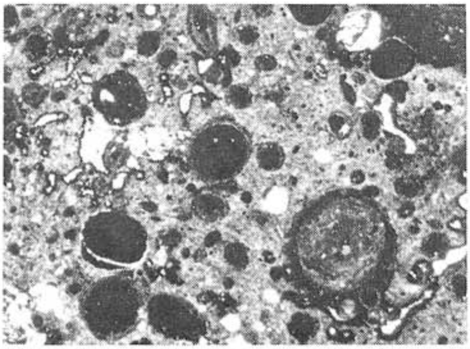
The work has begun. Most of the first stage is completed now and elaboration of the tasks of the second stage is in progress. The results of the first and second stages will be presented briefly in the followings:

Karst bauxites are essentially fine-grained clastic sediments consisting of particles, the size, shape and arrangement of which is the joint result of the threefold process of sedimentation (= weathering — transportation — diagenesis and epigenesis).

Since bauxitization on a karstic terrain is a diagenetic process meaning profound rearrangement of the constituents not only in the chemical but also in the mechanical sense, it tends to conceal all primary sedimentary structures, thus the fine-grained clastic nature of the sediment and the finely laminated structure can be recognized very rarely and in low-grade ores only where diagenesis was not so intense as in some high-grade types.







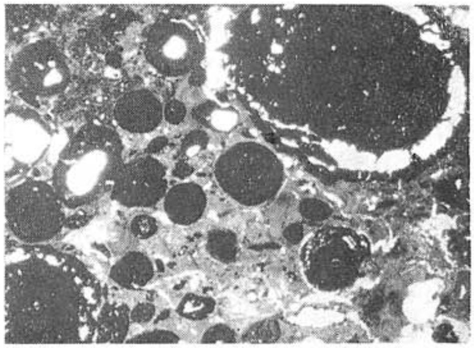


Fig. 11. Shear-fractures of compactional origin in an ooid (Iharkút). Magn. 35 ×.
Fig. 12. Compactional collapse of the outer shells of an ooid (Dudar). Magn. 20 ×. (With courtesy of Mrs É. Tóth-Gecse).

Note: Figs. 9—10 — Late diagenic structures formed mainly by chemical processes. Figs. 11—12 — Late diagenic — epigenic structures formed by compaction (= mechanical effect).

Fig. 13. Late-diagenetic pore-space filling alumina-precipitations (white) in the pelitomorphous groundmass of an ooid-bearing bauxite (Dudar) Magn. 35 ×. (With courtesy of Mrs É. Tóth-Gecse).

Fig. 14. Pore-space filling iron-hydroxide of late-diagenic origin in a kaolinitic-boehmitic bauxite (Halimba). Magn. 3 ×.

Having been deposited in the hollows of the karstic terrain, but not yet covered, the "prae-bauxitic" material may subsequently undergo several stages of local reworking and redeposition (= early-diagenic parautochtonous transportation). Steady chemical and mechanical agitation during these early-diagenic processes results in the formation of characteristic structures such as pisoids, ooids, roundgrains, various kinds of intraformational breccias etc.

Pisoids, ooids and round-grains may form, however, during later stages of diagenesis, too, when colloid-chemical processes lead to in-situ formation of spheroidal structures of both accretional and seggregational origin.

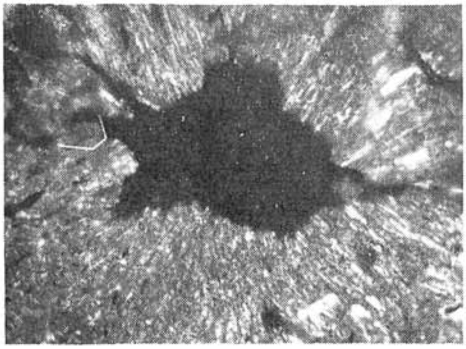
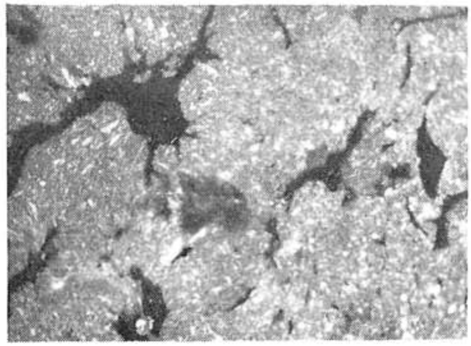
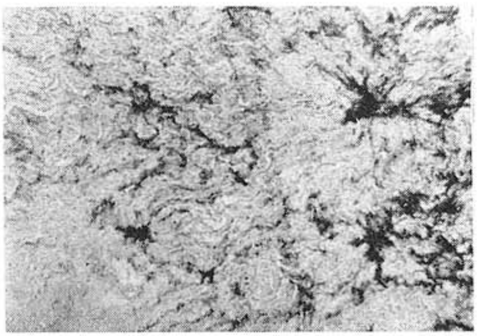
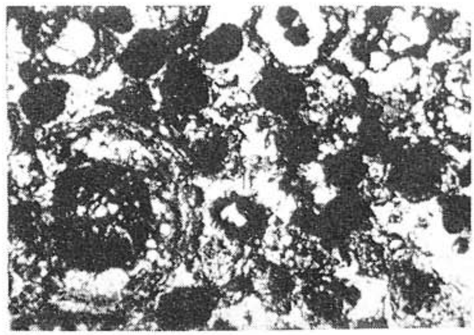





