THE HISTORY OF ACCUMULATION OF THE HALIMBA BAUXITE (W HUNGARY) ON THE BASIS OF ITS LITHOLOGICAL AND SEDIMENTOLOGICAL FEATURES

by

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INTRODUCTION

Knowing the exact sedimentological, lithological and palaeogeographical laws of the Halimba Bauxite Deposit is of importance, both from scientific and practical aspects. That is where a single deposit incorporates bauxite with Cretaceous as well as Eocene overlying beds, the study of which will clarify the kind of processes that took place during the period of denudation and bauxite accumulation proceeding between the Cretaceous and the Eocene.

* * *

I would like to express my gratitude to my subject-inspector J. HAAS, for his support by critical and constructive remarks throughout my work. Moreover, I am indebted to F. SZANTNER and to the colleagues of the Bauxite Exploration Company for their allowing me to collect the materials from boreholes and to use the documentation I needed, to T. ERDÉLYI for his help during the survey of mines, to E. JOCHA-EDELÉNYI and A. MINDSZENTY for their useful pieces of advice promoting my work.

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EXPLORATION HISTORY

Historical survey of the bauxite research at Halimba

The exploration of mineral resources in the present territory of Hungary started to boom after the 1st World War. It was also in the 20s that the exploration of bauxite was started in the Bakony Mountains. In 1920 J. STÜRMER and S. EIDLITZ set up a mining claim to the "red soil", i. e. the "terra rossa" in the vicinity of Halimba. They had an expert in the person of mining engineer A. GYÖRGY who described the underlying bed of the pisolitic and at places laminated bauxite as Hauptdolomit and limestones of likewise Mesozoic age, whereas its overlying bed was found as Middle Eocene nummulitic limestone derivable from the tropical weathering products of the granite of the Velence Mountains.

K. TELEGDI ROTH (1923, 1927) deemed that the bauxite deposits were likely to have been formed as beginning with the basin-uplift period taking place at the end of the Late Cretaceous time.

I. VITÁLIS (1928, 1932), after having found grey and brown sorts of clay including locally hand-span-thick coal seams, drew the conclusion that the bauxite is of terrestrial origin.

J. BALÁS (1927) had the opinion that the bauxite ought to be searched for at the base of the Cretaceous sequence.

T. KORMOS (1932), H. TAEGER (1936) and E. VADÁSZ (1935) have proved during geological mapping that the bauxite may be overlain also by Cretaceous beds. In the opinion of E. VADÁSZ (1935) "bauxite represents the initial member of the Cretaceous sequence formed in some zones of Transdanubia which became continental after the Jurassic time had come to an end". He deemed that the bauxite was likely to have eroded and redeposited several times during the Tertiary period. About the Halimba bauxite E. VADÁSZ also stated, (1946) that the silica content increases downwards in the bauxite body and, correspondingly, the grade is higher in the upper horizon. Furthermore, according to E. VADÁSZ (1946, 1951) the bauxite is derivable through the bauxitization of clay which had been formed owing to lateritic weathering of siallitic rocks of unknown origin and state.

I. NÁRAI-SZABÓ and J. NEUGEBAUER (1948) were the first to carry out mineralogical analysis of the Halimba bauxite. In the same year DE WEISSE (1948) found the Al-mineral of the Halimba bauxite to be hydrargillite.

Being a believer of the "terra rossa" theory, DE WEISSE considered the bauxite to be a residue of weathering of carbonate rocks. He points out that, the bauxite may be underlain, beside Hauptdolomit also by Kössen beds or Dachstein Kalk, whereas the overlying formations are represented by Turonian coalbeds in the northern extentions of the bauxite deposit and, in turn, by Eocene beds to the south. It is worth paying particular attention to the way he describes the bauxite as a sedimentary complex. It was K. BARNABÁS, who made a step forward relating to the mineralogical composition of bauxite as identifying only boehmite in the deposit covered by Cretaceous rocks, whereas finding not only boehmite but also gibbsite in the bauxite lying under Eocene beds. According to the genetic views of K. BARNABÁS (1957), the ground mass of bauxite was supplied partly by dolomite and limestone, partly by the clay-like products by the leaching of clay and marl under tropical to subtropical climatic conditions. "Their alteration into bauxite took place under terrestrial conditions". This conception represents a further development of the "terra rossa theory" on bauxite formation by considering that beside carbonate rocks, also argillaceous and marly substances may be regarded as potential parent rock.

From the beginning of the 50s a great number of mineralogical and geochemical tests have been carried out, the results of which were first reported by GY. BÁRDOSSY (1954), I. VÖRÖS and I. MEGYESI (1954).

According to the observation of S. JASKÓ (1956) which is of importance from sedimentological aspect, here and there dolomite pebbles are intercalated in the bauxite. M. DEÁK (1957, 1960) detected and identified pollens from the bauxite.

GY. BÁRDOSSY (1961), based on his tests formerly performed, confirms that the Halimba bauxite is worked and it might represent the Turonian bauxite level.

According to BÁRDOSSY the initial material of bauxite in the Transdanubian Central Range is derived from the lateritic weathering of metamorphic and eruptive rocks found in the line of the southern shore of Lake Balaton and of the Velence Mountains.

It is F. SZANTNER—M. ERDÉLYI (1960) and F. SZANTNER—E. SZABÓ (1962) to have taken the first steps in surveying the tectonic conditions of the Halimba and other bauxite locations, emphasizing the role the preforming tectonics has played in the preservation of bauxite.

In 1965 M. ERDÉLYI backs up the former statements concerning the redeposited state of the Halimba bauxite, although he deems that there are areas with no redeposition, too. He also states that the bauxite bed is underlain by stratified or unstratified dolomite or limestone clasts of varying thickness. He considers the Ca content as primary and deposited along with the bauxite material coming to the area in its very final form.

F. SZANTNER—E. SZABÓ (1966) observed that the bauxite or the bauxitic material may penetrate into the cracks of the underlying bed even to a depth of 10 to 35 metres.

B. BALKAY (1966) associates the formation of the Halimba bauxite with the contraction and uplift having taken place during the Pregosauian phase of orogeny. He seems that in addition to the redeposition of the Barremian bauxite, an independent bauxite formation also took place during Turonian time.

GY. BÁRDOSSY (1969) furnished another evidence of the redeposition of the Halimba bauxite, by describing a "graded bedding" within the bauxite body. He considered the dolomitic content of bauxite to be partly of detrital and partly of syngenetic origin.

K. TÓTH (1971) examined the transport direction of the dolomitic clasts detected on base of the bauxite finding it identical (SW—NE) with that of the bauxite. Dealing with the same problem Á. TÓTH (1976, 1977) stated that the carbonate material found both in the bauxite body and in its underlying bed is of detrital origin, and that the material with the coarsest grain-size is found at the SW part of the location, exhibiting a tendency of becoming finer towards the north.

J. HAAS and E. JOCHA-EDELÉNYI (1977) considers the Halimba bauxite as the initial member of the Upper Cretaceous sedimentary cycle of this region. E. JOCHA-EDELÉNYI (1979) has differentiated, chiefly through a computer-aided evaluation of main elements of the Halimba bauxite, four, definitely distinct areas in the region, in accordance with the bauxite grading.

The post-genetic structural character that was discovered by J. MÉSZÁROS (1981) who called it "Laramian Well" and considered it to have been formed during the Laramian dilatational-type tectonic movements, has certain bearings on mining conditions.

From the beginning of the 80s the Halimba bauxite has been studied by A. MINDSZENTY (1983) and M. NAGY-SZINTAI (1985) from a textural aspect. A. MINDSZENTY (1983) found glauconite in the carbonatic bauxite, deriving it from the Cenomanian Turrilitic marl. Based on this the beginning of the bauxite accumulation was appointed to the Turonian. She came to the conclusion that the Halimba Basin must have been an intermontane polje, into which bauxite and carbonate clastics were entered, from different directions, from the neighbouring regions, by sheet-wash and by intermittent waterflows, in which the distribution of material was mainly formed by the deposition itself, instead of the chemical processes of the „post-depositional diagenesis". She considers the ooids of Halimba bauxite to originate from the erosion of an older (?K_2) bauxite deposit and finds so that "there is no difference between the samples taken from beneath the Eocene or the (primary) Cretaceous overlying beds". A. MINDSZENTY assumes the presence of a rock assemblage consisting of metasediments and calc-alkaline granitoids exposed in the distant background during the time of bauxite accumulation.

M. NAGY-SZINTAI (1985) distinguishes two main cycles of sedimentation, based on the fine-grained lower and coarse-grained upper parts of the deposit, with both parts being clearly separated from each other.

METHODS OF EXAMINATION

This study prepared to clarify the lithological and sedimentological features of the Halimba Bauxite Deposit has been based on a system of key-profile investigations. Accordingly, from as early the very beginning I decided to make sampling as densely as possible. The sampling interval was 1 m for most of the cases and 0.5 m for a few sections. There are also sporadical samples where samples were taken for the purpose of a routine checking only, from the sequence that had been fairly defined formerly.

I began my examinations with a megascopical, visual checking of cores formerly drilled by the Bauxite Exploration Company as well as of samples I had collected when surveying the mines. Then I tested a total of approx. 1000 thin sections of rocks taken from 125 boreholes and of a great many samples taken from mines, in order to determine their microtextural properties and to record them in lithological profiles and photos. In every possible case I made a vertical thin section, from each rock sample. The bauxite textural nomenclature elaborated by A. MINDSZENTY (1983) could not be used for megascopic testing, since the Halimba bauxite does not fit into this system from a bauxite-textural aspect. That is why I have established a new textural system of redeposited karst bauxites, patterned upon the Halimba bauxite.

During the textural examination of thin sections I used the Folk's classification system for carbonate rocks (1959) to rely upon when describing the types of bauxite. The main textural element I have separated are as follows:

M a t r i x

Material
- argillaceous
- carbonatic
- bauxitic

Texture
- pelitomorphic
- granulomorphic (micro-grained)
- mosaic-type

With the reflection of later alterations
- deironized
- reironized

— resilicified
— sulphatized
— carbonatized, etc.

The compositional grain-size of matrix is less than 10 μm, whereas the *grains* are larger.

G r a i n s

Grains of bauxite material

— ooids
— pisolith
— bauxite pebbles
— oolitic clasts

Grains of non-bauxitic material

— limestone
— dolomite
— quartz
— microextraclasts

The size of ooids varies in the range of 10 to 800 μm. Larger ones occur rarely. The diameter of bauxite pebbles is larger than 2 mm. The size of oolitic clasts may vary in a wide range, but is typically in the range of 200 to 400 μm. To describe the arrangement of grain with respect to one another as well as to the matrix I have used the nomenclature (DUNHAM, 1962) known from carbonate petrography, to which I have added the following supplement concerning the "bauxite": bauxite packstone; bauxite wackestone if the ratio of grains exceeds 10%; bauxite mudstone, if grains less than 10% float in the matrix, without any contact with one another. The basis of the sedimentological nomenclature for bauxite, which I have applied, is shown in Table 1.

Table 1

Applied nomenclature for the description of bauxite

<table>
<tr><th rowspan="3"></th><th colspan="4">The grains</th></tr>
<tr><th colspan="2">are in contact with one another</th><th rowspan="2">have no contact</th><th rowspan="2"><10%</th></tr>
<tr><th>frequently</th><th>rarely</th></tr>
<tr><td>BAUXITE PEBBLE
more than 25%</td><td>bauxite packstone with bauxite pebbles</td><td>bauxite wackestone with bauxite pebbles</td><td>bauxite mudstone with bauxite pebbles</td><td rowspan="3">bauxite mudstone</td></tr>
<tr><td>OOID + PISOLITH
more than 25%</td><td>bauxite packstone with ooid-pisoliths</td><td>bauxite wackestone with ooid-pisoliths</td><td>bauxite mudstone with ooid-pisoliths</td></tr>
<tr><td rowspan="2">EXTRACLAST
more than 25%</td><td>bauxite packstone with extraclast</td><td>bauxite wackestone with extraclast</td><td>bauxite mudstone with extraclast</td></tr>
<tr><td>packstone</td><td>wackestone</td><td>mudstone</td><td></td></tr>
</table>

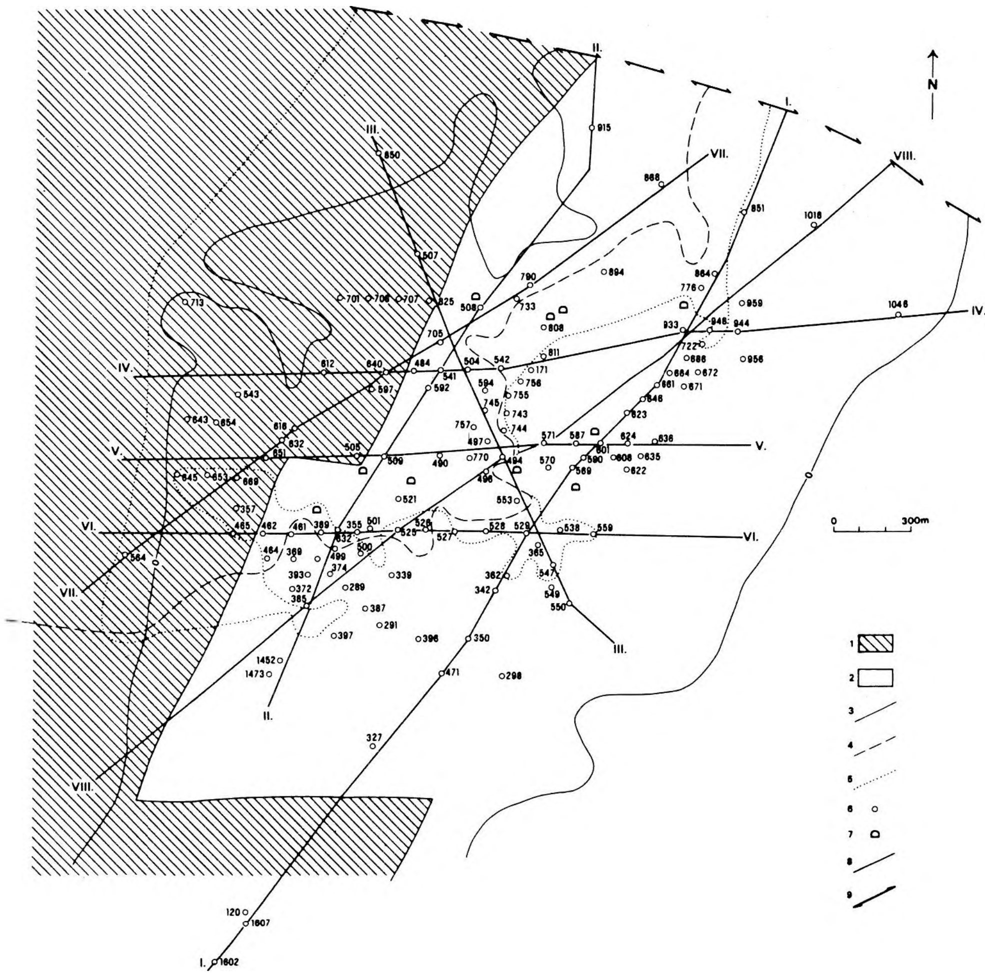


Fig. 1. Location of the examined boreholes and profiles on the basis of map "Underlying and overlying formation of the Halimba Bauxite Formation" (E. JOCHA-EDELÉNYI, 1974)

Upper Triassic: *1.* Hauptdolomit Formation, *2.* Dachsteinkalk Formation—Kössen Formation. *Upper Cretaceous:* *3.* areal extent of the Halimba Bauxite, *4.* areal extent of Senonian Formation, *5.* boreholes examined, *6.* sampling points in the mine, *7.* position of examined profiles, *8.* horizontal displacement

Due to the sedimentological features of the Halimba bauxite for identifying the set of facies, it was necessary, to borrow and adapt terms from the terminology of fluvial and lacustrine sedimentation. During the time of accumulation of the Halimba bauxite, there were neither fluvial environments taken in a general sense, nor lacustrine ones (a surface permanently covered by water) in the region concerned. However, the results show that during the stages of bauxite accumulation there was river with its streaming water suitable for transporting grains even large as 2 cm in diameter an that there was an environment similar to lacustrine in those areas where th bauxite is fine-laminated. Thus I have envisaged a sedimentary environmer that is not completely identical with the one or another of the sedimenta tion areas mentioned above but is similar to both of them from the aspec of its details. Based on this, the following definitions are used in the sed mentological description of the Halimba bauxite:

Channel facies

Channel bar facies

Bauxite clasts were deposited from stream water. The material is me dium-sorted. The arcuate bedding as well as the cross-stratification can b observed frequently. Grain size may vary from silt to fine gravel. Its textur is, for most of the cases, bauxite packstone or bauxite wackestone, eithe with bauxite pebbles or with ooids-pisoids (Plate III).

Channel load facies

A coarse-grained, unsorted formation consisting dominantly of bauxit pebbles. It has a grain-to-matrix ratio of 1:1, but in some cases the grain may attain even a higher amount. Its texture is packstone, containin bauxite pebbles ooids, and oolitic clasts. Its matrix is pelitomorphic, eithe rich in iron or partially deironized (Plate IV).

Flood plain facies

Medium-sorted or poorly sorted grains that were deposited with sligh lamination or without any lamination. In some cases graded bedding ma also occur. The matrix is dominant with respect to grains. Mosaic structur indicating desiccation cracks occurs frequently at the fine-grained argil laceous levels. The grains are generally of sand size, but smaller and large ones may also occur. It has a very diversified texture with the occurrence of bauxite packstone and bauxite wackestone with bauxite pebbles, pi soliths-ooids or extraclasts. Its matrix is pelitomorphic bauxite, but it car be carbonate bauxite also (Plate V).

Flood basin facies

The basin facies consists generally of grains of size of silt or fine-grained sand. Multi-laminated, parallel and laminated bedding may occur. It is well sorted, but in a few cases a larger grain can also be observed here. Mosaic-type structure may also occur but is much more rare than in the flood basin facies. Its texture is, most frequently, bauxite mudstone but can also be bauxite packstone or bauxite wackestone as well (Plate VI).

Marsh facies

It represents reductional environment. It is grey, argillaceous, and abundant in organic remains. Its texture is always bauxite mudstone.

The boundary between facies described before is not always sharp, in some places transitional zones may occur.

STUDY OF KEY-PROFILE BOREHOLES

Borehole sections representing some details of the Halimba Bauxite Deposit were examined as taken for key-profiles.

Borehole H 529

Borehole H 529 is found in the SE sector of the Cretaceous-overlain middle part of the Halimba deposit (Fig. 1). The borehole penetrated a 21.5-m-thick bauxite bed that was investigated after having been sampled at intervals of 1 m. A summary of study results is given in Fig. 2.

Based on thin section study it can be stated that our bauxite is of a uniform composition, with matrix and grains, the qualitative, quantitative and dimensional distribution of which is different and, at the same time determinant at each part of the profile. The grains may be bauxite pebbles, pisoliths, ooids, spherical grains, grains with deironized rims, as well as their clasts. Heading upwards in the sequence the matrix-to-grain ratio shifts towards the grains and at the same time the average grain size increases also. Grains with reduced rim, as well as the mosaic structure indicating the syngenetic desiccation, being characteristic of the matrix texture, occur at a few levels only. Fluidal segregations of iron hydroxide occur frequently particularly at the upper parts. At the lower two-third of the borehole section grains are arranged in arcuate strings, somewhere with clearly visible cross-strata, and are medium sorted (Plate III). With deposits derived from a streaming medium, this part conforms to channel bar facies, on the fluvial analogy.

No trace of lamination can be detected in the approx. 2-m-thick footwall and in the uppermost part of approx. 3-m-thick. The lowest part is fine-grained bauxite mudstone (silt), whereas the uppermost one is bauxite mudstone with coarser grain size.

At a depth interval ranging from 203.2 to 212.2 m an unsorted deposit consisting mainly of bauxitic clasts has been found. The maximum grain diameter may attain even 1.2 to 1.5 cm. The gaps found among the larger clasts are engaged by smaller grains. This represents a typical pattern of a bauxite-pebbly and oolitic, densely grained bauxite (packstone). Here the matrix-to-grain ration is approx. 1:1. This kind of evolution corresponds, within the channel facies, to the channel load facies (Plate I). At the uppermost parts (200.2—203.2 m) the grain size is decreasing and smaller ooids and bauxite grains can be found in the argillaceous matrix sporadically only. The average bauxite grade is the highest for the channel load facies, reaching at other sites the argillaceous bauxite grade only. The distribution of main elements as well as the amount of mineral components and trace elements are shown as a function of depth in Fig. 2.

Upwards, to the level of 216 m the mineral components identified by means of X-ray diffraction and derivatography methods of phase analysis have steady amount, practically with small fluctuations with their ratio also remaining unchanged (goethite-haematite-kaolinite-boehmite). The first change appears at approx. 215 m, with the amount of goethite increasing from 2—4% to 8%. This change has been detected in thin sections as indicated by fluidal iron segregations. Above this level the amount of haematite and boehmite decreases, whereas the amount of kaolinite increases from 30% to 50%. The same situtation is found near 209 m, where the amount of goethite is 6%, whereas at the overlying part of 1—2 m the amount of haematite and boehmite decreaseas and kaolinite increases considerably.

The distribution in depth of trace elements shows that Mn, Co, Ni and to a certain degree Ba also, vary according to the same trend. Zr is present in the same quantity — with the relative error of measurements taken into account also — varying within a very small range. In upward direction Cr exhibits a tendency of increasing with smaller fluctuations included. The amount of Mn, Co, Ba elements moving together decreases upwards. This tendency is interrupted at 212 m by a larger peak when the amount of elements concerned increases by one order of magnitude, and Ni and Mn increases by a half order of magnitude. However, even in this way they cannot reach the amount they have at the lower parts. The amount of Cr is gradually increasing upwards is in accordance with the fact that grains become coarser in the same direction. The smaller peak of the amount of Mn, Co, Ni and Ba at 212 m as well as its first decrease detected at 214 m complies with the changing of Cr amount in similar direction. Thus it can be assumed that the energy of the stream had decreased (213—214 m) then increased again. The decrease in energy may have led to the appearance of smaller marshes, as indicated by the goethite content (8%) increasing at 215 m. There is another level near 208 m, where the amount of Cr decreases, from 250 ppm to 100 ppm, which may also point to the decrease in stream energy. In the underlying horizon the amount of goethite increases again. The amount of kaolinite also increases, abruptly, in both media corresponding to a low level of transportation energy. Part of the haematite dehydrated into goethite through a hydrohaematite-goethite transition, in the stagnant water environment which had become marshy and muddied. It is of importance to mention that in horizons muddied. It is of

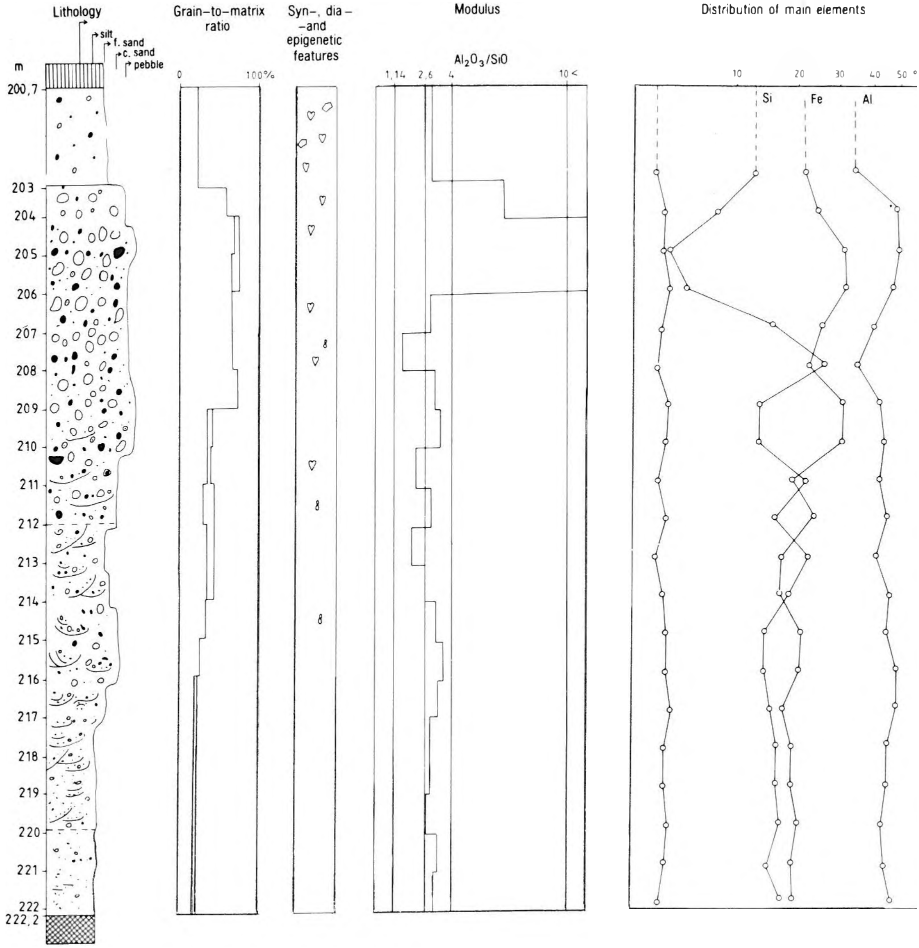
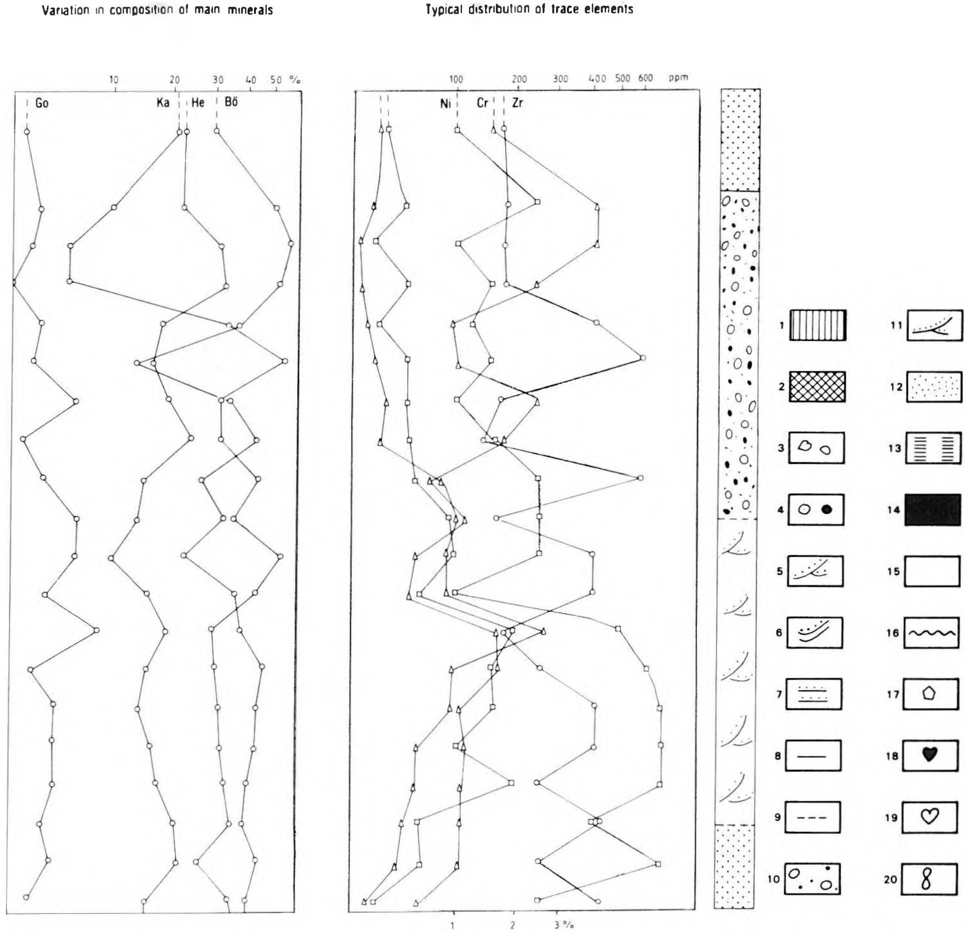


Fig. 2. Results of the testing and analysis

1. Overlying bed, 2. underlying bed. *Grains:* K=extraclast, *3.* clasts, *4.* pisoliths. *Bedding:* 5. cross-bed transition between layers. *Facies:* *10.* channel load, *11.* channel bar, *12.* flood plain, *13.* flood basin. gation, 19. deironization, 20. epigenetic features. *Module:* M>3.4=bauxite;

importance to mention that in horizons richest in kaolinite, traces of illite, and around 210 and 222 m chlorite can also be detected.

After the analysis of distribution of trace elements the samples taken from the coarse-detrital bauxite, with a sampling frequency of 1 m, were separated to grains and matrix and their trace element content was tested separately. Due to smaller faults in sample preparation the results are informatory only. The distribution of the elements as a function of depth is shown in Figs. 3, 4, 5 and 6. Table 2 shows the value of D, standing for the enrichment coefficient (D = the ratio of trace element content of grain to



of core samples from borehole H 529

ding, *6.* rippled, arcuate microlayers, *7.* parallel microlayers, *8.* sharp transition between layers, *9.* gradual *14.* marsh, *15.* Eocene bauxite, *16.* erosional surface. *Matrix: 17.* mosaic structure, 18. fluidal iron segre- $1.14<M<3.4$ = argillaceous bauxite; $0.85<M<1.14$ = bauxitic clay; $M<0.85$ = clay

the trace element content of the matrix). Based on their distribution, the examined elements can be divided into smaller and larger groups. Sc, Cr and Sb have the largest amount and the highest enrichment coefficient, whereas Co is present in a smaller amount also (Fig. 3). For every examined depth interval the amount of these elements was lower in the matrix than in the grains. Their amount vary within the same order of magnitude, with the exception of Co that exhibits a downward-increasing trend with fluctuation.

The quantitative distribution of REEs is not characteristic. Their amounts included in the matrix and in the grains are nearly the same, with

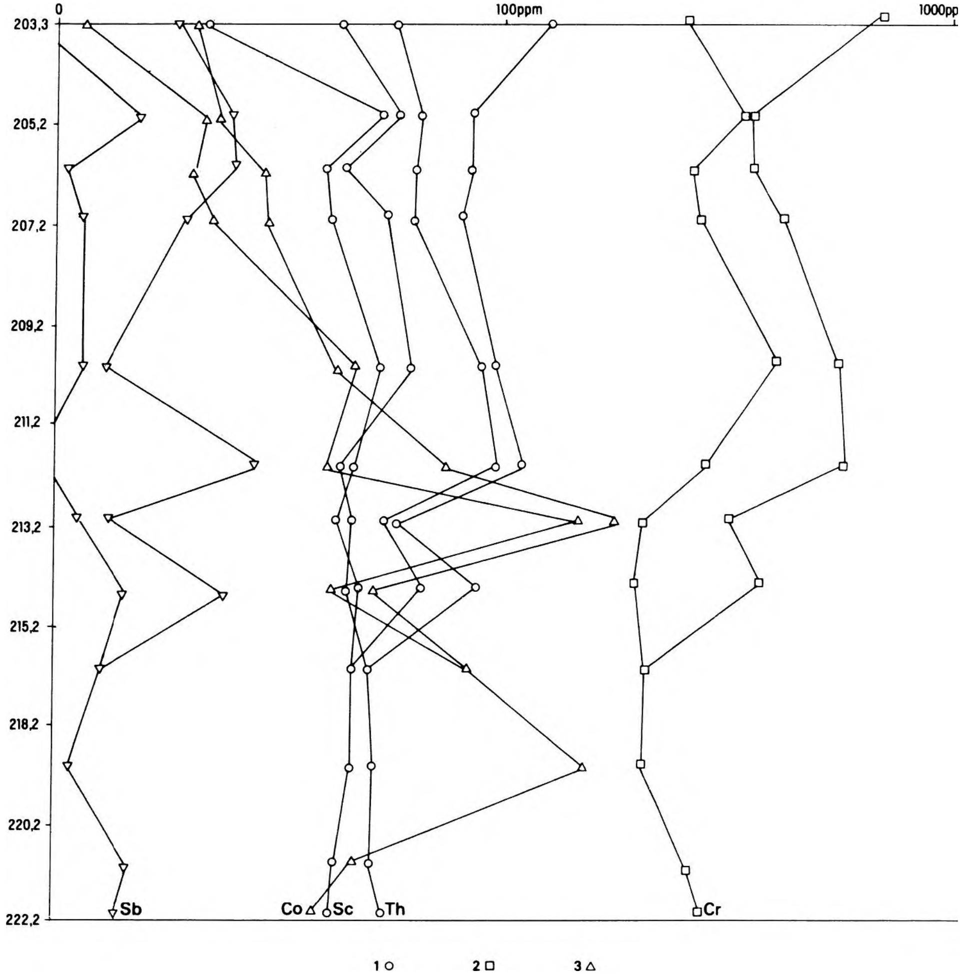


Fig. 3. Distribution of Sc, Cr, Co, Sb, as a function of depth, for borehole section H 529
1. In grains, *2.* in matrix, *3.* mixed

slight differences only. Lu and Ta have a behaviour similar to that of REEs. However, Hf is enriched in grains apparently, although it has a very small amount in every sample. Curves relating to Th and U (Figs. 3 and 6) are similar to that of Hf. They also have a nearly identical enrichment coefficient. As shown by electronmicroprobe tests, the bauxite matrix is rich in Al, has an Fe content and always incorporates more or less Si. For the most of the cases it is pelitomorphic, or sporadically gel-like. In this, Fe-Ti-Ca-, or Fe-Ti-Mn-composed grains and those made of TiO, ilmenite, dolomite and calcite are embedded.

At the uppermost part of the borehole section the grains appearing in a small number in the pelitomorphic matrix have Fe-Ti content.

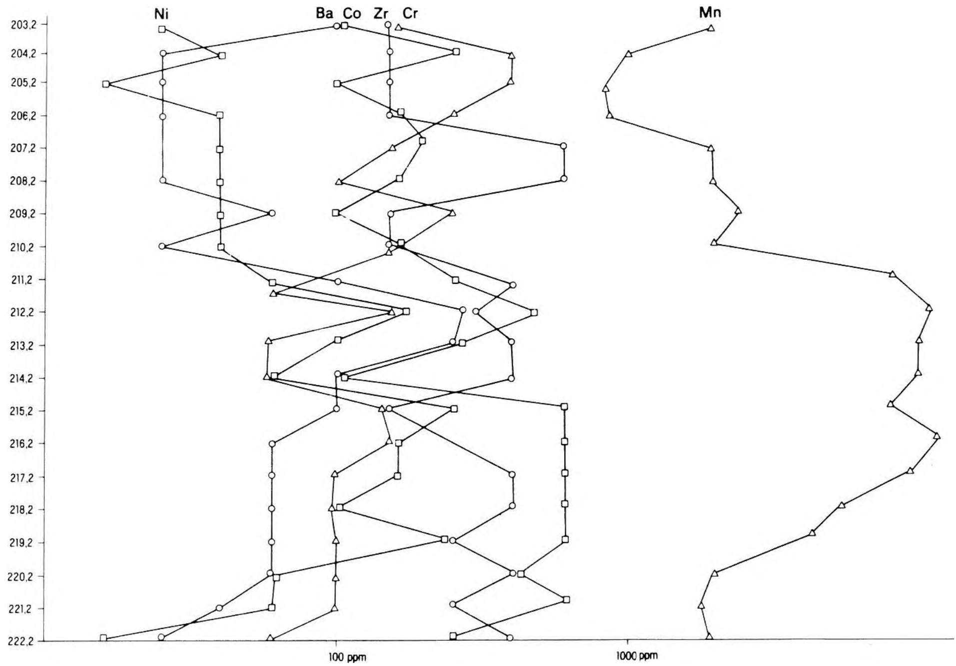


Fig. 4. The distribution of trace elements in borehole section H 529

Downwards the grains with varied size and Fe-Ti-Mn-Ca composition are frequent all along. Although the amount of Mn and Ca is low, close to the limit of detection, but it can be detected anyway (Plate VIII). In the middle part of the sequence the first bed of finer grain size appears, differring not only in grain size but also in composition from the beds lying above it. The matrix is pelitomorphic with grains of clastic origin (10 to 20 μm) arranged in the form of strings. In this bed grains with rich Mn content and considerable Ni-Co content as well as with a low content of other elements (Fe, Ca, Al, Si, K, Ti, V and S) appear. This sedimentary phase appears almost to the end of the profile, with the exception of the lower 2—3 m. In these grains Mn represents the main mineral component, the amount of Ni exceeds that of Co, whereas the amount of the other elements is low. The grains described here are very frequent at the mentioned parts of the sequence and have different size (Plate IX).

The whole sequence, particularly a part of the Mn-rich phases are characterized by the rearangement of elements due to later environmental impacts. This is indicated by the mass of fluidal iron segregations that are frequent at the upper part of the sequence as well as by the diffusion yard, a rim with poor Fe content observed from time to time around the grains, with sporadical "crystal piles" orientated perpendicularly to the grains, visible therein. The band became deironized, frequently in asymmetrical man-

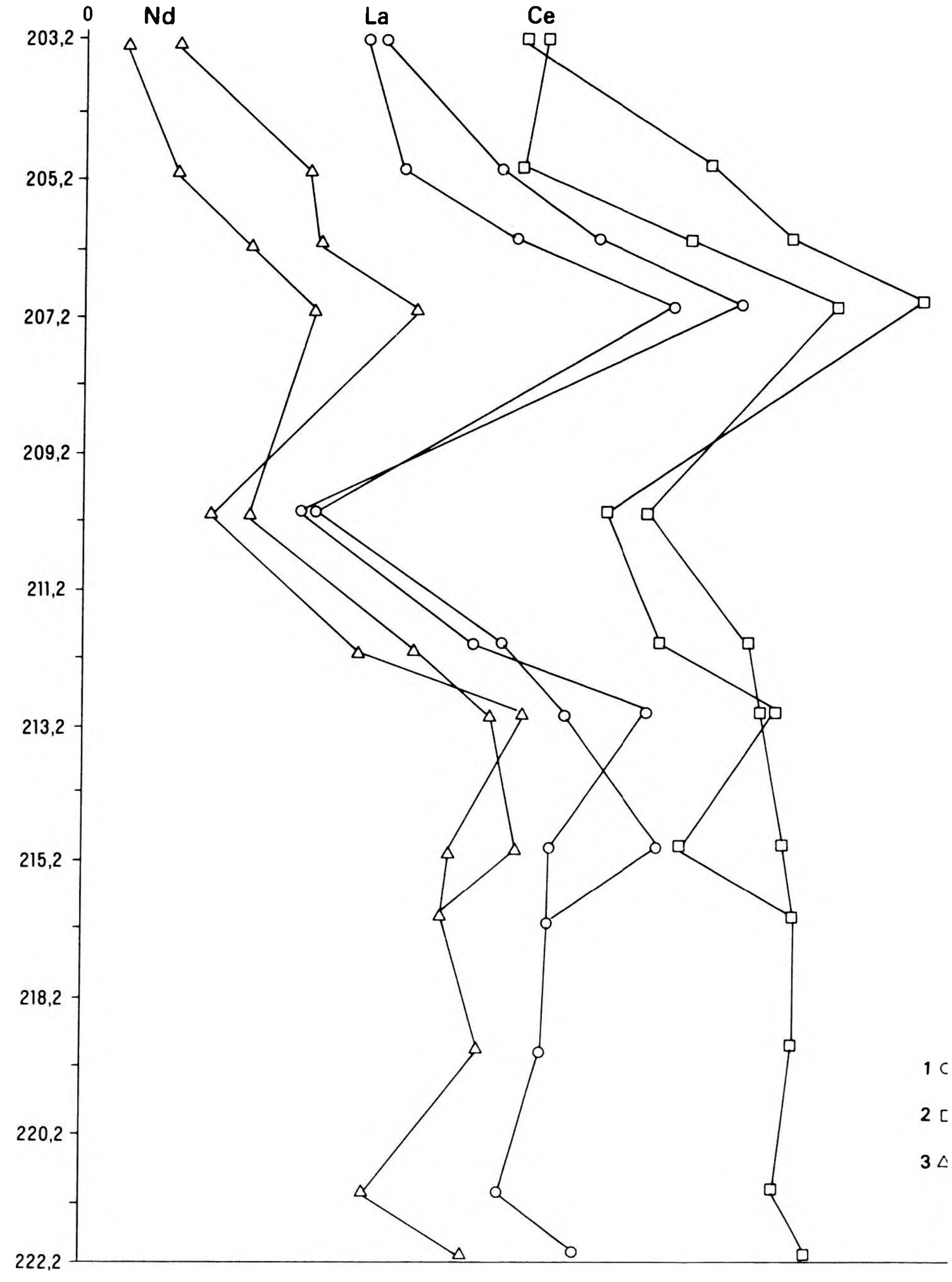


Fig. 5. The distribution of three REEs in borehole section H 529
1. In grains, *2.* in matrix, *3.* mixed

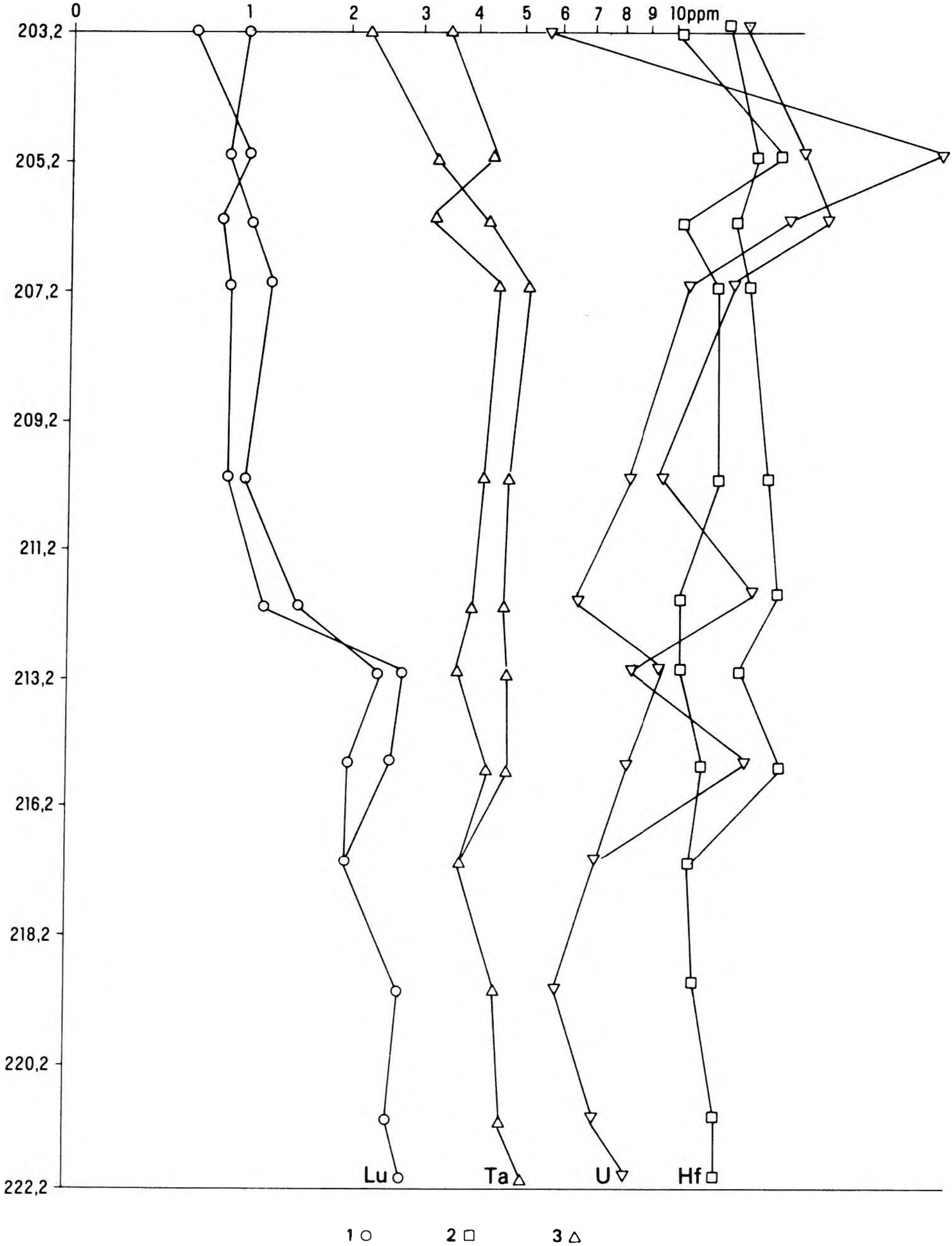


Fig. 6. Distribution of Lu, Hf, Ta and U, as a function of depth, for borehole H 529

1. In grains, *2.* in matrix, *3.* mixed ner, developing only on one side of the grains. On the Mn-rich grains foun at the lower third of the sequence an intensive element mobilization can b observed. As a result of this element mobilization, at some parts of th detrital grains Mn, whereas at other parts Fe, Ni and Co are concentrate Considering that the evidences of element mobilization are terminated b the outer skin of each grain, thus it must have been generated earlier.

As a general feature of the bauxite matrix, it is composed of isometri mineral plates ranging from 0.1 to 0.5 μm, combined into a few aggregate with size ranging from a few μms to some several 10 μms and with plate to-plate linking. The aggregates containing Al, a small amount c Fe and an even smaller amount of titanium form a lattice structure so tha they are in contact with one another on their surface or sides, leaving sma cavities or graps among them (Plate X). Gelly structures containing mainl Al, Fe and Si, with size ranging from several hundred μm to the order c mm can be observed sporadically among the aggregates in the matrix. It i also the matrix that incorporates the kaolinite plates in size generally rang ing from 10 to 20 μm, which appear, in some cases in the form of bundle (Plate XI).

The texture of spherical grains, like that of the matrix, has aggregate but these aggregates are smaller, thereby fitted more densely to one anothe than in the matrix (Plate X). Grains are rather compact, containing n larger crystals. They include practically no cavities, the shells succeed on another tightly, representing the typical examples of accretional ooids.

Twice two preparations were made from the bauxite sample taken fror the borehole for micromineralogical analysis. For this I have separated th upper bauxite bed with its majority representing the channel load facies an the lower bauxite bed with its majority corresponding to channel bar facie as well as their grains and matrix. The matrix of the bauxite of channel loa facies contained hardly any extraclasts turning out to be pure quartz crys tals. The preparation made from the matrix of the lower bauxite sequenc mainly of channel bar facies exhibited a little more diversified image: in ad dition to quartz monocrystals, also feldspar, apatite, rutile, bastnäsite, mag netite mineral grains as well as detrital grains of quartz+alkali feldspar an quartz+antimonite are contained. The preparations made from the grain contained parctically no mineral extraclast. The ooids and bauxitic clast that had disaggregated during deironization broke into Al-rich aggregation which included a zircon, rutile or quartz grain sporadically.

Borehole H 851

The examined borehole penetrated a 32-m-thick bauxitic bed forme in a deep doline, covered by Eocene, close to the Cretaceous-overlai deposits, in the NE part of the occurrence. The borehole can be found i Profile I (Fig. 1), whereas the results of analysis concerned are shown i Fig. 7.

Based on thin section study it has been stated that the lower part of the sequence is bauxite mudstone with carbonate matrix and extraclast (Plate XIII), in which limestone is dominant with respect to dolomite. Bauxitic clasts are present in a smaller amount in the argillaceous-carbonate matrix of silt size. Microclasts the matrix is composed of also are generally laminated. Around a depth of 300 m the extraclast form a packstone texture (Plate XIII). Here the carbonate grains are dominant. At places in the upper part traces of dim lamination appear. Upwards in the sequence the grain size of bauxite gradually increases and so does the amount of dolomite, beside limestone. In the uppermost part approx. 2-m-thick the largest bauxite grains may attain to 1 mm. It is assumed that a few metres from this horizon had been eroded off during the denudation taking place between the Cretaceous and the Eocene. Of the syngenetic features the mosaic structure as well as the synsedimentary textural elements originating from slumping of deposits and appearing in this borehole most expressively are characteristic of the upper part of the profile. The latter means that the material which had consolidated to some extent, slumped down from the nearby higher parts into the lower parts in the vicinity, preserving its original texture (Plate XIII).

Based on the facies analysis this profile can be divided into three parts which are as follows: lowermost flood basin, middle flood plain and uppermost channel facies. The last one could not be subdivided, due to the insufficiency of material that has remained in a thickness of 2 m only. The Fe, Si and Al content varies according to similar trend, within the same order of magnitude, fluctuating in a very small range (Fig. 7). They have no characteristic features of that kind would point to a later or local bauxitization. The main bauxite mineral is the boehmite, but at a single level 1% of gibbsite also occurs. Chlorite is present in the whole profile, not exceeding 11%. Illite and montmorillonite can be found also, with their occurrence indicating that the material of saprolite beneath the level of the eroded lateritic bauxite may have contributed to the accumulation of the Halimba bauxite. The amount of X-ray amorphous phase is rather high (8 to 10%) through all the profile.