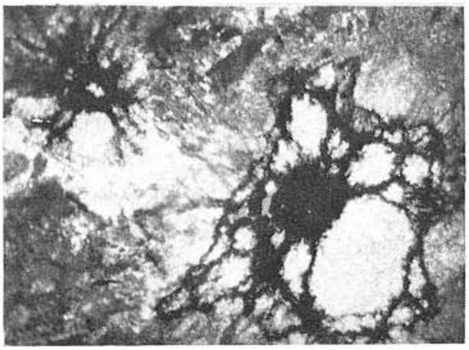
Fig. 15. Iron-poor bauxite with organic detritus (black) (evidence of reducing environment immediately below the swampy overburden) (Iharkút). Magn. 80 ×.
Fig. 16. Plant decay results in deferrification, resilication and the rearrangement of mineral grains surrounding the decaying material (note the radial orientation of the kaolinite grains) (Iharkút). Magn. 80 ×, crossed polars.

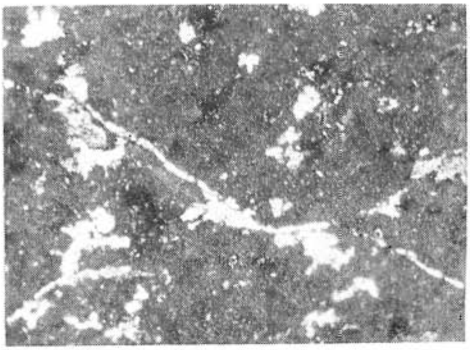
Note: Figs. 13–14 – Late diagenic – epigenic structures formed by chemical rearrangement of the constituents.
Figs. 15–16 – Epigenic structures formed by chemical alterations (mainly on reaction with descendant solutions).

Fig. 17. Vermicular crystals of kaolinite with scattered spots of fina organic detritus (= resilication structure) (Iharkút). Magn. 35 ×.
Fig. 18. Ooid-bearing bauxite, kaolinized and partly deferrificated but retaining its original structure (Iharkút). Magn. 35 ×, crossed polars.

Sometimes even broken fragments of early-diagenic ooids may obtain late-diagenic accretional coatings – examples of autochtonous chemical changes superimposed on early-diagenic structures.

Overburden compaction results in plastic deformation in respect of soft unlithified ooids or pisoids and in brittle deformation (collapse or shear) in respect of lithified rigid structural elements (e. g. ooids complete or fragmented) deposited after shorter or longer periods of parautochtonous transport.





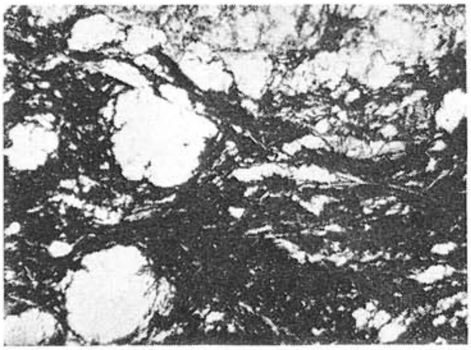


Fig. 19. Kaolinization-structure resulted by plant-decay with a fine network of haematite (Iharkút). Magn. 100 ×.

Fig. 20. Kaolinitic bauxite impregnated with finely dispersed calcite (non-tectonic "karst-contact" facies) found right along the side-walls of the karstic sinkhole (Iharkút). Magn. 35 ×, crossed polars.

Note: Figs. 17–20 – Epigenic structures formed by chemical alteration (mainly on reaction with descendant solutions).

Fig. 21. Kaolinized bauxite with a shear-plane and with signs of post-bauxitic remobilization of iron (opaque impregnations of haematite) ("fault-plane" facies) found along a young fault-zone (Iharkút). Magn. 20 ×.

Fig. 22. Decoloration-coloration features produced by successive stage of iron-mobilization. Epigenic reduction by descendant sulphur-rich solutions lead to the formation of pyrite (p) surrounded by deferrification patches (d). Successive oxidation resulted in alteration of pyrite into geothite and haematite (red and russet resp.) note the fine clastic character of the groundmass visible in the pale patches (Iharkút). Magn. 200 ×, crossed polars.

Partial remobilization of elements like iron, calcium, silica and alumina via true and/or colloidal solutions result in the formation of various pore-space fillings, coatings and seggregation structures within the already buried sediment. Radial orientation of fine-grained platy crystals (e. g. kaolinite) around remobilization structures and certain solid-state mineral alterations (like recrystallization by ageing of the colloids) are considered to be of late-diagenic origin, too.

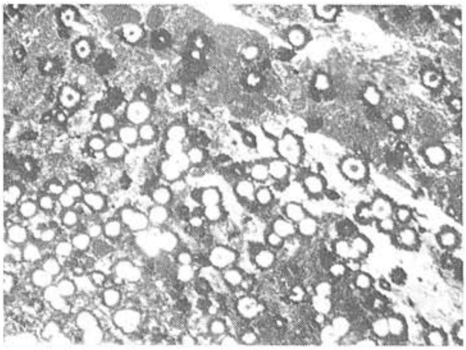
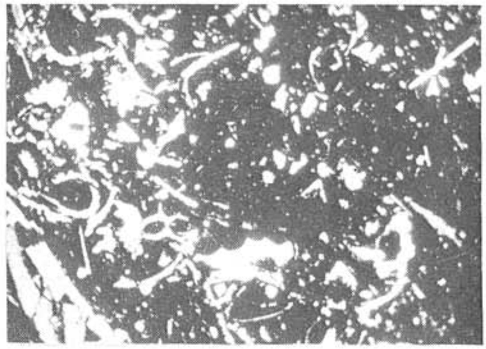
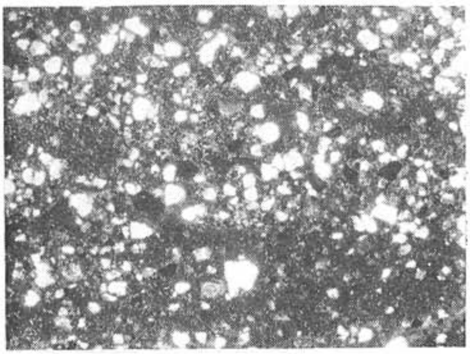
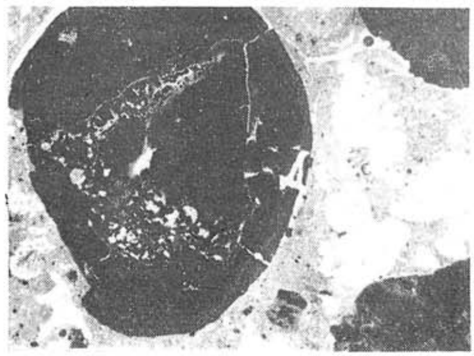





Fig. 23. Spherulitic aggregates of siderite with signs of beginning alteration into goethite and haematite (Red) (Fenyöfö). Magn. 35 ×, crossed polars.

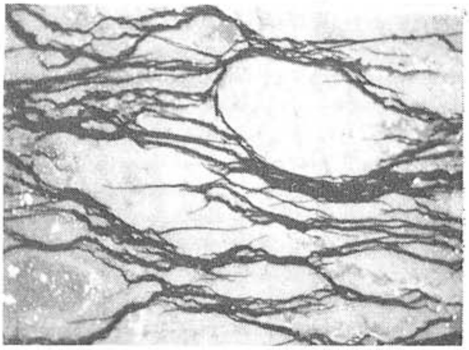
Fig. 24. Detrital fragments of fossil algae (Munieria sp.?) mixed with the iron-rich redeposited material of the uppermost layers of the L. cretaceous ("pere") bauxite horizon (Alsópere). Magn. 35 ×.

Note: Figs. 21—23 — Epigenic structures formed by chemical alteration (mainly on reaction with descendant solutions).
Figs. 24—26 — Epigenic structures formed by mechanical processes (reworking).

Fig. 25. Disturbed laminae of a quartz-dolomite silt cemented by and partly interbedded with iron-rich argillaceous bauxite. (Evidence of post-buxitization redeposition and the admixture of non-bauxitic clastic "impurities") (Iszkaszentgyörgy). Magn. 85 ×, crossed polars.