Of the trace elements Co and Ni vary likewise and have a small amount with respect to other boreholes. Cr has similar amount as in general for the other boreholes, ranging from 60 to 200 ppm. However, Zr has a very large amount, particularly in the upper sequence of flood plain facies. Considering that neither the Mn with an amount generally as high as 0.1%, Ba with its amount ranging from 100 to 400 ppm nor the rest of elements exhibit characteristic change, so their delineation may be omitted.

The mudstone of the lower, carbonate bauxite of flood basin facies contains practically no micromineral extraclast. Only a few grains of quartz and rutile could be identified. The upper bauxite bed of flood plain facies has a somewhat richer content, allowing to identify, beside quartz grains oc-

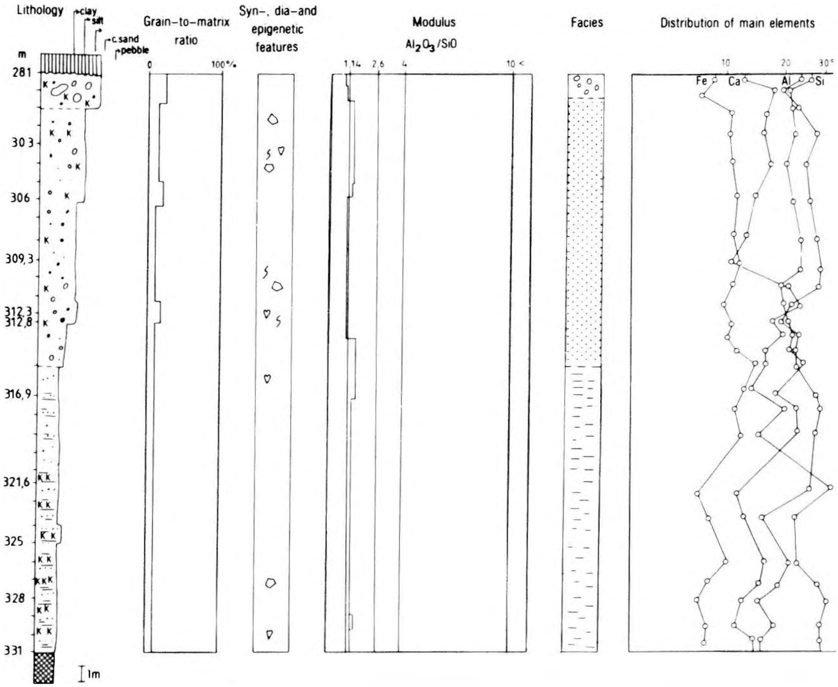


Fig. 7. Results of the testing and analysis of materials

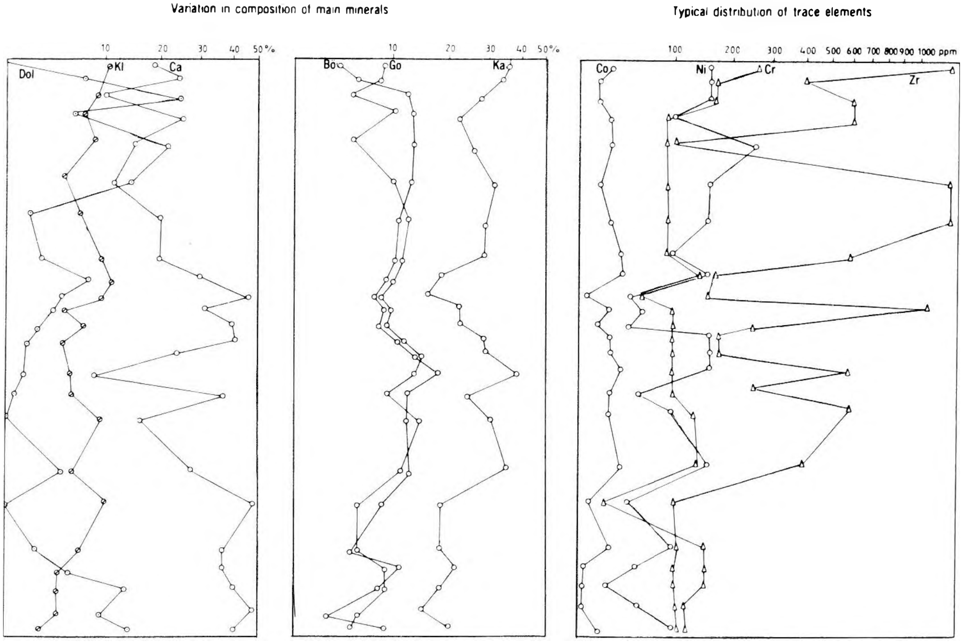
curring in a larger amount, also a few grains of rutile, zircon, titanite, mus covite as well as of several feldspar grains, one with albite composition purely.

The preparations made from the grains have proven to be barren as for extraclasts. The Al-rich, Si-free aggregates with low Fe content, into which the grains had broken, contained small (5 to 10 μm) grains of zircon, il menite, anatase, rutile and quartz as inclusions.

Borehole H 640

Borehole H 640 is found in the N part of the zone of Cretaceous-overlain bauxite deposits, comprising the intersection of profiles IV and VI (Fig. 1). Study results of the drilled profile are shown in Fig. 8. The bauxite bed with a thickness of 10.3 m only, has a very diversified lithological spectrum. Its material incorporates bauxite pebbles, pisoliths, spherical grains, accretion ooids as well as dolomite grains. The grain-to-matrix ratio is the highest at the lower part of the sequence where the bauxite grains with a maximum diameter of 1mm are found in unsorted arrangement in the pelitomorphic matrix.

The middle part (325—327.7 m) is bauxitic dolomite aleurolite. The dolomite grains are arranged in laminated form in the pelitic bauxitic



from borehole section II 851. For legend, see Fig. 2

matrix and a few smaller deironized spherical grains can also be observed. At this part a flood basin facies exhibiting the features of marsh facies also, into which only larger floods may have transported some bauxitic, argillaceous material, has been identified. At the upper part the bauxite grains of generally fine-grained sand size forming wavy strings, indicative of a streaming-water depositional environment reflected by their texture. In the uppermost 1 m the grains, having similar features, are somewhat larger. The syngenetic mosaic structure is particularly characteristic of the upper (322 m) and lower (330 m) parts of the profile. The bauxitic dolomite siltstone exhibits traces of intensive iron mobilization, which can be sufficiently explained by the environment becoming marshy. Just here, the dolomite siltstone displays a module of its highest value, since its SiO_2 content is very low, due to the decrease in clayey inflow.

Facies distribution has a diversified pattern: subsequent to a total of 1 m only, of the lowest flood plain facies the coarser grained channel load facies follows, with a gradual transition between them. Here the bauxitic material supply is interrupted, followed with a sharp transition by a dolomite aleurolite part which can be considered to be of a stagnant-water flood basin facies. Due to the repeated increasing bauxitic material in flow, the sequence ends with channel bar facies with deposition from a stream and characterizing the upper part, by a thin, slightly coarser clastic part

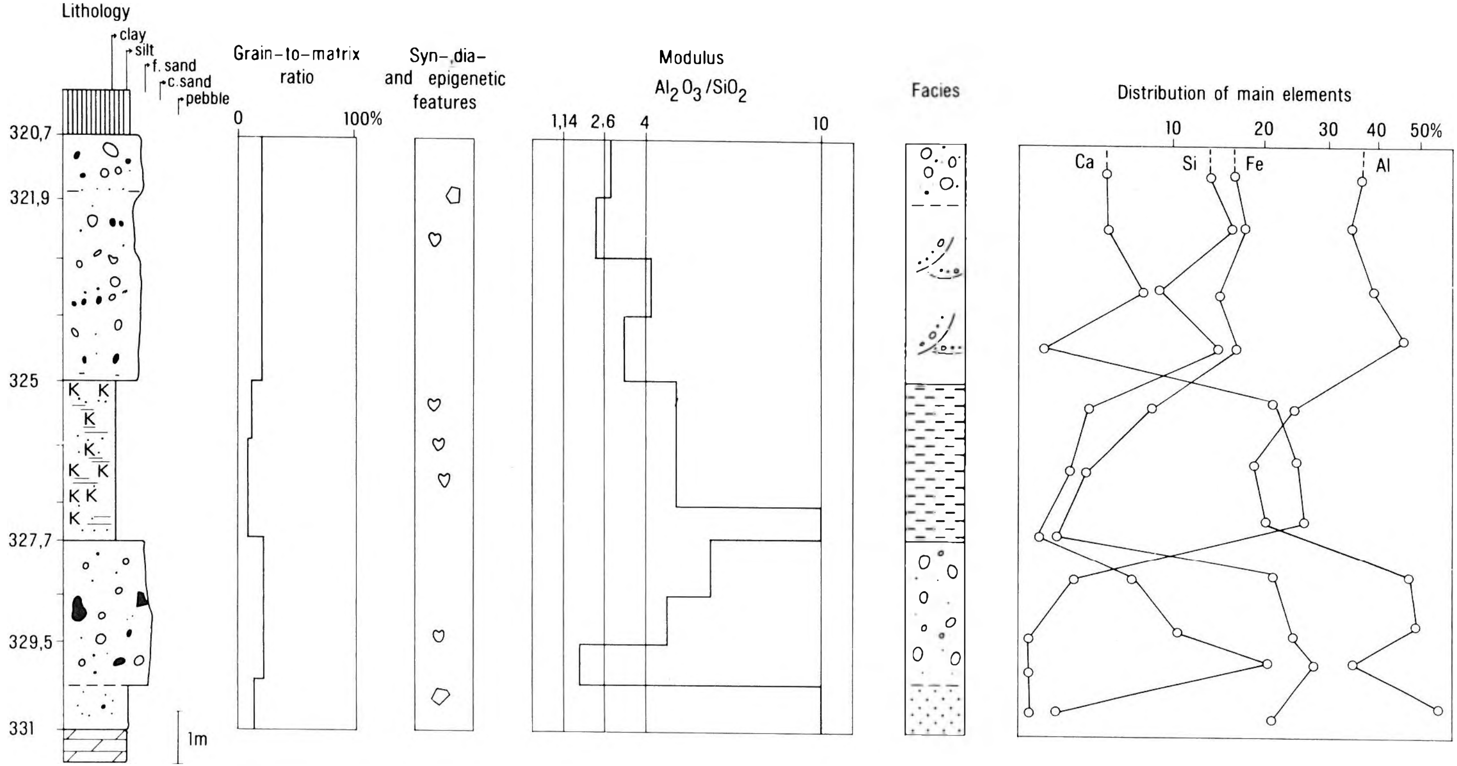


Fig. 8. Results of the testing and analysis of materials from borehole II 640. For legend, see Fig. 2

(1 m). As shown by the distribution of main elements, neither later bauxitization nor local desilification took place. The ratio of Al, Si and Fe remains practically unchanged all along the profile, with their curve corresponding to the same trend.

The textural examinations using electron-microprobe have clearly justified that the profile can be divided into three parts. Based on their microtextural properties the lower and upper parts exhibit some similarities. The matrix of the lower sequence of channel load facies is fine-grained, Al-rich, with Si and Fe content, and so is that of the upper one of channel bar facies (Plate XIV, Figs. 1, 2, 3, 4). Of clastic grains the frequent ones are the spherical grains with Fe (Ti) content, the accretional ooids and bauxitic clasts, as well as the rutile grains. Collomorphic Fe-rich segregations occur, too. At the upper part calcite grains can be observed also. At the middle part with dolomite siltstone, the aggregates of pyrite are rather frequent (Plate XIV, Figs. 5 and 6), indicating that marshy effects with actually reducing impact could also form in the flood basin environment. The composition of ooids, having an Al-Fe content contrary to the general Fe-Al composition also complies with this environment.

Borehole H 509

Borehole H 509 is found in the SW, middle part of the bauxite area with Cretaceous cover constituting the intersection of profiles II and V (Fig. 1). The borehole penetrated a sequence of 28.3 m of bauxite, with its features shown in Fig. 9.

Thin section study shows the matrix of the bauxite to be pelitomorphic, in which the bauxite pebbles, ooids and pisoliths form a wackestone texture (Plate 15, Fig. 1). Ooids of accretion structure also occur, in a smaller amount, at the middle (290—293 m) and lower (289—307 m) parts of the profile. No grains with reduced rim can be found in the profile. Extraclasts are found at the lowest (approx. 2 m) and uppermost (approx. 1 m) parts only. Grain types listed before are generally of silt, and for a few levels, of maximum fine sand size. Within this size range grains become always coarser in upward direction.

At the lowest part of 2 m the grains of silt size are arranged according to a arcuate string pattern. In the overlying bed, up to 289 m no trace of lamination can be observed. At the subsequent part between 289.9 m and 283.9 m the features pointing to a streaming medium are well-marked again. Reaching 287.9 m the grains form definite cross-beddings, followed by a relatively well-sorted unlaminated deposit. The whole profile is characterized by small grain size and rather good sorting. There is only one place (283—285 m) where the amount of grains attains approx. 20%. At other spots it is much less than this value. At the uppermost part of 2 m the grain size decreases, interrupting the grain distribution tendency of increasing upwards. The mosaic structure characterizes the whole sequence (Plate XIV,

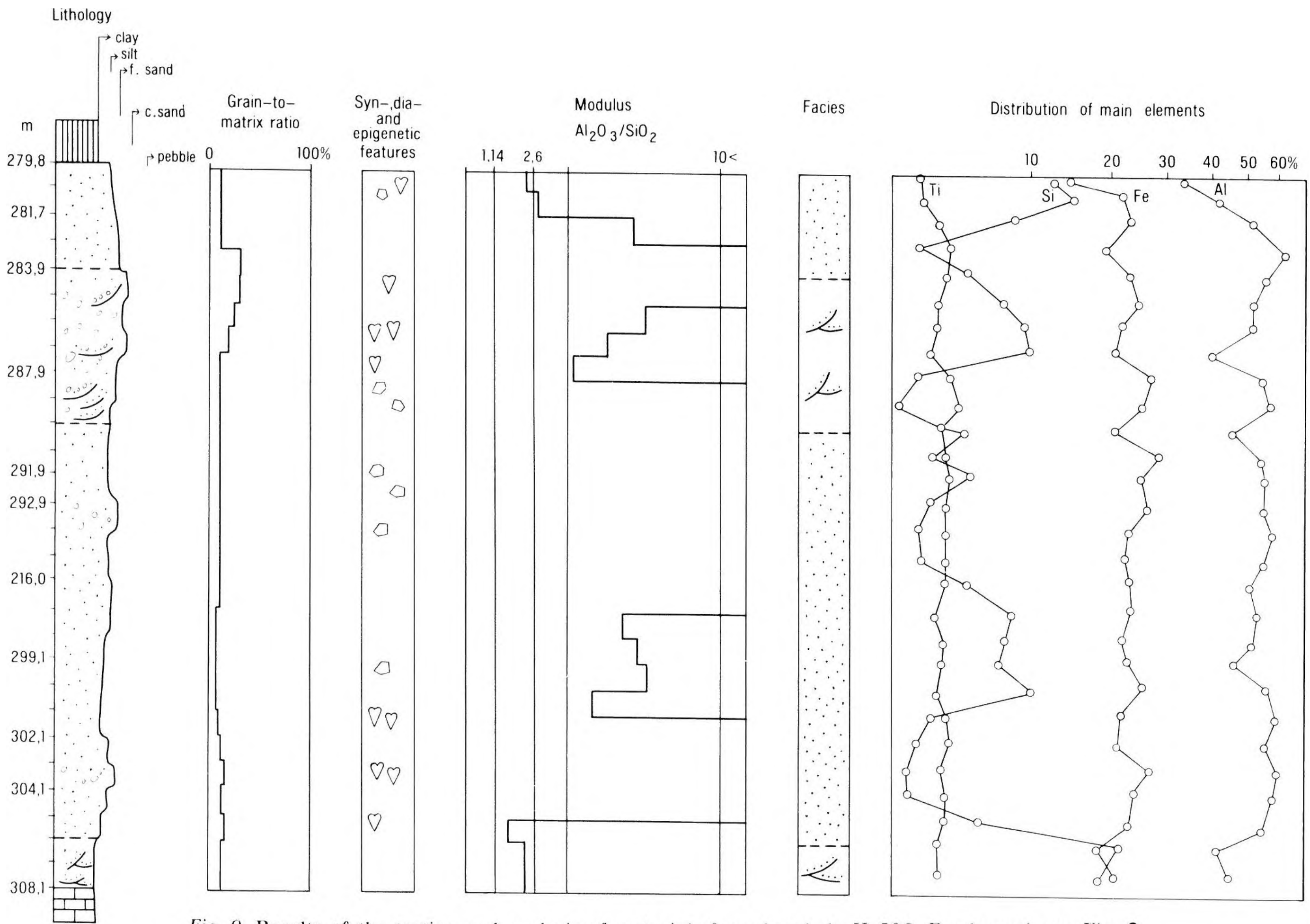


Fig. 9. Results of the testing and analysis of materials from borehole H 509. For legend, see Fig. 2

Figs. 2 and 3). So do the iron hydroxide segregations and deironizations, both reflecting the traces of iron mobilization, the latter also combined with pyrite segregation in the uppermost part of the profile.

The grade of bauxite, that is fairly high all along the profile, becomes lower in the uppermost 2 m only. As observed in other boreholes also, in the borehole concerned the amount of Si decreases to a large extent at those points where grain size increases, with the Al-content also increasing at the same time. Fe-content is about 20%, with smaller peaks in the coarse-grained layers.

In borehole H 509 there are two distinguishable facies, i. e. the channel bar facies at the lowest part and in the upper third (Fig. 9) and the flood plain facies for the rest. Compared with other boreholes having Cretaceous cover the matrix of bauxite in borehole H 509 is rather rich in mineral extraclasts which are as follows: antimonite, rutile, magnetite, titanite-magnetite, zircon, (?)pyroxene, amphibole, chlorite, feldspar, alkali feldspar, potash feldspar with low Fe content, albite, plagioclases, quartz and quartz+feldspar, as well as sedimentary grains of rocks with quartz+feldspar+muscovite content. No independent micro-extraclast has been found in the micromineralogical preparation made from bauxite grains. The small (5 to 10 μm) grains of anatase, zircon, quartz and ilmenite occurring sporadically form the part of bauxite aggregations broken into Al-aggregates due to deironization.

Borehole H 507

The examined borehole is found at the NW margin of the area of bauxite with Cretaceous cover falling in profile III (Fig. 1). A summary of results is shown in Fig. 10. The borehole penetrated 11.9-m-thick bauxite sequence which has a very diversified lithological pattern, consisting of the following three main parts. The lowest part, approx. 8-m-thick, consists of bauxite mudstone with ooids. At the lower third part an approx. 0.5-m-thick bauxite mudstone with carbonate matrix and ooids indicates the interruption of sedimentation (Plate II, Fig. 3.). Above and below, grains with their diameter attaining 1 mm only rarely are found sporadically in the pelitic matrix. The majority of grains have medium Fe content. The amount of Fe-rich grains as well as of grains with reduced rim is lower. The texture is composed mostly of ooids. Grains are well sorted. Subsequently, with a sharp transition an approx. 0.5-m-thick, grey, pelitic dolomite siltstone bed follows, in which plant remains and the contours of a few heavily deironized spherical grains can be recognized. This is followed, with an abrupt transition, by a conglomerate bed in which the diameter of spherical grains exceeds possibly 2 mm, and the diameter of limestone grains the majority of material is composed of may attain even 5 mm. Grains represented mainly by Dachsteinkalk clasts are angular or slightly rounded. In some cases ones with algal band texture can also be observed.

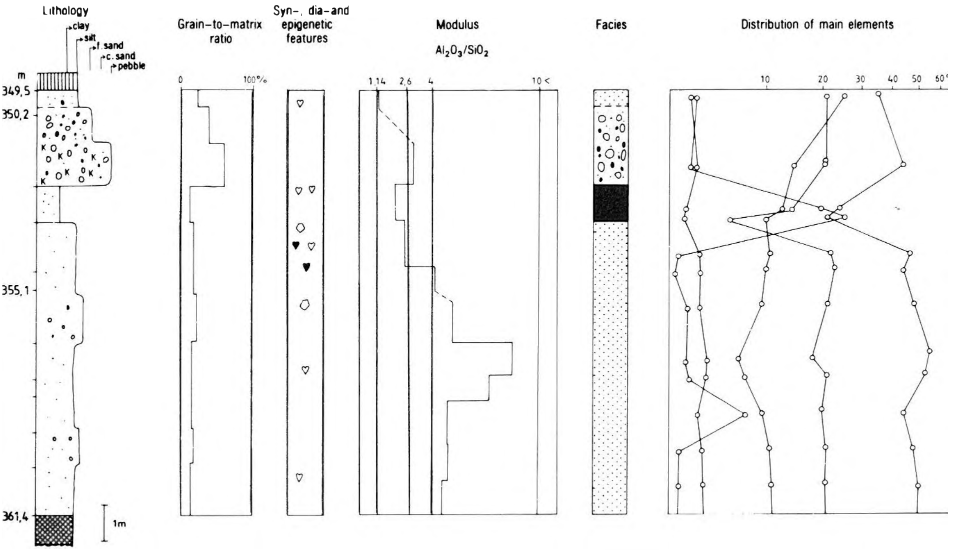
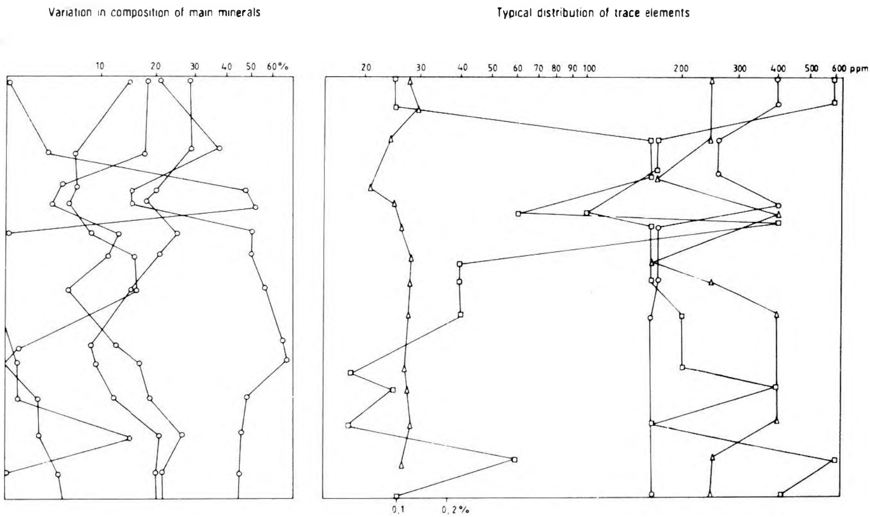


Fig. 10. Results of the testing and analysis of mate

At the uppermost 2 m part both the size and the amount of extraclast: decrease largely and only ooids (spherical grains) are included in the peli tomorphic matrix. The grain-to-matrix ratio approaches the value of 1:1 a the limestone clastic level only. At other levels there are only a few grain: as shown in Fig. 10. The whole profile is characterized by traces pointin; to iron mobilization, whereas mosaic structure can be identified at one leve only, at the lower third part.

Based on those described before three main facies can be identified flood plain facies — at the lower, thicker part and at the uppermost approx 1-m-thick part; marsh facies (with an abrupt transition from the lower flooc plain facies); then a sequence of channel load facies, abundant in large ex traclasts, overlying the previous facies through a sharp transition also. The bauxite grade is high particularly in the lower sequence of flood plain fa cies and is good at other parts. It is only the bauxitic dolomite aleurolite of marsh facies where the grade of bauxite falls down to the grade of baux itic clay.

As shown by chemical and mineralogical examination (Fig. 10) the amount of main and accessory minerals fluctuates randomly. Main Al-min eral is boehmite. Gibbsite appears in an amount of 1% in the dolomite aleurolite only. In this pyrite occurs also. Over this bed the amount of dolomite decreases and, in clastic form, limestone becomes dominant. There are present illite, montmorillonite and chlorite at several levels in the bore hole, particularly at the part of flood plain facies (Fig. 10). Illite and mont morillonite are minerals occurring rarely in bauxite may be the residues, due to weathering, of the initial rock. In addition to haematite, goethite can



rials from borehole H 507. For legend, see Fig. 2

also be found in the whole profile, with its largest amount observed at the 2—3 m part beneath the marsh facies.

Based on these all it is clear that neither chemical nor mineral components exhibit any tendentious changes characterizing either the maturation of deposit or local bauxitization. Bauxite came in different stages, with different material grade and has preserved its image so far (with the exception, possibly, of the Fe content which can be mobilized easily by the effect of later impacts).

The distribution of trace elements, as with that of the main components, fluctuates randomly. Ni and Co have essentially identical distribution curves. Co becomes enriched to a larger extent under the conditions of marsh facies with reductive environment (400 ppm). Zr has a rather great amount at the upper parts being rich in carbonates and a steady amount of 160 ppm in the lower bauxite sequence of flood plain facies. Cr behaves as it does in the other borehole sections; its amount increases slightly in beds with coarser grains, generally.

As shown by electron-microprobe tests the matrix has Al, Fe and Si content, frequently with calcite content. Spherical grains contain generally Fe and Al and have a low Ti content. In these samples Mn and Co could not be detected. However, iron segregations of fluidal structure as well as ferrous crusts pointing to a later iron mobilization are very characteristic. Pyrite segregations identified by means of electron-microprobe are in accordance with the influence of marsh facies identified using other methods. The micromineralogical preparation made from the bauxite matrix included a great number of quartz grains, feldspar grains, of them a few alkali feldspar grains, as well as grains of chlorite and muscovite. The preparation made from the bauxitic clast has contained, similarly to the cases described before, a few zircon, anatase and quartz grains embedded in bauxite aggregates being rich in Al.

Borehole H 350

Borehole H 350 is found in the SE part of the zone of bauxite deposits with Eocene cover, as falling in the line of profile I, and penetrating a total of 26.8 m of bauxite. Results of the examination are shown in Fig. 11.

From lithological aspect the bauxite can be divided into two main parts. Part one, from 196.7 to 180 m, of the sequence corresponds to the bauxite of borehole H 529 both from textural and from sedimentological aspects as well as from the angle of mineral and chemical composition. The size of grains consisting mainly of pisoliths and bauxite grains exhibits a tendency of becoming always coarser upwards in the sequence. At the lowest part the grains of fine sand size are arranged in arcuate microlaminae or without lamination in the pelitomorphic matrix having a gelly appearance sporadically. Grains are medium sorted. At a single spot graded bedding can also be observed (Plate XI, Fig. 1). Grains with a diameter exceeding 2 mm may also occur sporadically. At part ranging from 196.7 to 190.4 m grains with reduced rim have an amount of 1—2%. There are a few spots in the matrix where mosaic structure and the traces of deironization are observed. The matrix, with a low Fe content, of the subsequent overlying approx. 6-m-thick part includes grain generations corresponding to two dimensional ranges. The larger ones are bauxite pebbles with a diameter of 4 to 8 mm, whereas the smaller ones are represented by a spherical grains and accretional ooids, with a max. diameter of 1—2 mm, or by their clasts that are rounded to different extent. The grains form arcuate strings or elongated lenses at some spots. This level contains few grains with deironized rims.

This level is followed, with continuous transition, by the final member of the lower part, in which Fe-rich ooids and bauxite pebbles, arranged unsortedly, form bauxite packstone with ooid content. The maximum grain diameter is about 8 mm. The matrix is pelitomorphic and heavily deironized. The grain-to-matrix ratio approaches 1:1 at this part only. Then both the size and the amount of grains start decreasing gradually and the arcuate string-like microlaminae appear again (a part of approx. 1 m). The matrix of part ranging from the overlying bed to 178 m reflects the traces of later solution migrations heavily. Carbonate and sulphate impregnations (Plate XVI, Fig. 2), frequently, completely deironized details, whereas at other spots fluidal Fe segregations are characteristic. The maximum grain diameter is 5—6 mm. Grains are well sorted and contain well segregated ooids of "Iharkút-type" also, beside the accretion ooids of Halimba type, the spherical grains and other sorts of bauxite pebble described so far (Plate XVI, Fig.

3). At this part the bauxite has pelitomorphic matrix, and packstone texture, with ooids and bauxite pebbles.

Based on those described before the bauxite sequence exhibits clearly the sedimentological features of Cretaceous bauxite, representing, at the lower part, a facies with gradual transition from flood plain facies into channel facies, where both the channel bar facies and the channel load facies is well developed. The upper level does not fit into this sedimentological image at all. Due to its completely different facies it can be appointed to the Eocene cycle of sedimentation.

In addition to the thin section study, also the mineral and chemical composition of the sequence justifies the fact that the sequence can be divided into two parts. The lower sequence, that is typically of Halimba type, is characterized by a kaolinite content of about 20%, a boehmite content of 40 to 60% and a haematite content of about 10—20%. There is only a single part where few crandallite is contained.

The upper part (169.9—178 m) is characterized by heavy pyritization, considerable sulphate and carbonate content, as well as by a gibbsite content attaining even 5% and the usual goethite content. However, the amount of kaolinite is smaller here than at the lower part. The Eocene bauxite forming the upper part of the complex (Fig. 11) seems to be of high grade, but is actually deteriorated by the considerable amount of sulphate, carbonate and other accessory minerals. At the lower part the grade fluctuates, but the tendency observed when examining other boreholes, i. e. the parts that are more abundant in grains and the parts with coarser grains have a higher grade, holds true here also.

These two parts can be observed in the distribution of trace elements also. The amount of Co, Ni and Mn becomes higher at the part of Halimba type, but the amount of Cr is lower here. Lead, zinc and the rest of the elements exhibit no significant typical change as a function of depth.

The Cretaceous bauxite (that has remained "in place"), drilled by borehole H 350, can be texturally correlated with the properties of deposits in borehole section H 529, upon the results of electron-microprobe analysis, too. The matrix is pelitomorphic, with Al, Fe and varying Si content. Of the grains, ooids with Fe-Ti-Mn-Ca, Fe-Ti-Mn or Fe-Ti-Ca composition, as well as spherical grains, bauxite pebbles and $CaCO_3$ clastic grains are frequent, in a wide range of size (100 to 600 μm). Ca does not form an independent mineral therefore it cannot be compared to the diagenetic calcite identified by A. MINDSZENTY (1982) in the ooids of the Iharkút bauxite.

The upper part of profile includes a great amount of limestone debris, which decreases downwards in the sequence. The amount of S, included probably in the form of FeS_2-$CaSO_4$ also decreases downwards in the sequence. Sulphur is very frequent in the matrix in dispersed distribution as well as in the form of crusts segregated around grains of $CaCO_3$ and less frequently the Fe-rich grains. For a few samples beside S, also Al can be identified, probably in the form of alunite. The detrital grains with Fe-Ti-

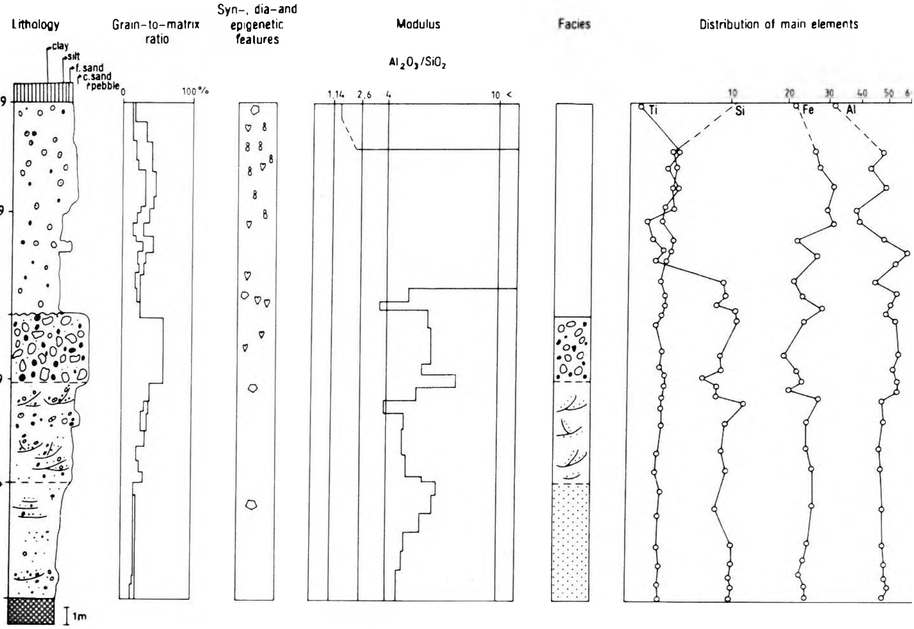
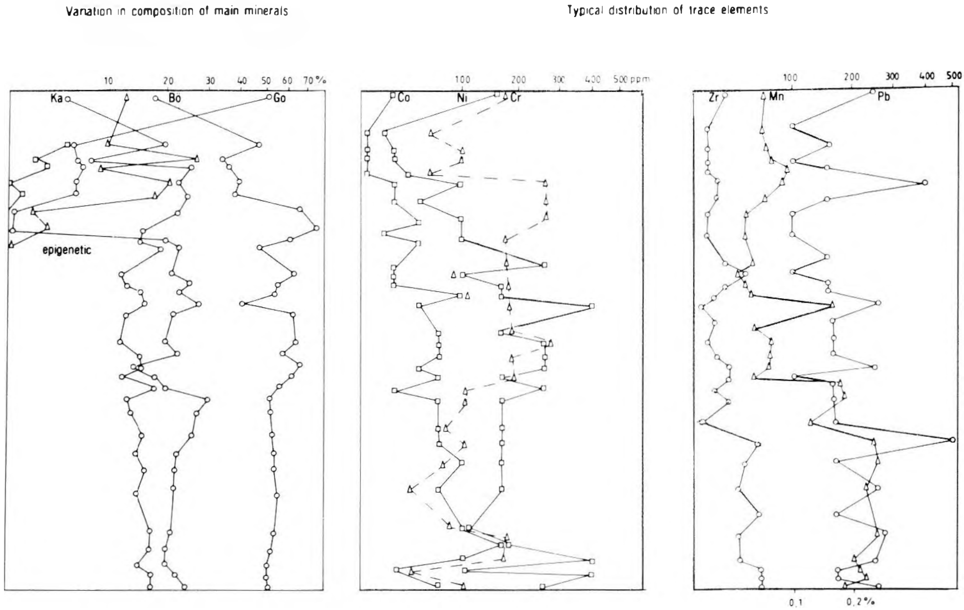


Fig. 11. Results of the testing and anal

Mn-Ca are very characteristic at the lower part and occur in each sample At the upper part the amount of grains with Fe-Ti-Ca content is higher. A the lower part Mn becomes enriched in grains, although its amount varie: in a rather wide range. At the lower part of the profile the traces of Ni, ir the form of a few grains with Fe-Ti-Mn composition, can also be observed

The later phenomena concerning element mobilization are frequent anc characteristic in the whole profile. These processes resulted in the mass oi fluidal iron segregations of collomorphic structure, with sporadical Si and ε very low Mn content. The formation of gypsum cover and alunite can be ob served around the detrital limestone grains. For a part of detrital grains thir films with Mn content as well as Fe-Mn crusts can be observed. Having sep arated the material of the upper Eocene and the lower, in situ Cretaceous bauxite in order to make micromineralogical preparations. It was not founc any typical differences between the two bauxite sequences. The matrix anc grains of both sequences were prepared separately. The upper (169.9—178 m) Eocene bauxite contains a wide range of minerals and rock fragments in cluding antimonite, galena, magnetite, titanomagnetite, garnet, zircon, mus covite. Feldspar is represented by a few Na-rich grains, as well as by detri tal grains composed of quartz+feldspar, quartz+biotite, albite+titanite. quartz+chlorite+plagioclase, Na feldspar+amphibole and quartz+mus covite+K feldspar and by Ca-REE phosphate grains. Galena and antimonite occur always in quartz, as an inclusion. Although in a small amount, but



ysis of materials from borehole H 350

each micro-extraclast listed before has been identified in the Cretaceous bauxite.

The micromineralogical preparation with hardly any mineral extraclast content, made from the bauxite grains exhibits a less abundant spectrum. Beside a few Fe(Ti)-crust detritus only a few small (about 10 μm) zircon grains, as well as REE phosphate and ilmenite grains have been found in the disaggregated Al-rich aggregates.

The composition of micro-extraclasts allows to take a diversified assemblage of rocks as the initial material of the Halimba bauxite, into account. The amphibole detrital grains can be derived from the Ladinian volcanic tuffs, whereas the albite and the chlorite+muscovite grains from the metamorphic sequence of greenschist facies, whereas the quartz grains with ore content can be the residue of metamorphic schist, or of a granitic sequence, or even of carbonate rocks.

Micromineralogical analysis of other profiles

In additon to the borehole sections analyzed and described as key profiles, the bauxite material from several other boreholes (H 705, H 592, H 547, H 385, H 497, H 641, H 642) was also subjected to micromineralogical analysis. Applying a meter-by-meter sampling, a total of 23 preparations were made and tested from the material of the last two boreholes. The mi cromineralogy of matrix of bauxites from boreholes listed here is not differ ent essentially from those described for the key profiles. Minerals pointin to granitic source area (quartz, feldspars, muscovite, chlorite, albite) an their clasts occurring in a wide range of variations of theirs, as well as th typical quartz grains with antimonite and galena inclusions are included i the largest amount. As partly shown earlier for each key profile borehole the bauxite grains have a rather low extraclast content. However, there ar a few boreholes (H 529, H 497) where grains are disaggregated into aggre gates with rich Al content, which include veins, impregnations with Mn, N content. They may have replaced, as the pieces of the ferruginous-man ganese-bearing crust of an older bauxite location (?laterite), the place o ooids, formations they are confined by.

Having summarized the results of micromineralogical examinations i can be stated that the parent rock weathered completely when the ooids o the bauxite were to be formed; no micromineral suitable for identificatio has been preserved. The micromineral content of the matrix indicate granitic, epimetamorphic, sedimentary (carbonate and sandy deposits) a well as volcanic rocks. There is no significant difference in the micromin eral content of Eocene and Cretaceous bauxites. However, considerabl differences in the micromineral content of each facies appear within th deposit. This is due to sedimentological reasons, associated with the fea tures of the fluvial system.

Palaeontological examinations of the bauxite from borehole H 570

Due to its very special position, the profile of borehole H 570 should be discussed separately also.

The borehole H 570 can be found at a distance of approx. 200 metres to the SW, of the intersection of profiles I and V where the overlying bed of bauxite is dated as Eocene. The argillaceous approx. 2-m-thick bauxite is found on Dachsteinkalk (245.9 to 247.9 m). The bauxite sequence is followed by an Ugodian Limestone bed with a thickness of 20 metres with its surface overlain by another bauxite bed also with a thickness of 2 m. The lower bauxite is grey and red, with brecciated texture and sporadically oolitic. The relation between the matrix and the ooids is figured by scanning electron microscope in Plate XVII. The argillaceous matrix practically surrounds the grain. The curve of EDAX analysis relating to the area shown in the picture is shown in Fig. 12. As indicated by the palynological examinations of the grey part of the lower bauxite level—with the identification and evaluation performed by Á. SIEGL-FARKAS—the sequence is dated as Late Santonian and incorporates the following sporomorphs: *Ciathydites australis* COUPER, *Complexiopollis complicatus* GÓCZÁN, *Complexiopollis* sp., *Emscheripollis* sp., *Hungaropollis microculus* GÓCZÁN, *Leiotriletes* sp., *Oculopollis biczoki* GÓCZÁN, *O. orbicularis* GÓCZÁN, *Oculopollis* sp, *Polypodiaceoisporites* cf. *fortis* W. KRUTZSCH, *Pseudoplicapollis peneserta* PF., *Vadaszisporites minutireticulatus* JUHÁSZ.

Figs. 2 and 3 of Plate XVII show the upper bauxite bed overlying the Ugodian Limestone. As shown by the results of the EDAX point analysis (Figs. 13, 14 and 15) and by the textural tests, the upper bauxite level has a lower Si content than the lower one has. The bauxitic clasts form definite layers in the matrix and are fairly well sorted, and mostly of "Halimba type". Due to this defined sporomorph assemblage the age of sedimentation of Cretaceous bauxite is assigned to palynological zone B of the Upper Santonian (or being earlier in time, thus allowing to date the final phase of sedimentation of the Halimba bauxite fairly precisely). Sporomorphs corresponding to palynological zone B of the Upper Santonian characterize the first deposit sequences of Csehbánya Formation also. This find has clearly justified that the Halimba bauxite had been deposited at the very beginning of the Senonian, as its initial member.

A summary of key-profile examinations

Based on the examined boreholes (a total of 125 five of which have been discussed in details in the chapter dealing wuth the key-profiles, the following summerized conclusions have been drawn:

1. Boehmite (max 66%) and haematite (max. 35%) are respectively the main Al- and Fe-minerals of the Halimba bauxite, containing also some kaolinite. Gibbsite (max. 8%) can be found frequently in areas where denudation as well as transportation of new material took place between the Cretaceous and the Eocene. In most cases goethite represents the typical accessory mineral of those parts of the deposit which were subject to iron mobilization due to formation of marshes of reduction medium.

2. The main, the accessory, and the trace elements of the Halimba bauxite show an irregular distribution in depth with no trend of change indicative of a subsequent desilification or "in place" bauxitization.

3. The concentration of trace elements in the ground mass of bauxite is 2 to 4 times that of the concentration of trace elements in acid rocks (TUREKIAN and WEDEPOHL, 1961)—a fact which corresponds to an enrichment expected to have taken place during a lateritic weathering process.

4. The bauxite has a varied textural composition, including bauxite clasts, ooids, pisoliths, extraclast, for most of the cases with pelitomorphic, bauxitic matrix. The ratio of the detrital textural elements and the matrix (the texture) has always been determined by the actual micro-environment of sedimentation.

5. The coarse-grained bauxite is usually a high-grade one.

6. Ooids are of accretion structure and of compact texture. Their com-

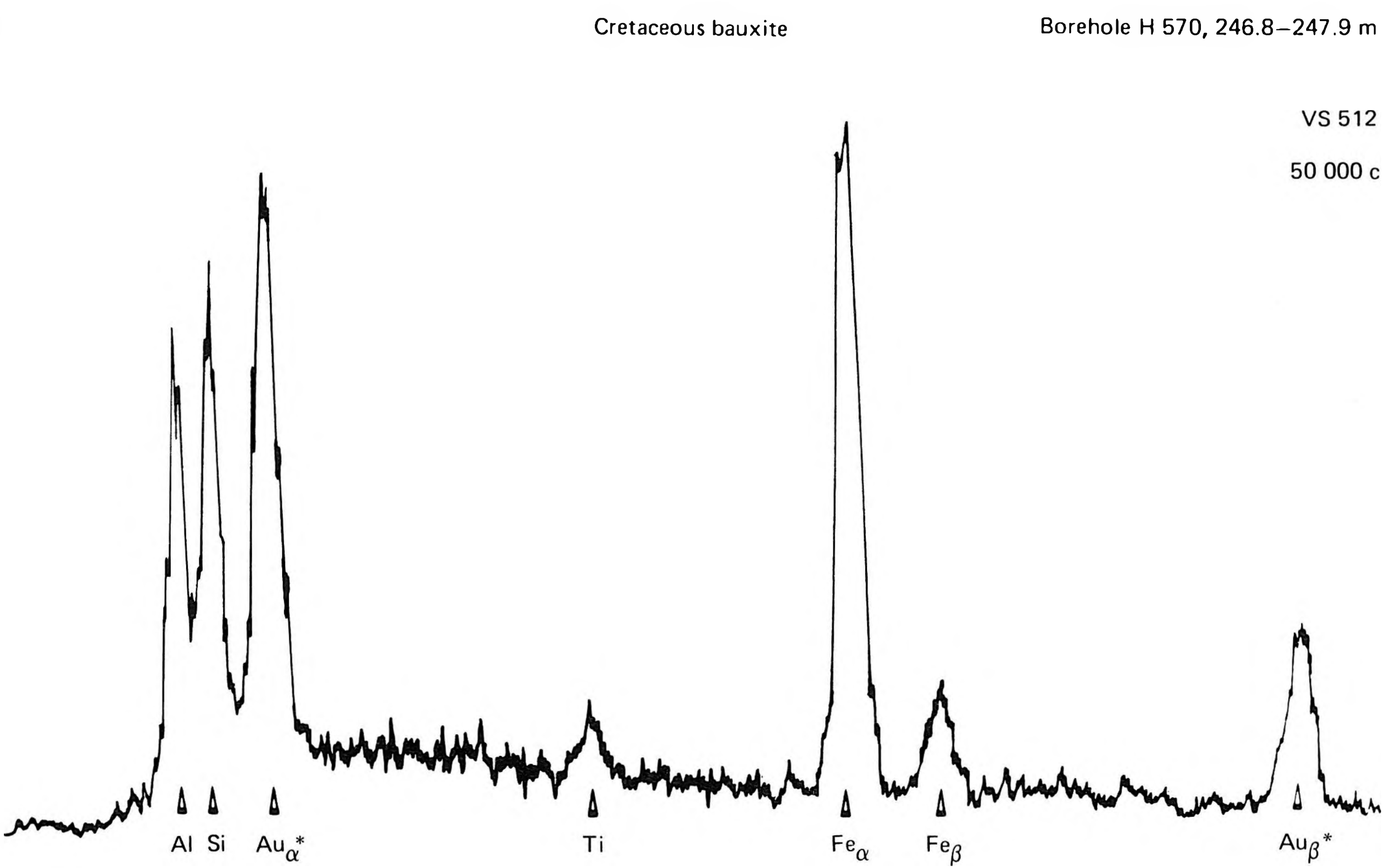


Fig. 12. The distribution of elements of the bauxitic clast and the matrix shown in Fig. 2 of Plate XVII. on the basis of EDAX area analysis.