Fig. 26. Iron-rich ooids, bauxite pebbles and some fragmentary remnants of the Munieria sp.? cemented by an argillaceous-bauxitic matrix (Alsópere). Magn. 40 ×.

Structures and textures resulted by e p i g e n i c p r o c e s s e s: along the walls of the karstic sinkhole $CaCO_3$ precipitates from hydrocarbonate rich waters and impregnates the ore in the form of finely-dispersed xenomorphous masses of calcite. Kaolinization of Al-minerals as a result of interaction of $Al(OH)_3$ with the dissolved silica content of descendent meteoric waters is also a common phenomenon here, leading to local deterioration of the grade of the ore ("karst-contact" facies).



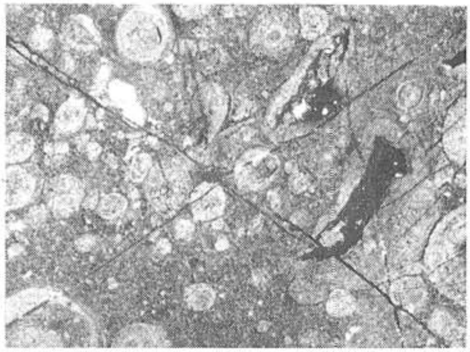


Fig. 27. Slightly tectonized pelitomorphous microclastic bauxite with haematite-filled planes of fracture-cleavage (example of post-lithification deformation). (Nagyharsány). Magn. 80 ×, crossed polars.

Fig. 28. Shear-fractures formed along planes of maximum stress in a pelitomorphous ooid-bearing bauxite (typical example of postlithification deformation). (Nagyharsány). Magn. 35 ×.

Note: Figs. 25—26 — Epigenic structures formed by mechanical processes (= reworking).
Figs. 27—28 — Structures indicating postlithification tectonism.

At places where the ore is covered by swampy layers downward percolating low-Eh swamp-waters, rich in organics may cause manyfold epigenic mineral alterations in the uppermost horizons of the bauxite body. Ferric iron is generally converted into the ferrous form here, and combining with S or CO_2 results in the formation of undesirable impurities such as finely dispersed pyrite or siderite.

In addition to chemical alterations also the effect of mechanical processes may be deteriorative from the point of view of grade. The admixture of non-bauxitic clastic material (such as quartz-sand or silt-size carbonate grains) during post-diagenic redeposition may for instance lead to relative decrease of the Al-content of the ore.

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REFERENCES

AUGUSTITHIS, S. S. – MACK, E. – VGENOPOULOS, A., 1978: Textural and geochemical comparisons of the oolitic and pisolitic structures of the Parnassus bauxites and the Ni-Cr-Fe laterites of Larymna (Lokris and Euboea) areece. Proc. of the 4th Intern. Congr. of ICSOBA, Athens. Vol. 1.

BÁRDOSSY, Gy., 1977: Karsztbauxitok (Karstic bauxites). Akadémia Kiadó Budapest, pp. 1—413.

BÁRDOSSY, Gy. – NICOLAS, J., 1973: Proposition pour une terminologie des bauxites. Travaux ICSOBA No. 9. (Proc. of the Leoben Meeting 1971).

GECSE, É. – MINDSZENTY, A., 1979: Structure and texture of karst bauxites. In: UNIDO Group Training in production of Alumina. Vol. 1. (Principles and methods of bauxite prospecting). Ed.: Komlóssy, Gy. – Szantner, F. – Vörös, I.

HIDASI, J., 1978: Oolitic textural elements in the Hungarian bauxites. Proc. of the 4th Intern. Congr. of ICSOBA, Athens. Vol. 1.

HIDASI, J. – MENSÁROS, P., 1976: Electron microprobe analyses of karstic and lateritic bauxites. Ann. Univ. Sci. Sec. Geol. Budapest.

MINDSZENTY, A., 1976: On the structure and texture of some diasporites Travaux ICSOBA No. 13. (Proc. of the Dubrovnik symposium).

NICOLAS, J., 1968: Nouvelles donnees sur la genese des bauxites a mur karstique du Sud Est de la France. Mineralium Depos. (Berlin), 3, pp. 18—33.

VALETON, I., 1972: Bauxites – Developments in Soil Science. Elsevier Amsterdam, 1, pp. 1—226.

VALETON, I., 1973: Nomenclature of bauxites. Travaux ICSOBA No. 9. (Proc. of the Leoben Meeting 1971).

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