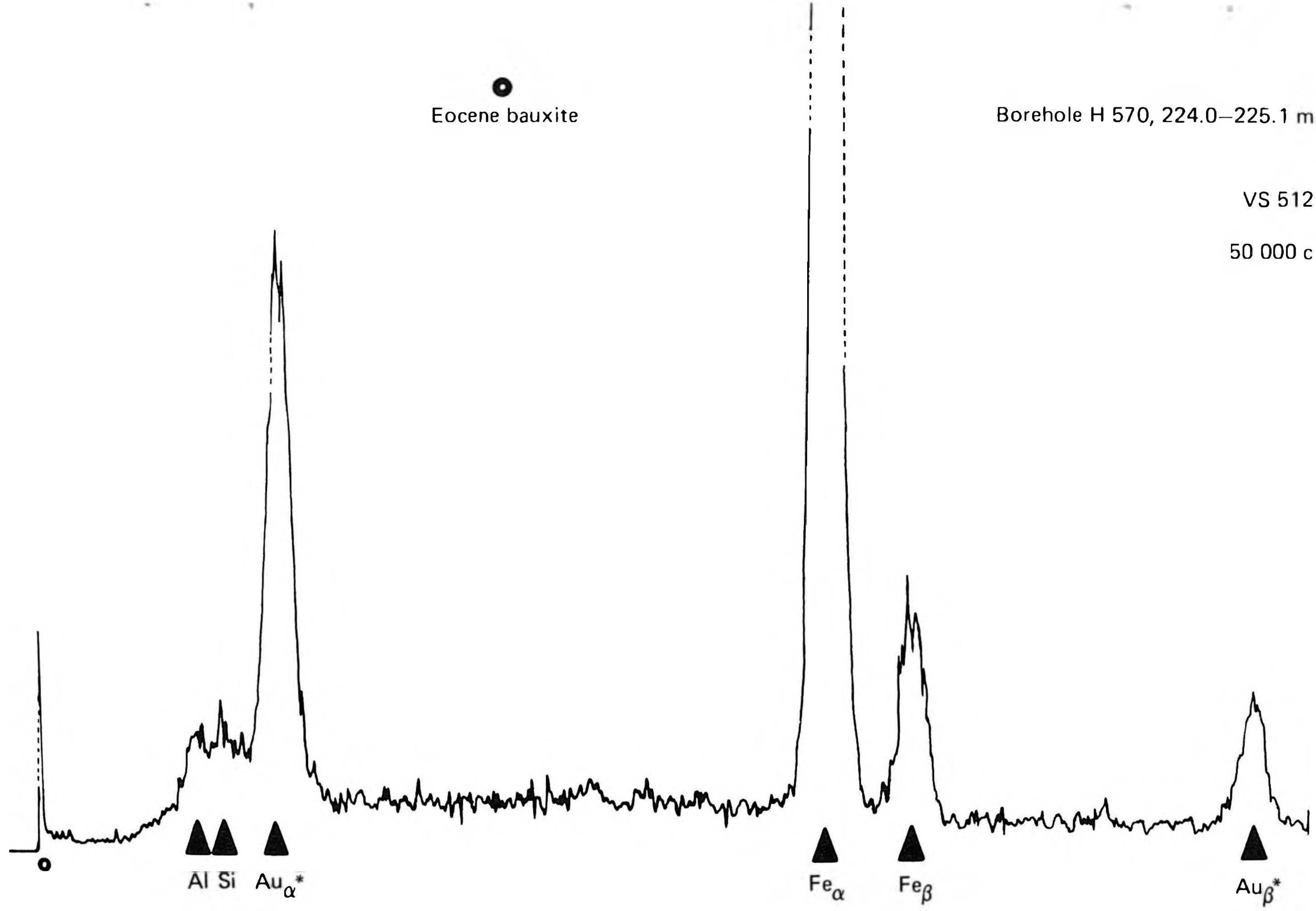


Fig. 13. The distribution of elements of a bauxitic clast shown in Fig. 2 of Plate XVII. on the basis of EDAX point analysis in the area denoted by 1. (Au is applied as a preparatory material of samples)

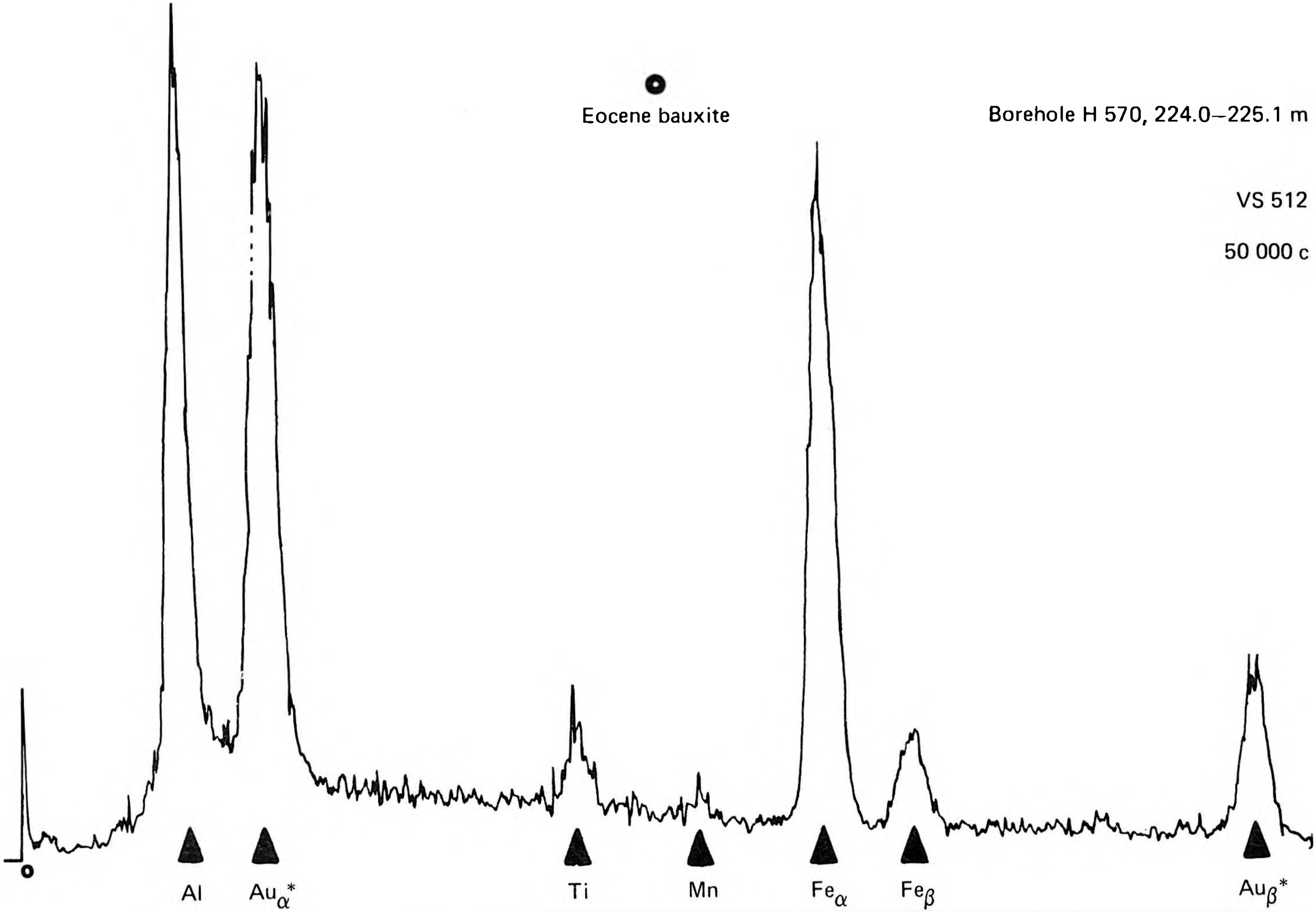


Fig. 14. The distribution of elements of the coating of a bauxitic clast shown in Fig. 2 of Plate XVII determined by EDAX point analysis in

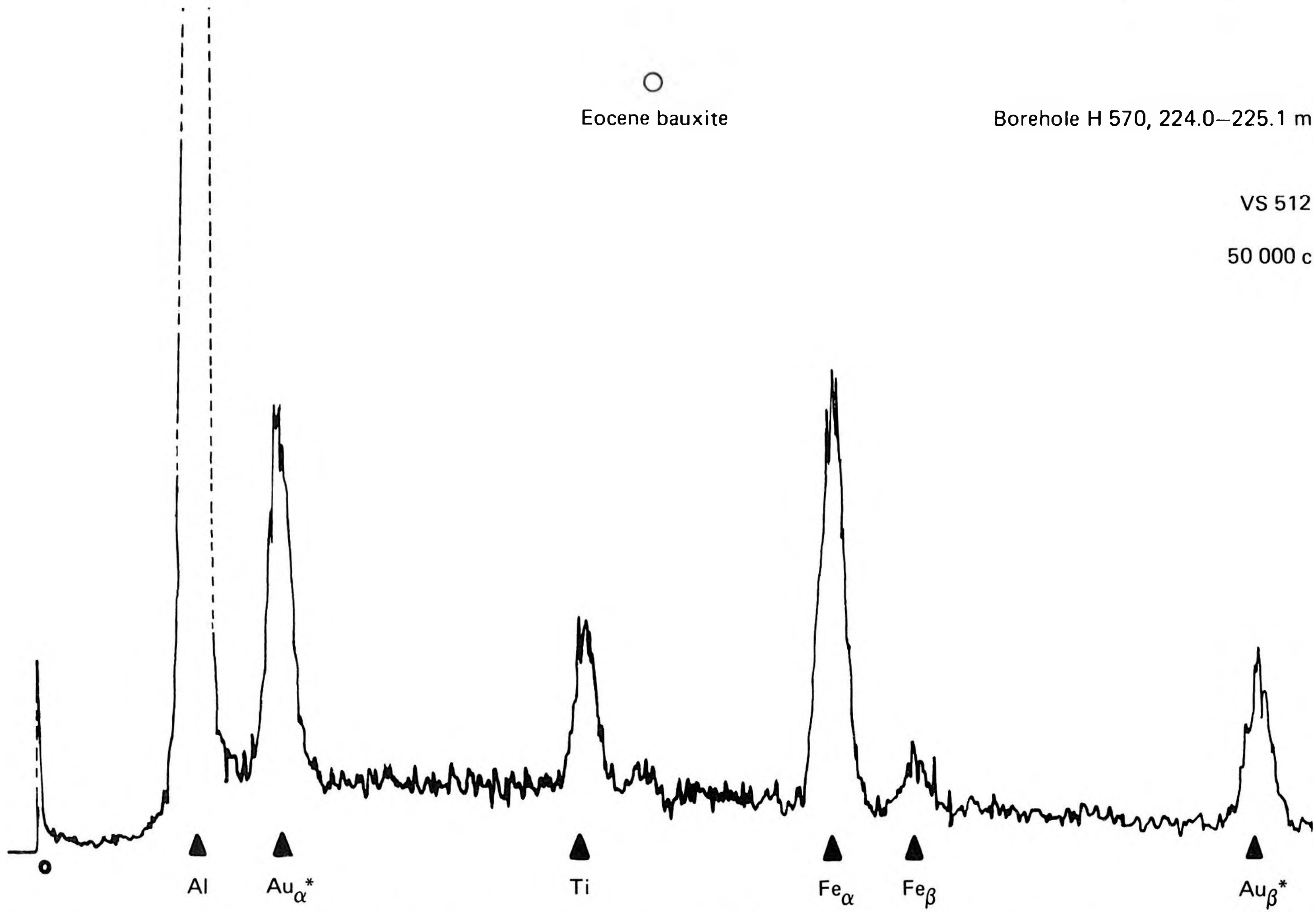


Fig. 15. The distribution of elements of the matrix shown in Fig. 2 of Plate XVII, on the basis of EDAX point analysis in the area denoted by 3. (Au is applied as a preparatory material of samples)

positional aggregates with size ranging from 2 to 5 μm are orientated. Sporadically, element mobilization phenomena that are not continued in the matrix can be observed in them. The number of accretion shells may attain a maximum of 10 to 12. The ooids and clastic bauxite grains were worked several times which is clearly reflected by each reduced shell frequently ocurring in them.

7. The matrix is rich in Al and contains also Fe and Si. Results of micromineralogical tests indicate a source area consisting of granitic, metamorphic, sedimentary and volcanic rocks. (The micromineralogical results do not enable us to make more precise identification.)

8. Based on the micromineralogical analysis of ooids and bauxite grains separated from the matrix it has been stated that the bauxite grains contain actually no mineral extraclasts, only few quartz or zircon grains occur, in Al-rich aggregates as inclusions.

9. The grain size of the in situ Cretaceous bauxite shows a tendency of becoming coarser upwards, up to the uppermost 2 to 3 metres, where the final member includes finer grains, more argillaceous matrix and smaller ooids. As shown by the sedimentological analysis the bauxite sequence represents a total of four main facies which are as follows: marsh, flood basin, flood plain and channel facies, of which the last one can be subdivided into channel bar and channel load facies. In a marshy environment element mobilization came into action. Cracking pointing to syngenetic desiccation and resulting in the formation of mosaic texture can be observed most frequently in the areas of flood plain facies.

10. It has been clearly proven both by textural and by geochemical, mineralogical or micromineralogical tests that during the period between the Cretaceous and the Eocene not only denudation took place, but the upper part of smaller or larger thickness of the Cretaceous bauxite bed had turned to be redeposited then mixed with the Eocene bauxite and possibly with the eroded material of nearby bauxite sequences becoming exposed in the meantime was reworked and settled down on the Senonian Halimba bauxite. Thus the Eocen bauxite of Halimba appeared. The sedimentological features of bauxite accumulated in the Eocene sharply differ from those of the original Cretaceous bauxite.

SEDIMENTARY FEATURES ALONG PROFILES

We set eight profiles across the bauxite body (Fig. 1). Each profile has been plotted on a scale of 1:10,000 with a vertical exaggeration 1:10 in order to ensure that each facies be easily plotted and studied. Having obtained a strongly exaggerated figure thereby, it was given each profile on the same scale but with an enlargement in height 1:2 for a better understanding of the real situation.

Profile I (Fig. 16) is set across a bauxite body lying on Dachsteinkalk. The overlying formations of bauxite are Cretaceous rocks in the NE and middle parts, and they are Eocene formations elsewhere. In the N segment of the profile the bauxite deposit comes to an end and the basin becomes shallow. To the south, the original edge of the basin could not be outlined precisely, since the original state has been altered by the denudation between the Cretaceous and the Eocene as well as by the inflow of the new bauxitic material. However, based on the observation that the autochtonous deposit of the southernmost areas is argillaceous bauxite and dolomite-silty argillaceous bauxite, I can draw the conclusion that the basin is terminated in this direction also. The underlying bed is slightly differentiated. The greatest difference between the erosional base levels and the karst hills does not exceed 20 metres, which is considered to be a very low value with respect to the level difference of typical cone or tower karsts of tropical areas, ranging from 200 to 300 metres. The Halimba basin can be considered as an alluvial karst plain from which karst hills with flat sides protrude. In the northern, lower part of the profile the bauxite complex 10 to 20-m-thick is of flood basin facies and is overlain by flood-plain-facies bauxite with a thickness of 10 m or more. The former, in the middle of the profile is alternating with the flood-plain-facies bauxite, then it becomes predominant and lastly the only one. Of those facies that are characteristic of streaming medium with coarser grains it is the channel bar facies which is present at several levels, separated laterally also. It has the greatest thickness (8 m) at the middle part, whereas bodies of channel bar facies, becoming always thinner can be observed towards the rims. The channel load representing the facies of coarsest grains can be found complete and in full thickness in borehole H 529 only, since its certain part became destroyed

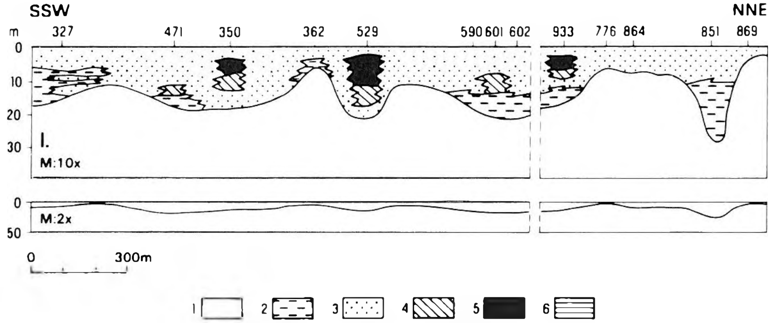


Fig. 16. Facies distribution of Profile I

1. Upper Triassic underlying beds, *2.* flood basin facies, *3.* flood plain facies, *4.* channel bar facies *5.* channel load facies, *6.* marsh facies

by denudation at the two other sites. One of them is borehole H 350, described in details in the chapter dealing with key-profile boreholes, and the other one is borehole H 933. The latter has drilled one of the thickest bauxite body (approx. 40 m), of which a total of 17 m has been identified as in situ Cretaceous bauxite on the basis of textural analysis. The sequence ranging from 258.5 to 297.8 m has, at its part from 277.8 to 279.3 m, green clay with pyrite content, identified as Eocene with Lower Cretaceous redeposited pollens, on the basis of palynological tests. Both the identification and the evaluation have been performed by L. RÁKOSI: *Granulatisporites* fsp., *Arecipites granulatus* (KDS.) RÁKOSI, *A. pseudotranquillus* NICHOLS AMES, TRAVERSE, *Striatopollis communis* (GRUAS-CAVAGNETTO) RÁKOSI *Psilatricolporites globus* (DEÁK) KDS., *Retitricolporites thiergarti* KDS. *Ilexopollenites microiliacus* (TH. et PF.) KE et SHI, *Tetracolporopollenites sapotoides* PF. et TH., *Plicapollis pseudoexcelsus* (W. KR.) W. KR., *Triporopollenites urkutensis* KDS., *T. undulatus* KDS., *Subtriporopollenites urkutensis* KDS., *Minorpollis gallicus* KDS., *Platycaryapollenites levis* (R POT.) W. KR. et VANHOORN, *Plicatopollis plicatus* (R. POT.) W. KR.

Of the Eocene biozones of the Transdanubian Central Range, it is the assemblage zone of Plicapollis pseudoexcelsus and Triporopollenites urkutensis representing the oldest Eocene sporomorph assemblage-zone identified in Hungary so far. The texture of bauxite underlying this argillaceous bed can be correlated with the nearby Cretaceous bauxites (from textural aspect). A few metres of the uppermost-situated bauxite of channel load facies are likely to have been eroded, that is why 17 m is attributable to the original Cretaceous bauxite.

Based on the profile it can be stated that the bauxite sequence becomes always coarser from NNE towards SSW, then in the middle of the sequence, having reached the coarsest composition, becomes gradually finer. The fact that grain size becomes coarser upwards holds true for the whole profile. Bauxite accumulation took place practically from the start to the very end

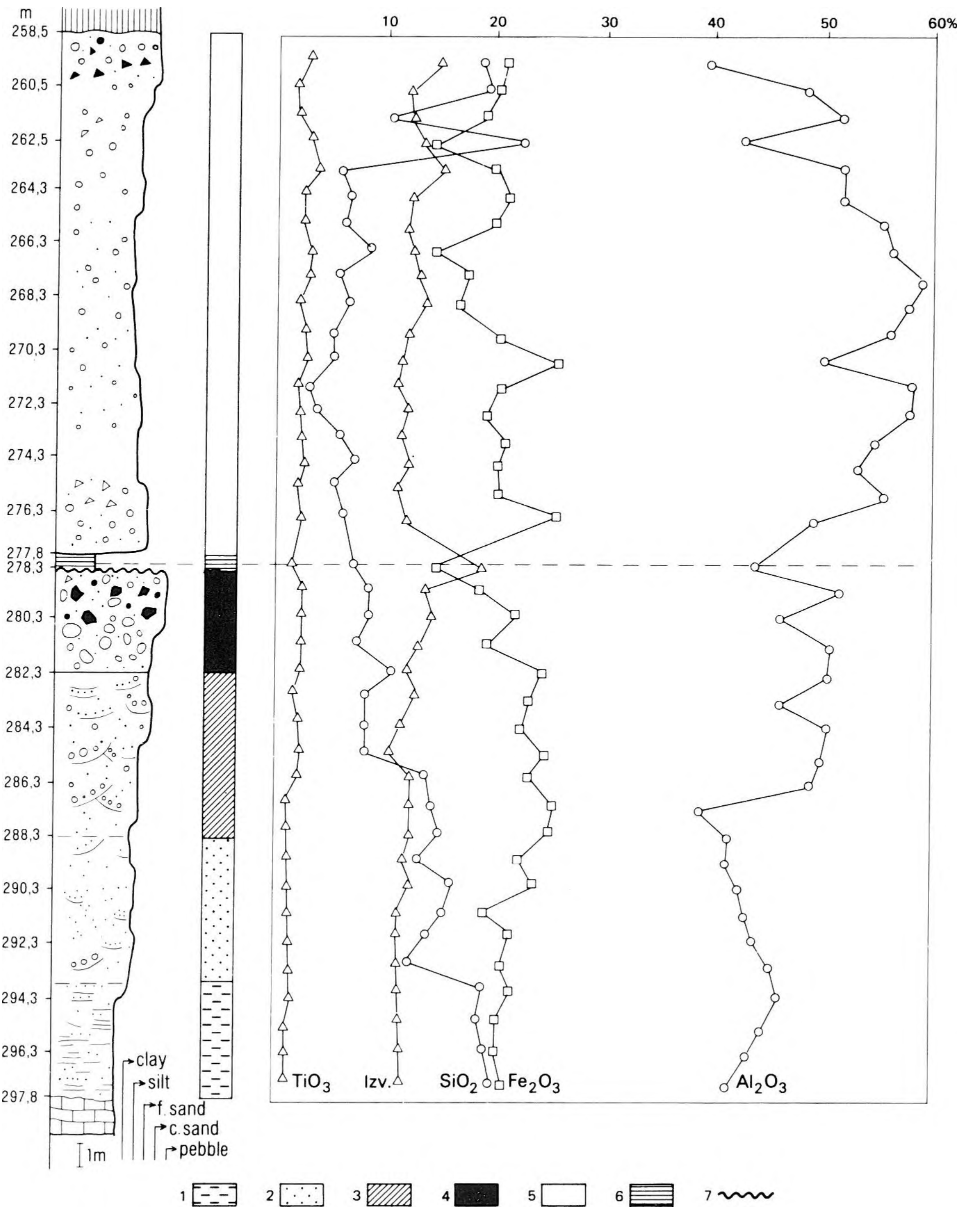


Fig. 17. Lithological profile and the distribution of chemical components as a function of depth, for borehole H 933

1. Bauxite of flood basin facies, *2.* bauxite of flood plain facies, *3.* bauxite of channel bar facies, *4.* bauxite of channel load facies, *5.* Eocene bauxite, *6.* marsh, *7.* unconformity

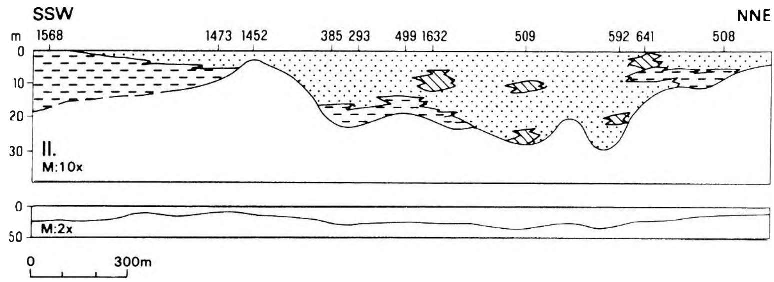


Fig. 18. Facies distribution for Profile II. For legend, see Fig. 16

from streams of lower or higher energy in the middle part of the profile however, this type of deposition was intermittent elsewhere (boreholes H 327, 350, 601, 933).

Sporomorphs of the green, pyrite bearing argillaceous bed found in th bauxite of borehole H 933 dates exactly the beginning of Eocene bauxite accumulation, which represents the oldest Eocene known in the Transdanubian Central Range. The 19-m-thick, fresh, oxidative, massive Eocen bauxite overlying the argillaceous bed excludes the opportunity that pollen may have been washed in from the cover Fig. 17 shows the lithological features of the borehole as well as the variation of chemical components as a function of depth.

Profile II (Fig. 18) is found W of Profile I (Fig. 1). Compared it wit Profile I it can be observed that the foot wall is a less rugged alluvial plai with slightly undulating surface, becoming deeper in the middle. There ar a few karst hills with a height ranging from 5 to 10 m, elevating from thi plain. This basin has natural termination in the northern part of the profil and becomes fairly shallow in the south. The greater part of the central depression is covered by Cretaceous beds, whereas, to the SSW, Eocene cove beds also appear. As shown in the profile, the bauxite of flood plain facie has a rather small amount, having a higher frequency on the rims only. Th facies distribution of the middle, deeper basin shows that the sedimentation began with deposition from a streaming medium and then the environmen became a flood plain, probably due to the clogging of the karstic passages In the upper part of bauxite of flood plain facies representing the majority of the sequence there are several levels where channel bar bodies have been found. This points to the fact that the energy of waterflows as agent of material input became always higher.

For the whole bauxite complex, shown by Profile II, it is characteristic the small grain size coming to the fine sand category in a few bodies of channel bar facies only, having the size of clay and silt at other spots.

Profile III (Fig. 19) is orientated NNW—SSE (Fig. 1). Towards the north, a thinning and pinching out of the deposit can be observed, whereas

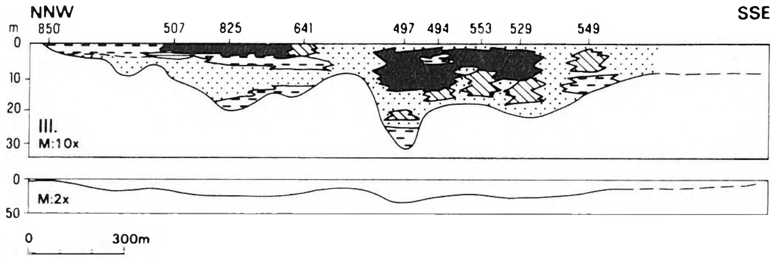


Fig. 19. Facies distribution for Profile III. For legend, see Fig. 16

on the southern side the original position cannot be recorded due to the denudation taking place between the Cretaceous and the Eocene. The profile has a length of 1800 metres and includes a total of 8 boreholes examined in details. The underlying bed is composed of Hauptdolomit and Dachsteinkalk and has rippled surface. At the middle part (borehole H 497) there is a deeper doline, from which the basin becomes more shallow in both directions, forming two sub-basins that are separated by an elevation consisting of Dachsteinkalk. This elevation, as shown by the different facies of bauxite, used to serve as a natural barrier, for a long period, during the sedimentation. In the southern part of the basin there are two smaller bodies of flood basin facies, one of them on the bottom of the deepest doline and the other one at its rim. Both of them are followed by a thin bed of flood plain facies. The majority of bauxite found in this sub-basin is of channel facies. In the middle part channel bar facies appears first and is followed by channel load facies with the coarsest grain bed in a max. thickness of 10 metres.

In the northern sub-basin those facies which have a finer-grained composition are dominant. The lower bauxite of flood plain facies representing the majority of the sequence is overlain by a deposit of flood basin facies that is likely to turn into marsh facies towards the northern edge. The appearance of marsh facies allows to draw the conclusion that the period of inflow of sediments had a temporary cessation. The fact that the sedimentary transport restarted with high power at the uppermost part of this section of the basin has been justified by the thin bodies of channel bar and channel load facies, respectively. It is characteristic of the whole profile that grain size decreases towards NNW and becomes always coarser upwards in the sequence.

Profile IV (Fig. 20) has, of the three profiles of WE orientation, the northernmost position (Fig. 1). The surface of the footwall is medium rugged. The deepest doline is found at the contact of the Hauptdolomit and Dachsteinkalk. Heading outwards more shallow dolines and depressions separated by smaller and larger hills and ridges are encountered. On its western side the basin becomes shallow, and to the east, only a hypothetical

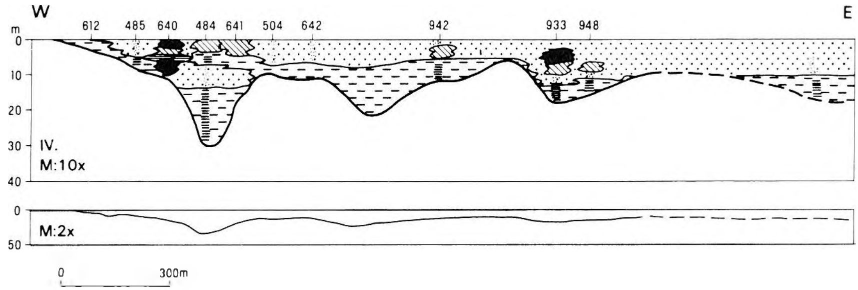


Fig. 20. Facies distribution for Profile IV. For legend, see Fig. 16

state can be described, due to the resedimentation between the Cretaceous and the Eocene. As shown by the examination, the original bauxite deposit may have ceased to exist farther to the E from its present-day boundaries.

The greater part of the bauxite complex demonstrated by Profile IV is composed of bauxite deposit of flood basin facies up to 15-m-thick in the depressions, and 5 to 8 m at other sites, and covering the underlying rocks as a blanket. The western part of the profile displays bauxite of flood basin facies as turning into marsh facies (Borehole H 640). The flood basin facies is overlain by flood plain facies incorporating smaller channel bar bodies pointing to a streaming medium of deposition. There are two channel load bodies also, appearing above and below, the largest body of channel bar facies found in the western part of the profile.

A channel load facies body can be found at the middle part of the profile (Borehole H 933), but here erosion should be taken into account.

The whole profile is characterized by the small size of grains. The majority of the sequence is composed of materials of bauxite silt or fine sand. The small amount of coarse-grained detrital sequence is concentrated in two areas only. However, it was not so originally. In the upper part of the profile a sequence consisting of Cretaceous bauxite and having been redeposited to a smaller or larger extent and mixed with new bauxite also, is found. Here the bauxite contains angular bauxite clasts 2 to 3 cm large embedded in argillaceous ground mass—which show the characteristic arcuate strings and cross-stratification of channel bar facies. Therefore it is assumed that at the middle part channel bar facies with large thickness and probably channel load facies also existed. Both of them are likely to have been destroyed by the denudation between the Cretaceous and the Eocene.

Profile V (Fig. 21) stretches across the bauxite location in WE direction (Fig. 1). Its underlying bed is built of Hauptdolomit and Dachsteinkalk of uneven surface. In the area cut by the profile there are three dolines, each with a depth of 30 m, one of them forming a double doline. They are separated from one another by a 10 m high saddle. The surface between these three dolines is dissected by flat hill with a relative height of 20 m.

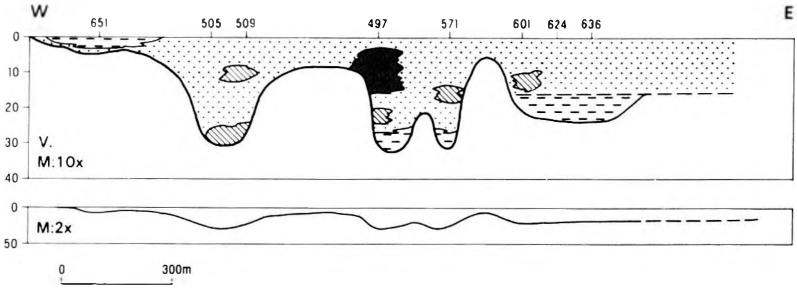


Fig. 21. Facies distribution for Profile V. For legend, see Fig. 16

With the exception of the marsh facies, all other ones occur in the bauxite. At the bottom of the double doline bauxite of flood basin facies, whereas in the two other depressions bauxite of channel bar facies are included. This allows to draw the conclusion that in the beginning of bauxite accumulation the doline acted as an active sink-hole. This is followed by a flood plain facies in which several bauxite bodies separated vertically in several layers as well as laterally, are included. The channel load facies also becomes considerable in a rather large thickness of 15 m in the middle, to upper segments of the profile.

The grain size is coarsest at the middle part, becoming gradually finer towards the rims.

At the western boundary the bauxite location attenuates gradually and terminates finally. However, its original extension cannot be identified at the eastern side, since here the bauxite is represented by Eocene bauxite with redeposited Cretaceous bauxite content and bauxite of original texture has not been preserved.

Profile VI (Fig. 22) is WE-directed, showing the southern part of the deposit (Fig. 1). The underlying bed is Hauptdolomit in the west and Dachsteinkalk in the east. A doline with a depth of approx. 20 m was formed where they are in contact. The eastern part of the basin is an elongated, flat, alluvial plain which is separated from the doline by an elevation with a relative height of 15 m. This depression has a largest diameter of approx. 600 m and a largest depth of 22 m.

In general the bauxite is fine-grained, particularly in the western part of the profile, with the flood basin facies being dominant here. In the middle part the bauxite deposit is coarser-grained and the facies distribution is more diversified also. In the marsh facies being dominant in the most of the area there are two sites where channel bar can be observed. For borehole H 529 and H 525 they are overlain by channel load.

The whole profile is characterized by coarsening grain size from the west to the east. Towards the west, the deposit is pinched out. In the eastern areas the rim could not be identified due to the denudation taking place

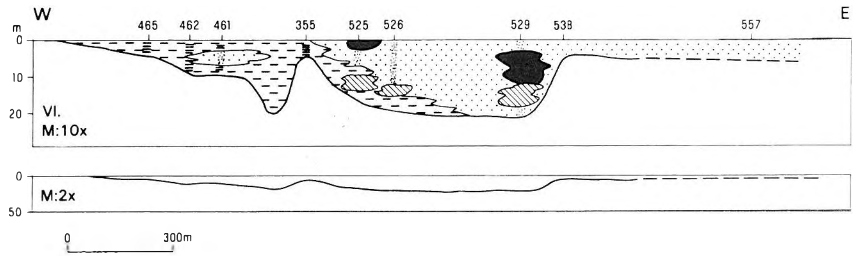


Fig. 22. Facies distribution for Profile VI. For legend, see Fig. 16

between the Cretaceous and the Eocene, the redeposition and the mixin with new bauxitic material, since bauxite with original texture has not bee preserved.

Profile VIII (Fig. 23) stretches across the Halimba Bauxite Deposit i SW—NE direction (Fig. 1). The underlying bed is mostly Dachsteinkalk i the profile. A small amount of Hauptdolomit occurs in the western par only. There is a deeper doline between them. The deepest dolines are foun in the middle part of the profile and the basement becomes more shallov gradually towards the margins. The double doline described in details fo section dealing with Profile V occurs in this profile also, although the ridg separating them is a little higher here (10—12 m). The fine-grained bauxit of flood basin facies can be found at the bottom of dolines and other smalle depressions and they are overlain by the bauxite layer of flood plain facie representing the major part of the sequence. The coarser-grained bauxit bodies of channel load or channel bar facies are found at three spots i lateral extent, forming the largest mass in the middle part of the profil (boreholes H 496 and 494), with smaller bodies E and W of here. For th description of the sequence penetrated by borehole H 933 in the east, se the detailed description of Profile I. As for the upper horizon of the com plex only a minor erosion should be taken into account.

The deposit becomes shallow-situated towards SW, without bein pinched out. The margin cannot be outlined properly, but the bauxite foun here that is generally bauxitic clay or argillaceous dolomite siltstone, ha led to the conclusion that in the SW the original basin acted as a deposi tional basin, but during Cretaceous time no high-grade bauxite was trans ported into this area. In the E and NE areas the complex has partly bee preserved, therefore the original state can be roughly reconstructed.

The granulometric compositon of the complex, being the coarsest in th middle part, becomes gradually finer towards the rims. Grains becomin coarser from down upwards is characteristic here also.

Profile VII (Fig. 24) is situated parallel to Profile VIII, to the NW o it (Fig. 1). The underlying bed of bauxite is built of Triassic Hauptdolomi and Dachsteinkalk. The largest subsidence, with a depth of 17 m only, i

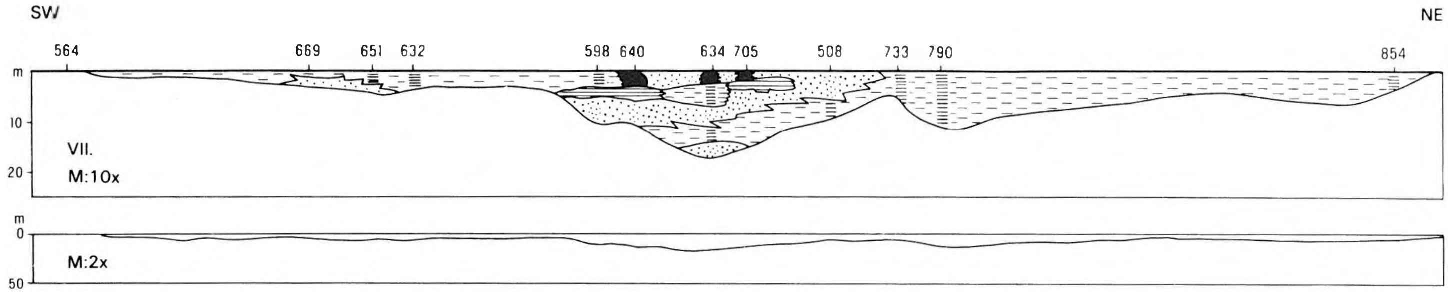


Fig. 23. Facies distribution for Profile VII. For legend, see Fig. 16

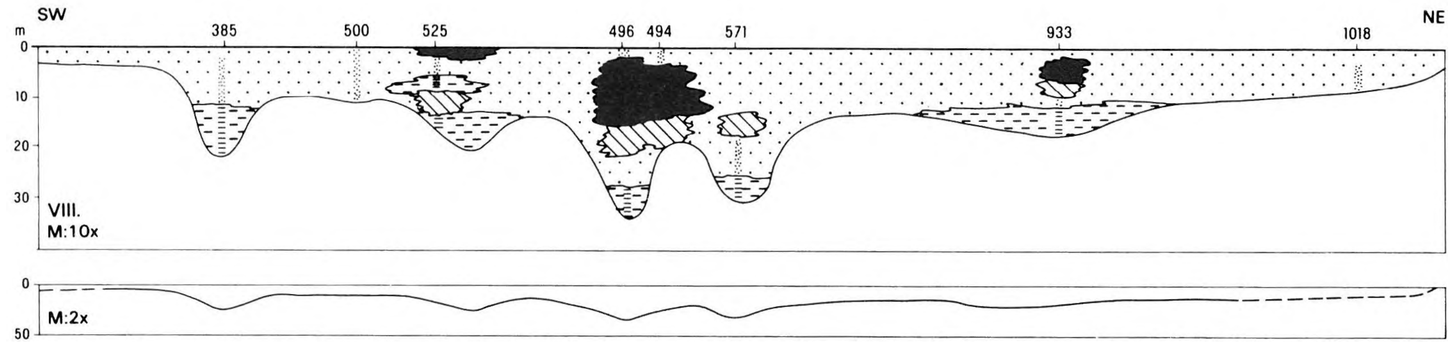


Fig. 24. Facies distribution for Profile VIII. For legend, see Fig. 16

found where they are in contact. As indicated by this, the basin sect(shown by Profile VII is rather shallow depression of fairly even botton which becomes attenuated towards the margins in both directions, In th flat downwarp there is just one site where a small hill can be found.

The bauxite complex consists of a rather fine-grained sort of bauxit(dominantly of flood basin facies, which is interfingered with marsh facie in its upper part. The profile displays a small proportion of flood plain f cies and even a negligible constituent by flood basin facies.

In the middle part of the profile the grain-size composition of bauxit becomes coarser in an upward direction.

A summary of profile descriptions

The study of profiles allows to draw the following essential conclusions

— The bauxite deposit becomes gradually thinner towards north an west and is pinched out;

— The fine-grained deposits become dominant towards the margin and the flood basin and flood plain facies prevail;

— The presence of marsh facies is restricted to the NW part of th bauxite deposit area;

— Along with the contacting track of the underlying Triassi Hauptdolomit and Dachsteinkalk a series of dolines stretches a filled mostly by bauxite of flood basin or flood plain facies;

— The N and NE areas become shallow, and their material is o flood basin or flood plain facies, as with that of the NW area;

— The original margin cannot be properly recognized in the S and th SW areas, but here the bauxite complex which at first alternat with flood plain facies and flood basin facies turns into a pur flood basin facies with material of bauxitic clay, and farther of argillaceous dolomite siltstone, let us predict that there was n considerable deposition of remarkable bauxite in this area;

— On the eastern side, particularly in its middle part the margins o the original deposit cannot be identified under the presen conditions;

— In the Eocene a bauxite deposit even 18 to 20-m-thick may hav been deposited on top of the partially eroded Cretaceous bauxite o the basin bedrocks by the reworking of the bauxite in addition t new bauxitic material;

— All facies with coarsest grain-size composition are dominant in th middle part of the eastern side of the Halimba bauxite deposit area and they form bodies becoming thinner towards SW, W, NW and N as finger-like spurs but are less frequent with respect to this area.

PALAEOGEOGRAPHICAL RECONSTRUCTION

The palaeomorphological map of the Halimba basin has been plotted on the basis of the facies analysis of the profiles (Fig. 26). The marker horizon was the first non-bauxitic marl bed may have been deposited on the bauxite everywhere nearly at the same time. Compared to the marker horizon formed by the marlbed, the thickness of bauxite has constituted the basis, for the Cretaceous-overlain areas, to plot the isobath map showing the basement depths which is identical with the isopach map of bauxite concerning these areas (Fig. 25). As for zones overlain by Eocene, mineralogical, textural and lithological features and palaeontological results have served for a correction of bauxite thickness in order to ensure that the presumably original morphological conditions be reconstructed here, too. The plotted palaeomorphological map (Fig. 26) has served as basis for representing any other events.

An essential feature of morphology of the basement is that it is a rather flat alluvial karst plain with a low relief diversity as being varied only by depressions 10 to 30 m deep, or by karst hills. There is a line of dolines with a maximum depth of 30 m, striking NNE—SSW, stretching in the line of contact between the Hauptdolomit and the Dachsteinkalk. Parallel to and E of this there is another line of dolines, less deeper than the former one. Parallel to the line of dolines there are round or elongated, flat, here and there double elevations with small diameter exhibiting a definite NNE—SSW arrangement. Even the deepest, central doline has a depth of 35 m only. This morphological pattern corresponds to a mature tropical karstland, getting already close to the level of the erosional base.

A part of the original karstic surface of the basement (plotted in space with a vertical exaggeration 1:10) is shown in Fig. 27.

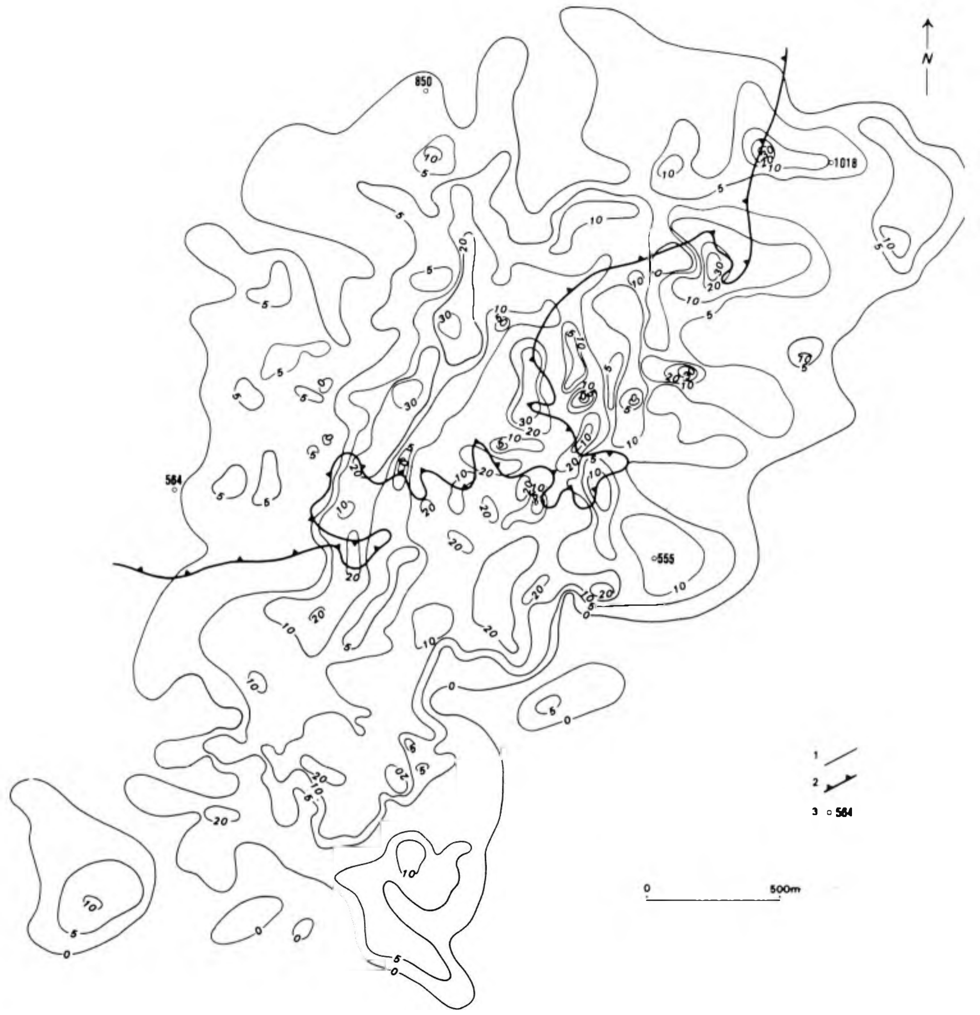


Fig. 25. Isopach map of the Halimba Bauxite Deposit based on the map of F. SZANTNER (1966)

1. Contours of bauxite thickness, *2.* areal extent of the Upper Cretaceous formations, *3.* borehole sites for identification

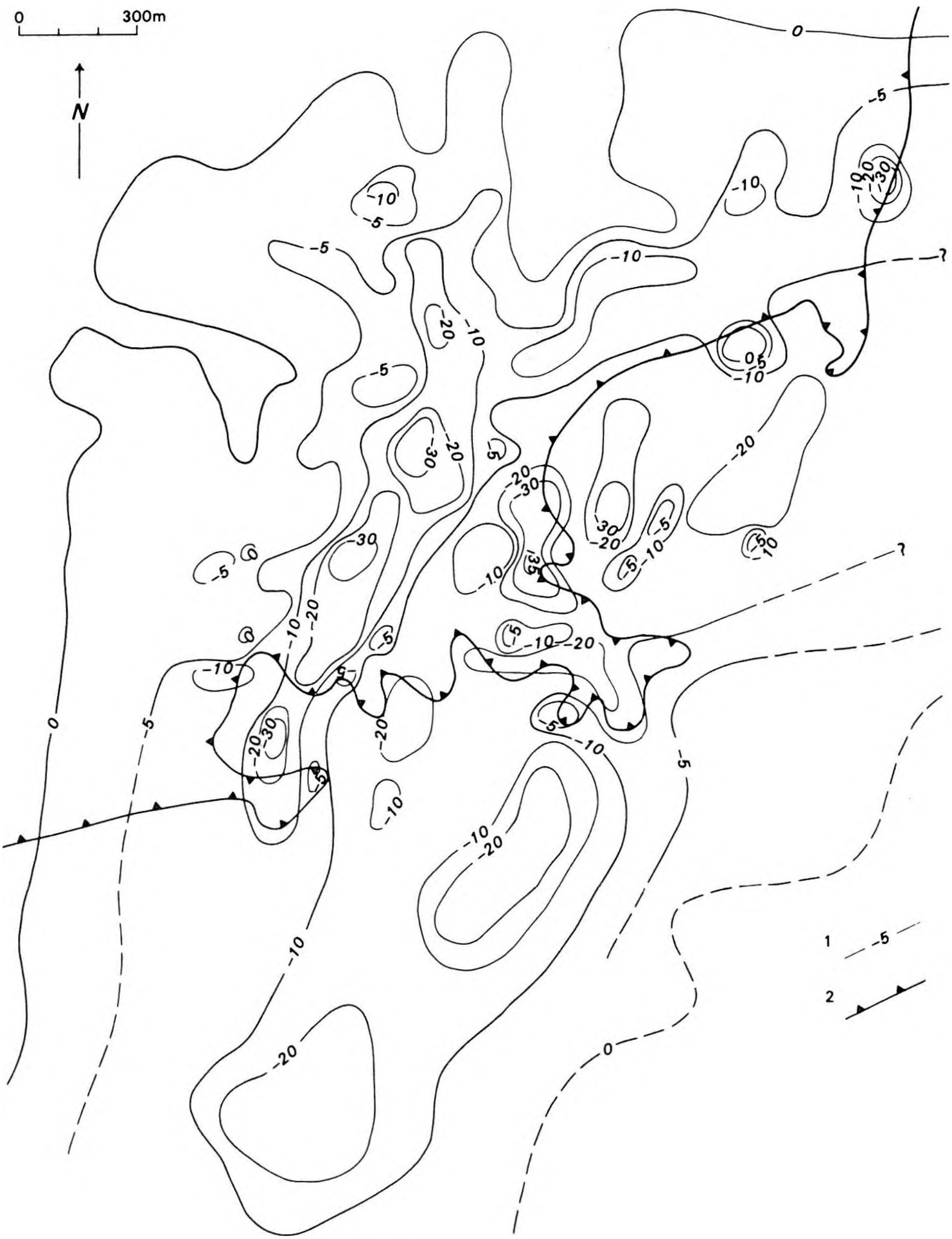


Fig. 26. Paleomorphology of the basement of the Halimba Bauxite Formation

1. Depth with respect to the marker horizon, *2.* line of extension of Upper Cretaceous formations covering the bauxite

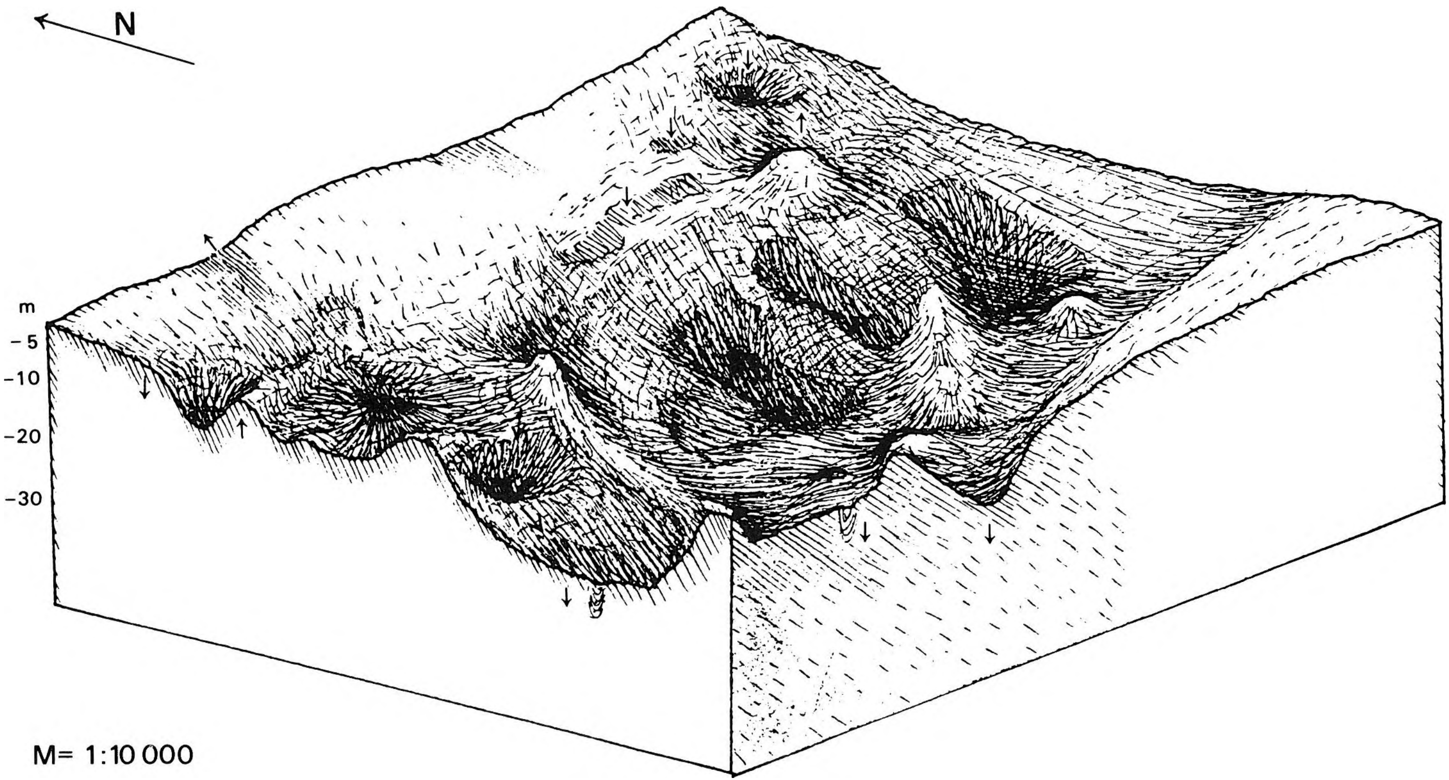


Fig. 27. Block-diagrammatic representation of the karstic surface of the Halimba Basin

The course of accumulation of bauxitic deposit in the Halimba Basin is shown in Figs. 27 to 35, showing the spatial distribution of each different facies of the bauxite deposit at 5 m intervals, from the marker horizon i. e. from the first non-bauxitic marl layer. In smaller and larger patches and sporadically, moreover in the form of thin intercalations inside the bauxite complex, or on base of it, carbonate detritus (of limestone and dolomite) can be detected. Fig. 28 shows the extension of Cretaceous carbonate detritus, that of lying below the bauxite, on the basis of the map plotted by J. KNAUER—É. TÓTH-GECSE—M. KNAUER-GELLAI (1981). The carbonate patches are found near the places where at the time of deposition smaller or larger karst hills emerged from the sedimentary basin of undulatory surface. At the edges of the basin, in deeper dolines, in a water-inundated environment only local i. e. carbonate material had been deposited, forming laminated microstrata, until the inflowing bauxitic sediment became dominant towards the margins (Figs. 29 to 38).

Fig. 29 shows the deepest, i. e. the early stage of the bauxite sedimentation. Deposit with its major part corresponding to flood basin facies is found in the deepest depressions with their depth exceeding 30 m only. Besides, there is a small area at the bottom of the doline where a sort of bauxite that is texturally similar to the bauxite of channel bar facies, deposited from a streaming medium, probably indicating that the doline acted for a short period as a sinkhole during the time of sedimentation.

Fig. 30 shows the facies distribution at a level of 25 m from the marker horizon. Whereas the earlier beds of flood basin facies were replaced by bauxite of flood plain facies or channel bar facies in the central depressions, then the deposition of fine-grained laminated-microlaminated bauxitic deposit of flood basin facies went on towards the margins.

Fig. 31 shows the facies distribution at a depth level of 20 m measured from the marker horizon. In the central part of the basin the deposition of bauxite of channel bar facies indicative of a streaming medium is going on. However, the bauxite deposited in its vicinity represents flood plain facies. At the edges of the sedimentary basin, with an always increasing spatial

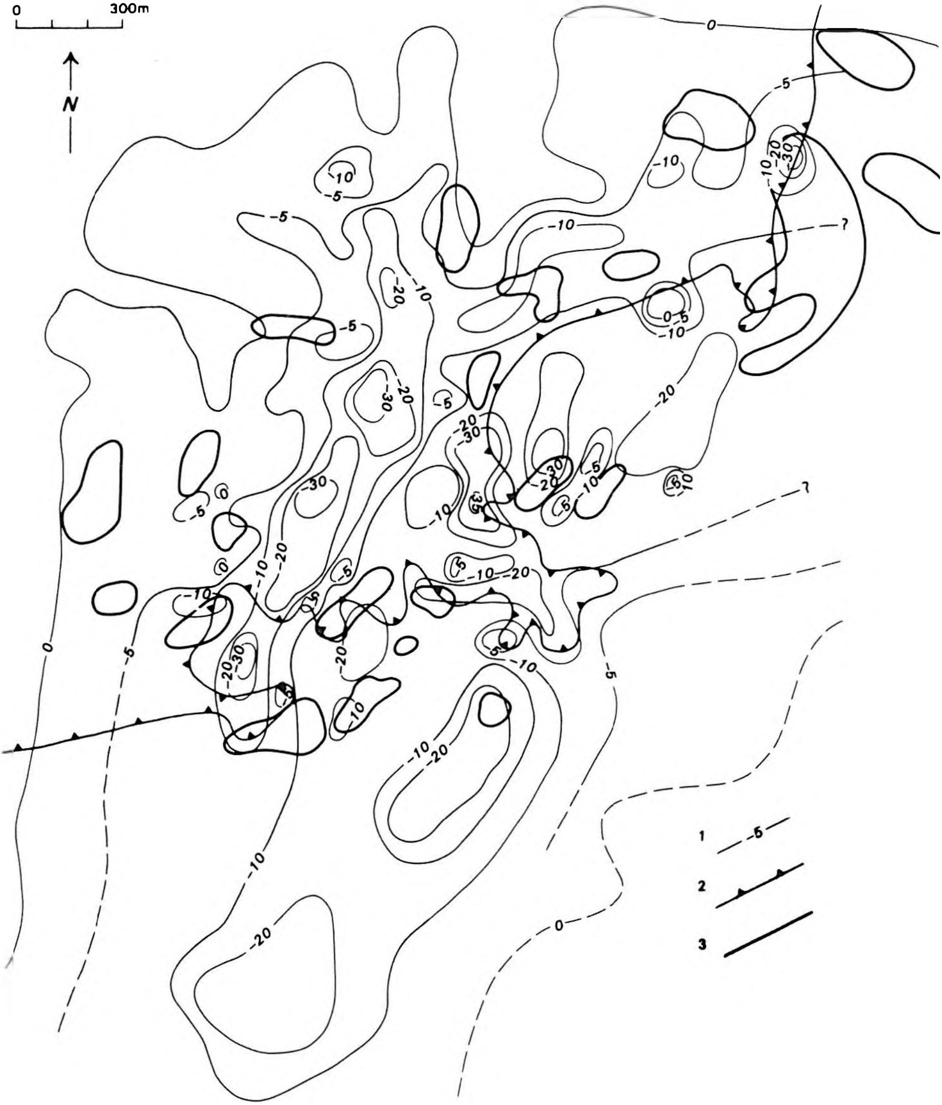


Fig. 28. The extension of carbonate beds underlying the Halimba Bauxite Formation
1. Depth related to the marker horizon, *2.* line of extension of the Upper Cretaceous cover formations
3. carbonate beds underlying the bauxite

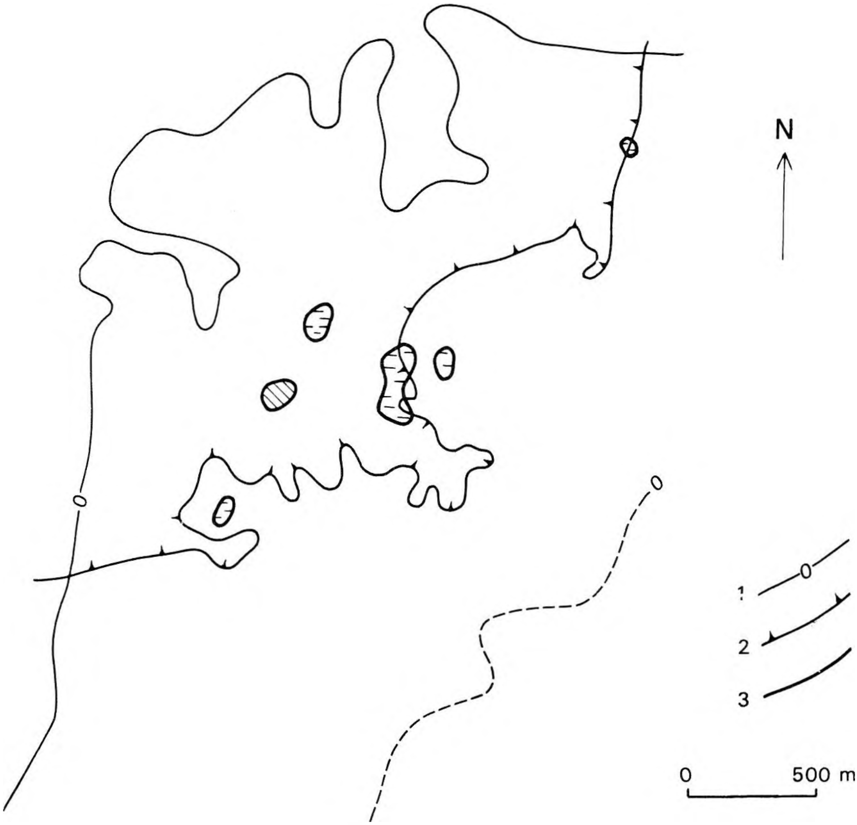


Fig. 29. Facies distribution map of the horizon of 30 m as compared to the marker horizon
1. Line of extension of the Halimba bauxite, *2.* line of extension of Upper Cretaceous formations covering the bauxite, *3.* line of extension of different facies

extension—the sedimentary basin being shallow, the deepest depressions are already filled up—the accumulation of bauxite of flood basin facies goes on.

Fig. 32 shows the facies distribution at a level of 15 m, reflecting the dominancy of the channel bar facies. The bauxite bodies of channel bar facies are arranged in finger-like form towards N, NW and W. With this area included, the flood plain facies will increase, encroaching onto new areas of the territory formerly covered by flood basin facies.

In Fig. 33, at the level of 10 m below the hanging wall, coarse-grained channel load facies appears in the area of the central subsidence formerly overlain by bauxite of channel bar facies. The bodies of channel bar facies were shifted, as fingers, further towards the sedimentary basin margins in N, NW, W and SW directions. The bauxite of channel load facies forms an

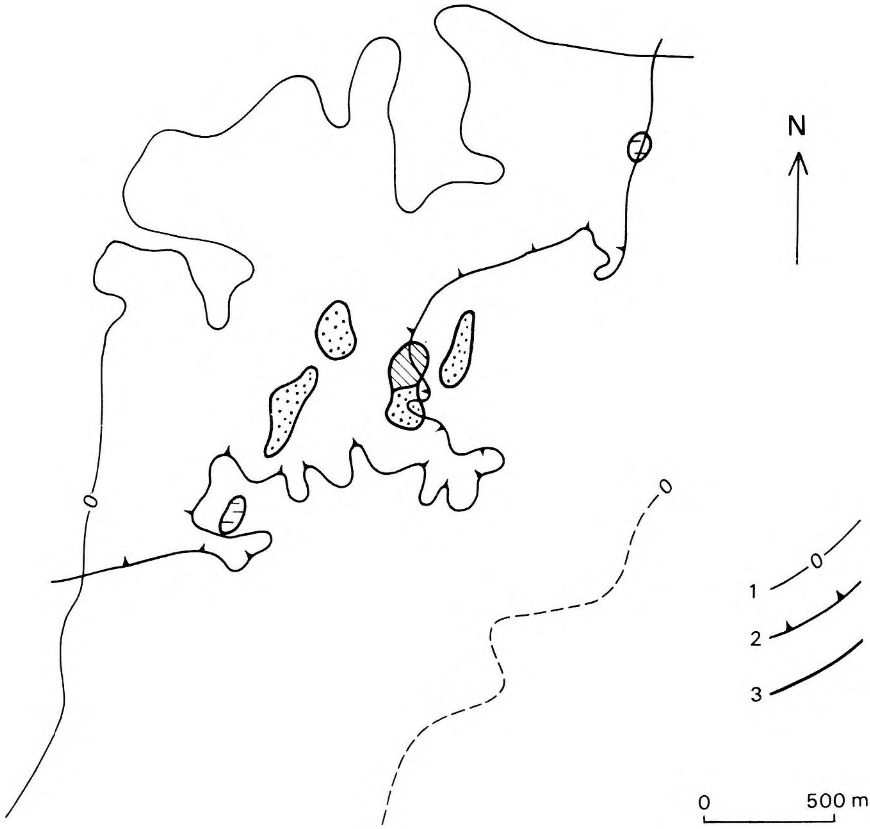


Fig. 30. Facies distribution map of the horizon of 25 m as compared to the marker horizo
For legend, see Fig. 29

elongated body of NW—SE direction, flaring out towards NW. Bauxite o flood basin facies was formed only in the SW and N parts of the sedimentary basin.

The facies distribution at a level of 5 m, shown in Fig. 34, illustrate that the number of bodies of channel bar facies decreased, the channel loa facies with central position did not increase, but E and S of it two smalle channel load bodies were formed. However, at this level it is of prime importance that marsh facies gained space in the NW part of the sedimentar basin, where, correspondingly, the bauxitic deposit which had formerl been of flood plain facies was replaced by flood basin facies. The appearance of marsh facies at this level indicates that the material inflow does no keep up with the subsidence, thus the vegetation in the areas covered b water for a long period grows apace, resulting in a reductive medium o deposition.

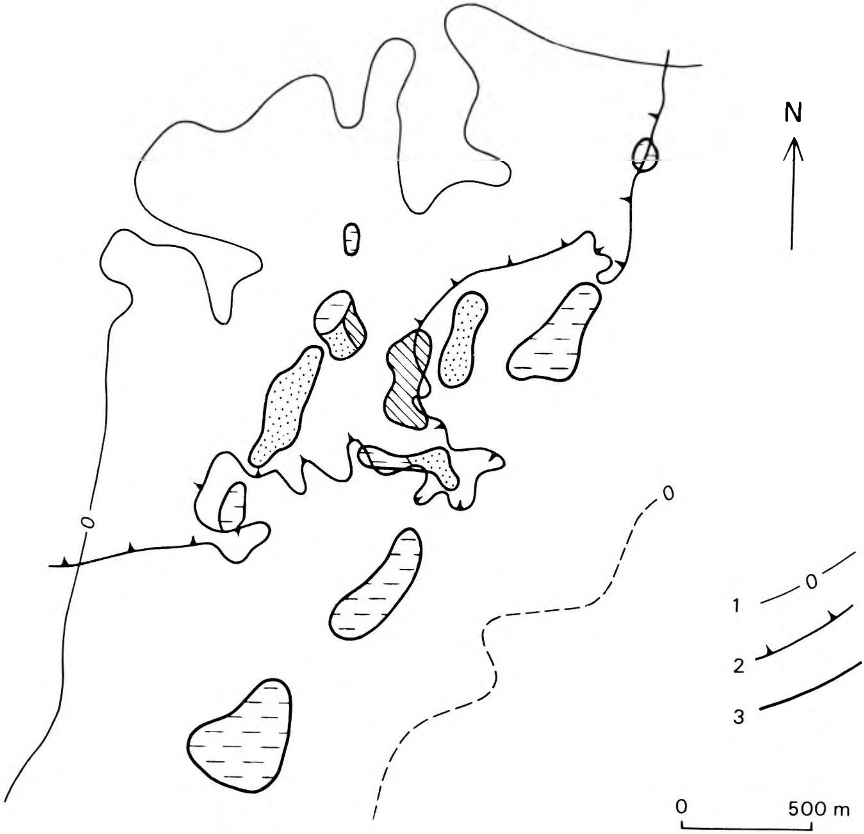


Fig. 31. Facies distribution of the horizon of 20 m. For legend, see Figs. 16 and 29

Parts with flood basin facies of the deposit (Fig. 33) are found in the greatest thickness at the edges of the Halimba Basin, particularly in its N and NW areas, heavily bonded to the dolines found at the rims.

The bauxite of flood plain facies, as shown in a map with its extent and thickness (Fig. 36) exceeds a thickness of only 10 m where linked with the W line of dolines. At other sites it stretches in a thickness of 5 to 10 m, forming a body of double wedge shape, and following the arched line of rim the sedimentary basin margin.

Combining the smaller and larger patch-like bar bodies appearing at different levels in the equal-thickness map of bauxite of channel bar facies (Fig. 37) a finger-like surface with sinuous borderline has been obtained, which apparently indicates the direction of deposit inflow. The main directions are E and SE.

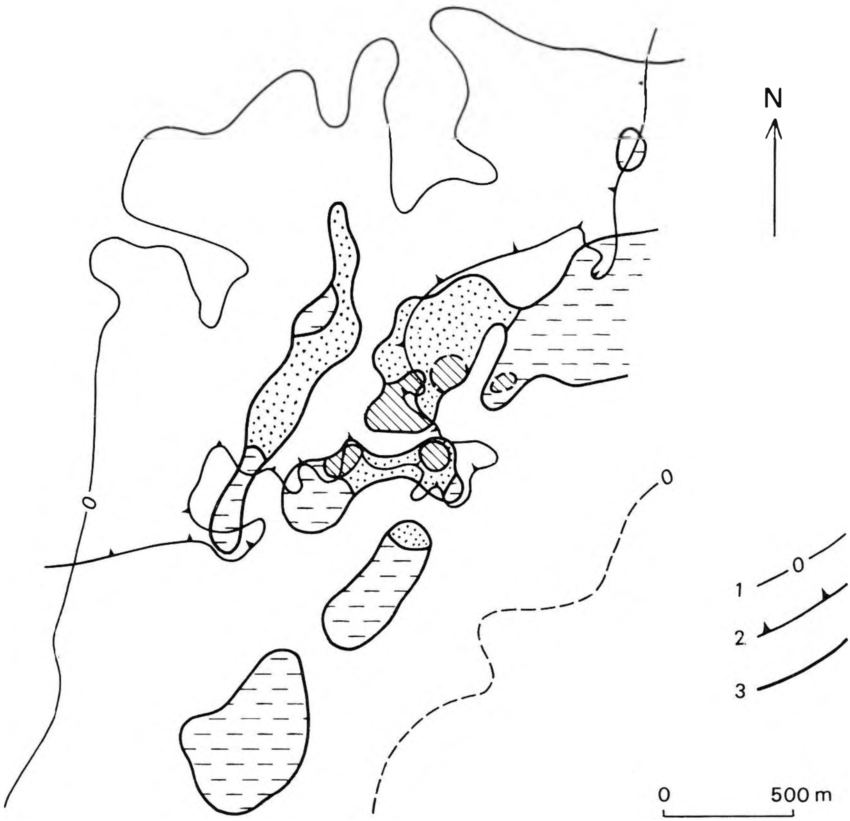


Fig. 32. Facies distribution of the horizon of 15 m. For legend, see Figs. 16 and 29

The combined extension of bauxite bodies of channel load facies i: shown in Fig. 38. Here the central body has a likewise finger-like extensioı which is similar to the distribution of the channel bar facies. The initia connection of the N, NW and SE smaller channel load bodies cannot bı identified because some post-sedimentary effects degraded the upper par of the bauxite sequence (2—4 m) to different extent. These small bodie: that are positively identified, confirm the E and SE direction of influx pre sumable upon the distribution of channel bar facies.

Fig. 39 shows the thickness of the conglomerate bed of the coveı sequence consisting of rather coarse particles (pebbles with a diameteı ranging from 1 to 20 cm) found above the thin marl bed directly overlyinį the bauxite bed. The main transport directions remained unchanged. The E direction remains dominant, with a slight increase of the southerı widenings verifying also a NE-directed sedimentary transport.

Fig. 33. Facies distribution of the horizon of 10 m. For legend, see Figs. 16 and 29

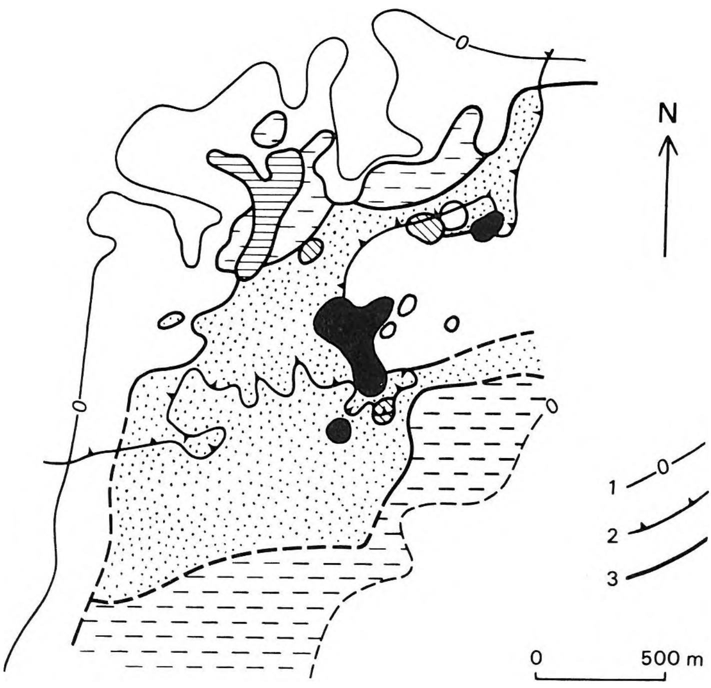


Fig. 34. Facies distribution of the horizon of 5 m. For legend, see Figs. 16 and 29

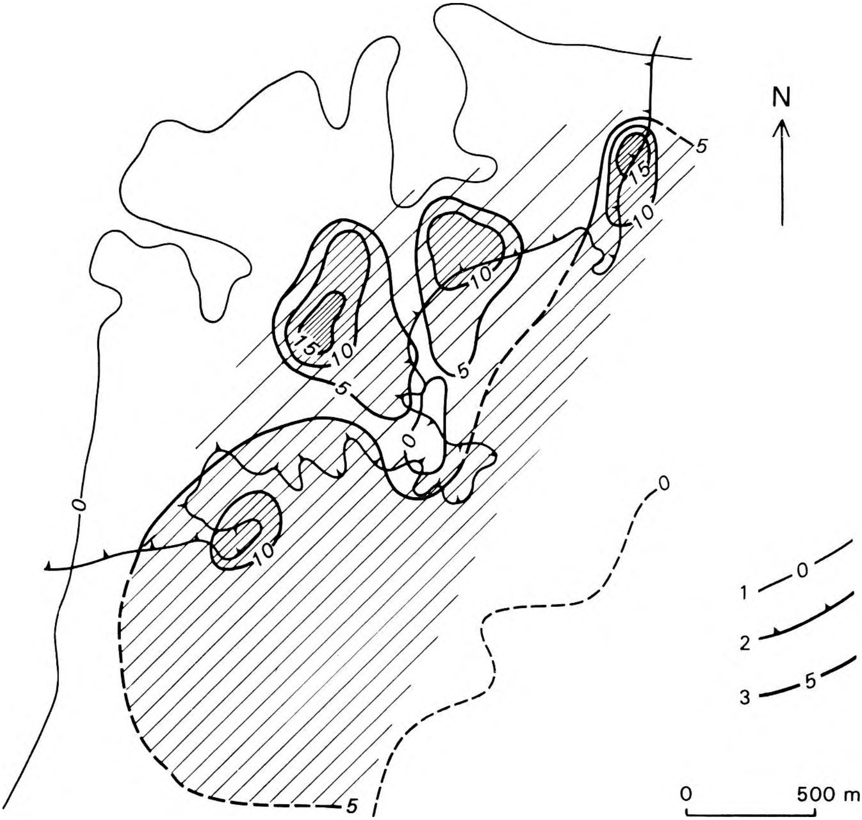


Fig. 35. Isopach map of the flood basin facies. For legend, see Figs. 16 and 29

A summary facies analysis

- The bauxitiferous sediment was transported into the Halimba basin from a background area with gradually increasing relief energy;
- The influx took place from E and SE (according to the present directions!);
- In the central depression facies of streaming water depositional environment are dominant (channel bar, channel load facies);
- After the filling-up of the central depression a nearly flat area was formed (flood plain), on which the river transporting the bauxitic sediment broke into branches (Figs. 32 and 33);
- Only the fine, floating detrital material could get in and settle down, forming microlaminated sediment of flood basin facies in

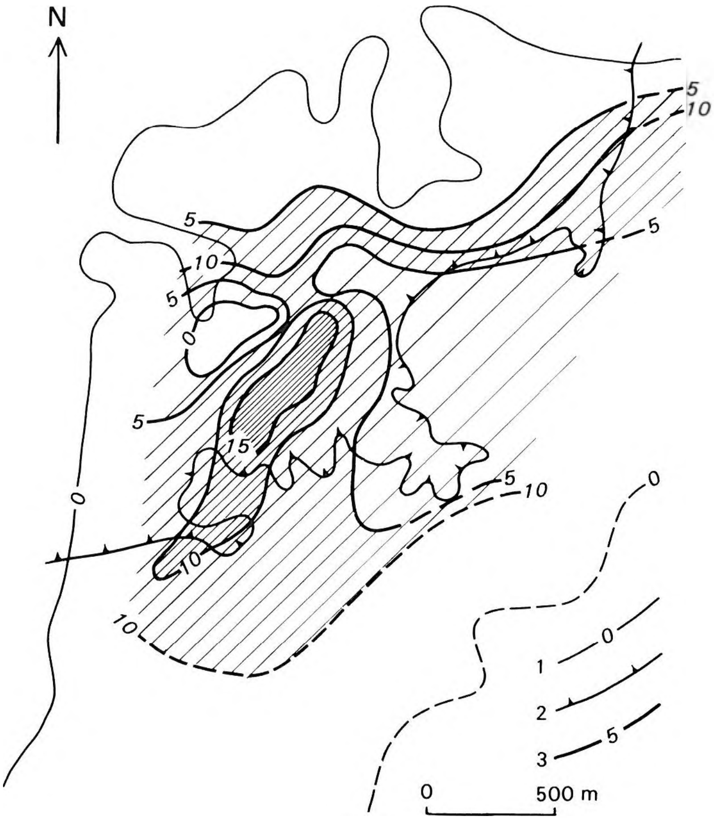


Fig. 36. Isopach map of the flood plain facies. For legend, see Figs. 16 and 29

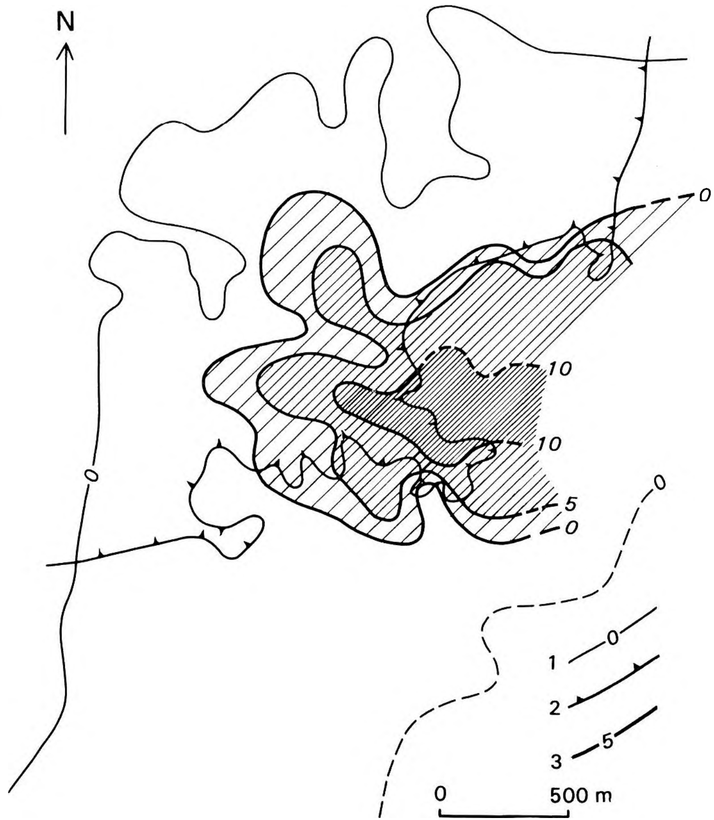


Fig. 37. Isopach map of the channel bar facies. For legend, see Figs. 16 and 29

Fig. 38. Isopach map of the channel load facies. For legend, see Figs. 16 and 29

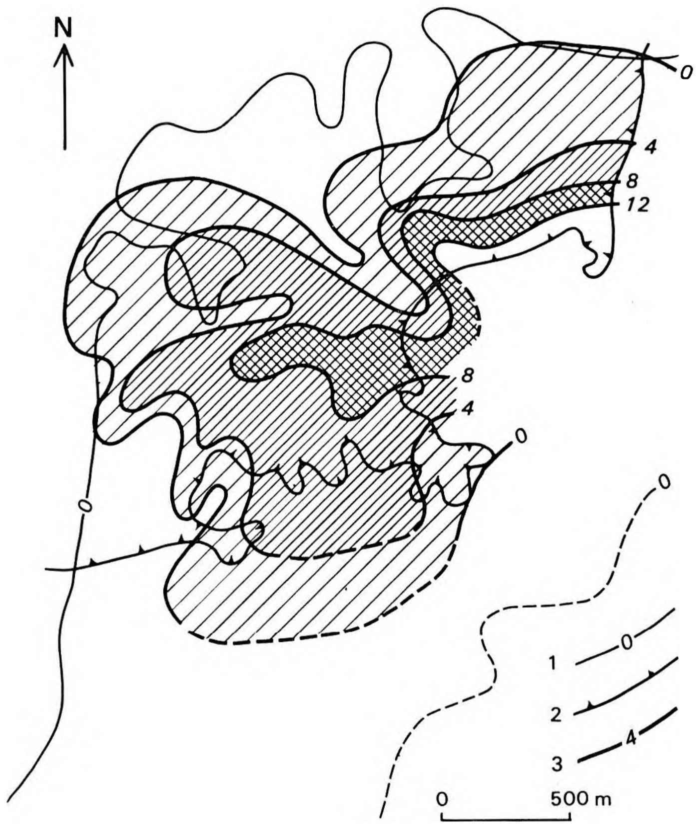


Fig. 39. Isopach map of the conglomerate overlying the Halimba Bauxite Formation. For legend, see Figs. 16 and 29

the small karst lakes persisting for long on the bottom of deeper dolines found on the margins of the sedimentary basin;

- At the end of inflow of the bauxitic sediment the subsiding rate of sedimentary basin was higher than that of the material income, therefore marsh facies was formed at several sites;
- The sequence of flood plain facies becomes gradually thinner in the form of double wedge towards the rims and the depression centre, becoming thinner and thinner to be pinched-out in both directions.

The Halimba Bauxite Deposit, representing an allochthonous one consisting of bauxite with bauxitic clast content, was formed in two cycles namely in the Senonian and the Eocene cycles of sedimentation. In the firs phase of the Senonian cycle bauxite was formed from different parent rock due to lateritic weathering. Then this bauxite together with the erosiona products of the Middle Cretaceous karst bauxite, exposed in the meantime were transported—mainly by river transport—to the sedimentary basin an deposited in accordance with the actual microenvironment.

Cycle 1

Based on the evaluation of geochemical and mineralogical study results it can be stated that there are several rock assemblages which may have been the parent rock of the Senonian bauxite. During the detailed micromineralogical analyses many micro-extraclasts were identified, which prove that the matrix of bauxite can be derived from metamorphic rocks of greenschist facies, along with igneous rocks of granitic composition, and, in all probability, volcanic rocks originating from Triassic tuffs as well as carbonate and sandy sedimentary rocks alike. The weathering of rocks took place on a differentiated hilly terrain and—as shown by bauxite texture—in several phases. During Cretaceous period two continental interval may have had suitable environments for lateritic weathering: before the Albian-Cenomanian age and before the Senonian ages. The texture of some extraclasts of the Halimba bauxite indicates that the eroded detrital grains of the older Albian bauxite may also have been transported into the Halimba bauxite. However, the greater part is composed of products of weathering, produced in the Turonian—Coniacian ages of the Late Cretaceous. At that time at the SE rim of the Transdanubian Central Range the Palaeozoic metamorphic rocks with Carboniferous granite intrusions as well as the Mesozoic carbonate sequences which had karstified to a different degree depending on their quality were exposed to the surface, and lateritic weathering profile may have been formed mainly on tuffaceous intercalations.

The different rocks also responded diversely to erosion and weathering. This led to the formation of an area with rugged morphology which resulted in the further differentiation of products of weathering. Weathering crusts were formed on the surface of rocks. Sequences with large thickness became laterite and lateritic bauxite and formed laterite bauxite deposits of different extension near the site of primary formation. As shown by certain marks these deposits are likely to have been subject, from time to time, to reductive environment also (element mobilization within grains, grains with deironized rims). The Subhercynian (pre-Gosauian) stage of the Alpine orogenesis was accompanied by dilatational tectonic movements. A differentiated terrain was formed and the erosion increased to a great extent in these areas also. Weathering was not able to keep up with the erosion anymore and the lateritic bauxite developed till that time and, along with the various products of weathering crusts were eroded. The older, Middle Cretaceous bauxite becoming exposed in the meantime are also likely to have eroded.

The weathering products were collected and transported from the hill and/or mountain ranges elevating gradually and to an increasing extent at the present SE rim of the Transdanubian Central Range, by the intermittent rivers and rivulets starting in (present) W and NW directions, into the karst basins of the foreland. One of these basins may have been the Halimba Basin, which had an undulatory surface but with small elevations only. It represented the SE sub-basin of the Late Cretaceous sedimentary basin, with special terrestrial sedimentation taking place in it. Rivulets and rivers transporting the bauxitic sediment performed their destructive and constructive work on their way in accordance with the climatic and terrain conditions, creating channel bars and flood plains etc. and transporting their load filled up the karst basins gradually. The filling-up began generally with fine-grained argillaceous deposit with bauxite content, into which the local carbonate material was also mixed in most cases (Fig. 40). Starting from the lower third part of the deposit, extending both laterally and vertically, the bauxite of flood plain facies occupied the largest areas (Fig. 41) where in the upper part of the deposit channel bar bodies of different size can be found, whereas in the central part the bauxite is covered by a very thick coarse-detrital sequence, a channel load cone consisting of bauxite pebbles (Figs. 42 and 43).

Towards the end of bauxitic transport, which is dated as shown by the pollens included in the upper, argillaceous part of the bauxite, as zone B of the Upper Santonian, the separation in sedimentation of the Halimba Basin ceased and the sedimentation became similar to that of the coal marsh of the Ajka Basin. Thus the first cycle of sedimentation of the Halimba Basin was completed, and the first member of the Senonian sedimentary cycle, i.e. the bauxite complex, as now called the Halimba Bauxite Formation, took shape.

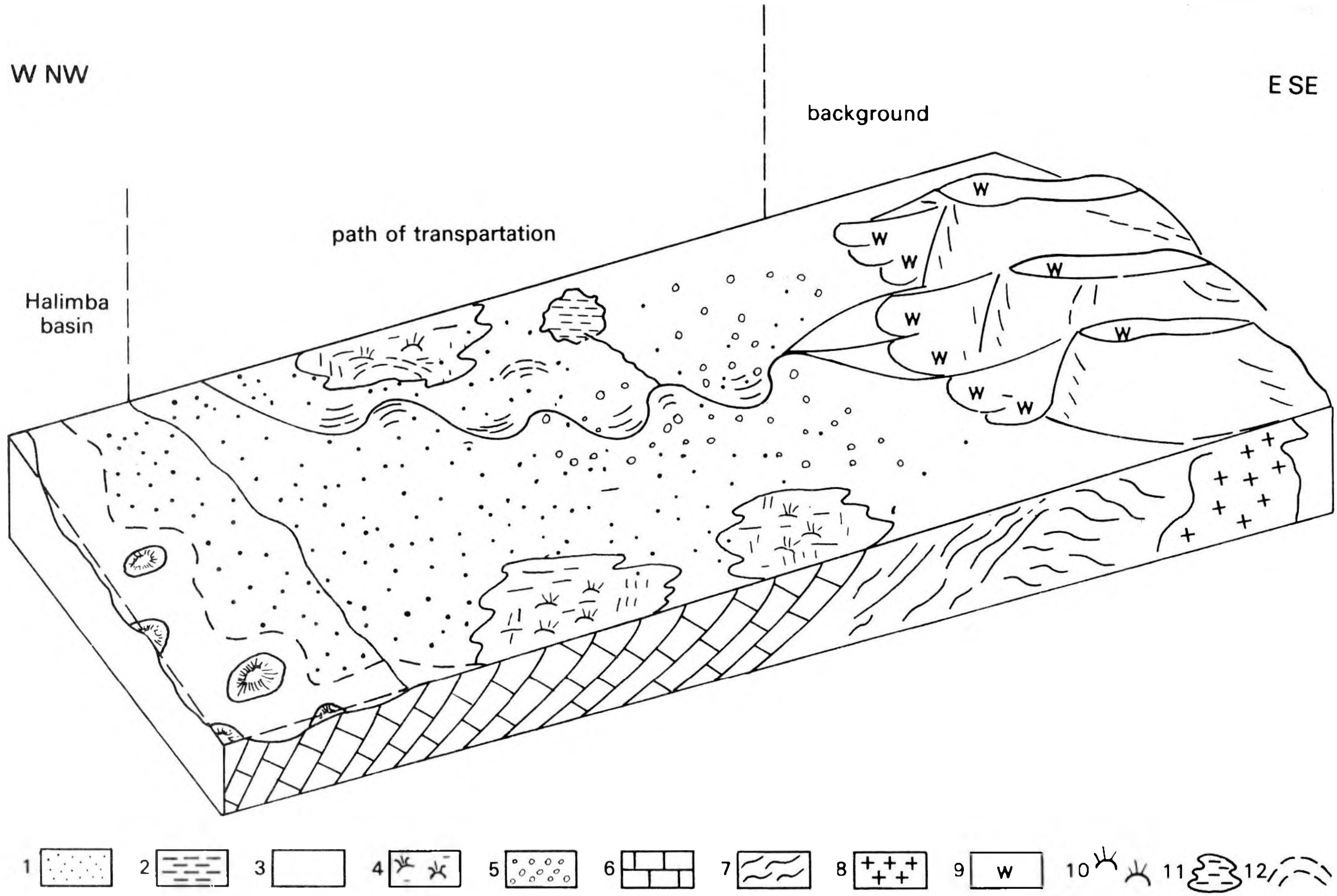


Fig. 40. The first stage of filling up of the Halimba Basin

1. Flood plain facies, *2.* flood basin facies, *3.* channel bar facies, *4.* marsh facies, *5.* channel load facies, *6.* Mesozoic carbonate rocks, *7.* Paleozoic epimetamorphic sequence of schist, *8.* granite instrusion, *9.* profiles of weathering and their accumulated material, *10.* marsh, *11.* lake, *12.* ox bow lake

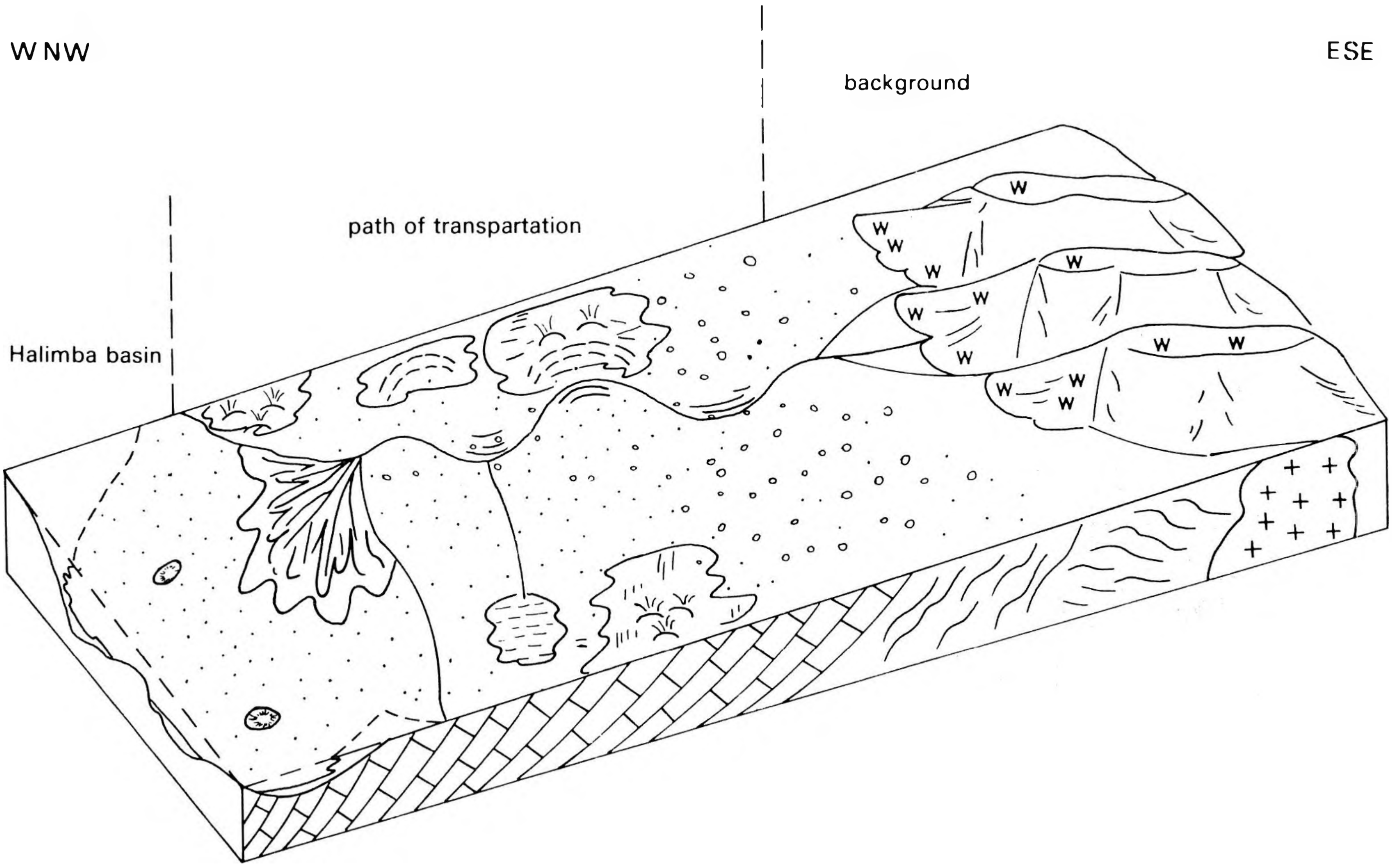


Fig. 41. The second stage of the infilling of the Halimba Basin. For legend, see Fig. 40

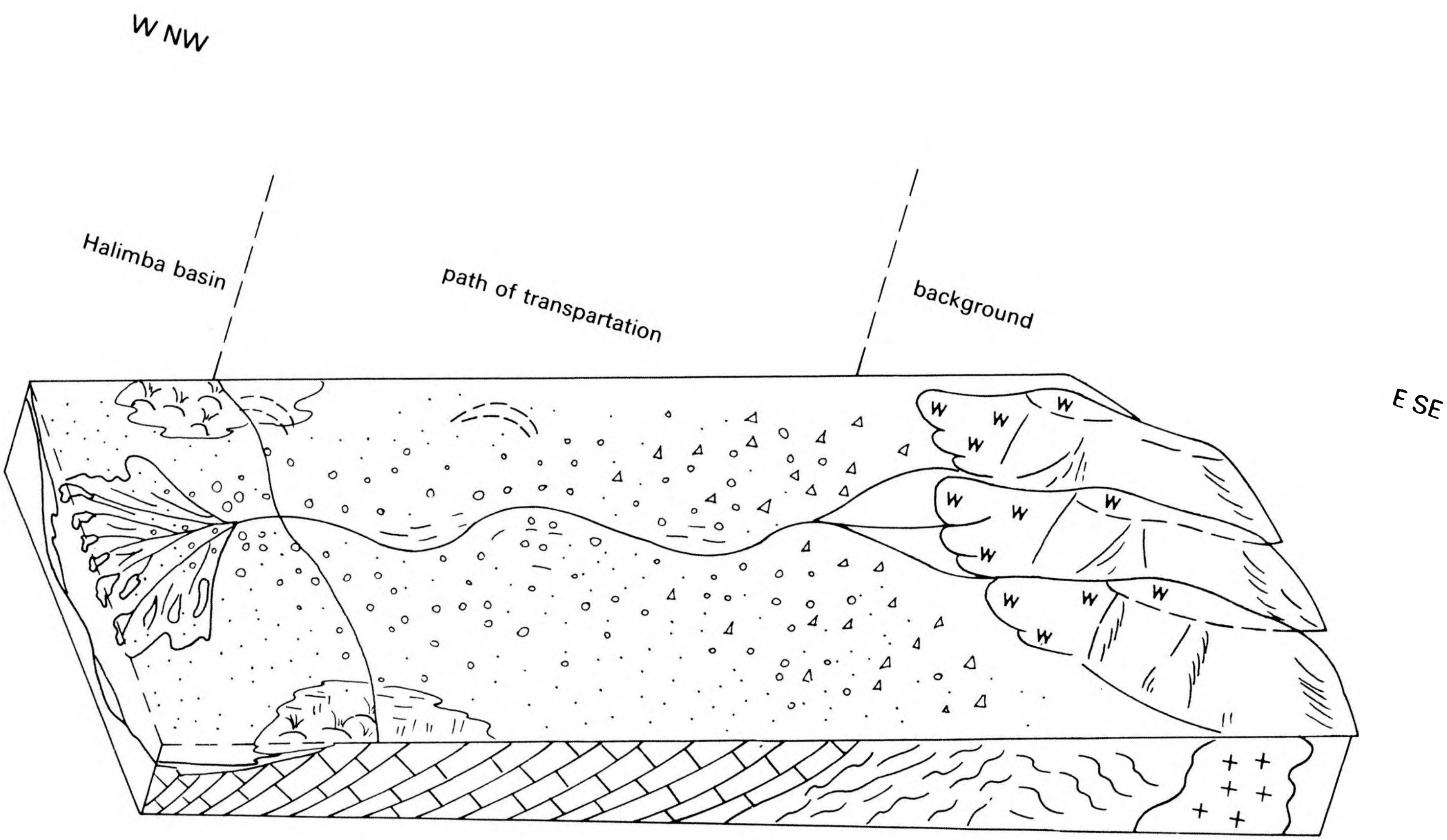


Fig. 42. The third stage of the infilling of the Halimba Basin. For legend, see Fig. 40

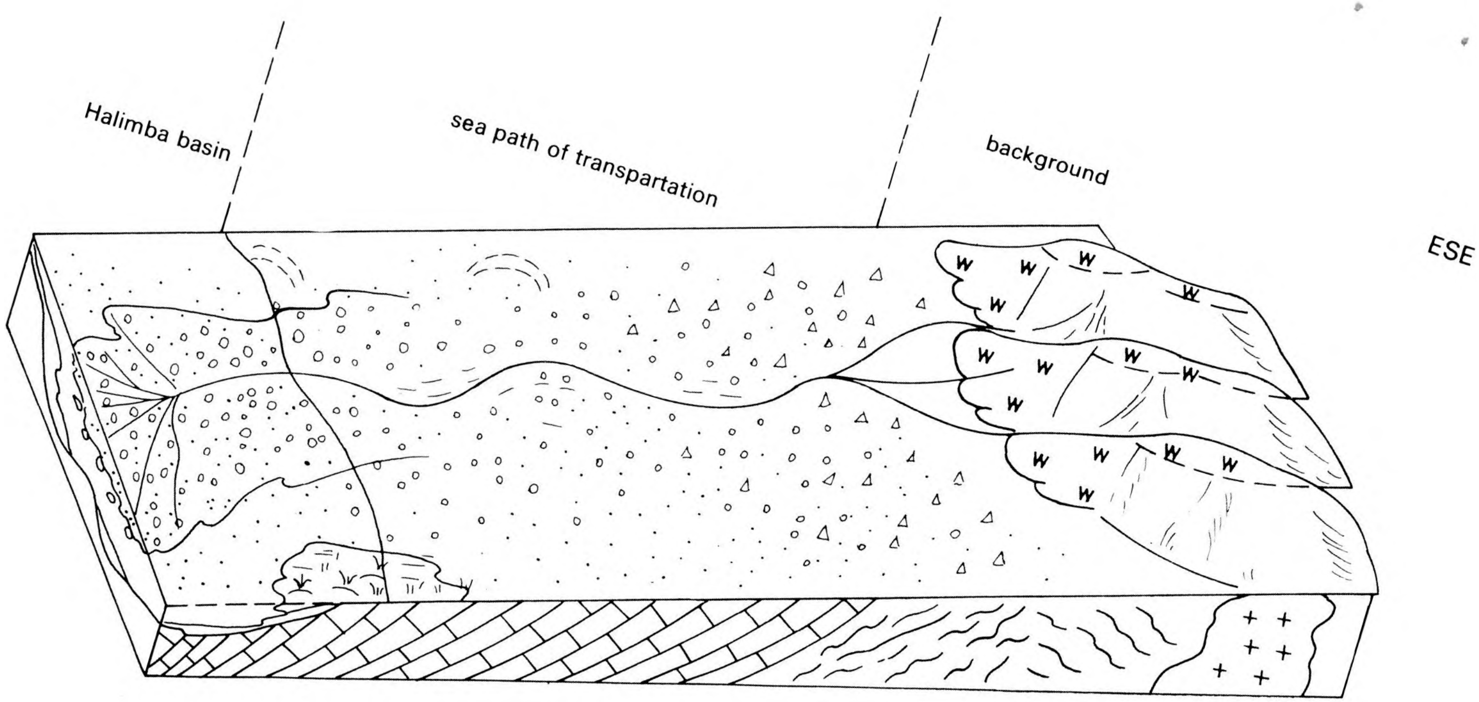


Fig. 43. The final stage of the infilling of the Halimba Basin. For legend, see Fig. 40

Cycle 2

A great erosion destroying partly the bauxite itself is likely to ha taken place between the Cretaceous and the Eocene. Marshs of differe size were formed on the surface of the bauxite. Some of them were pr served. The pollen grains found in them indicate the earliest Eocene in tl Transdanubian Central Range, allowing to identify the beginning of Eocer bauxite accumulation in the area of the Halimba deposit precisely. In acco dance with the changed palaeomorphological situtation, in the erosional va leys a thick bauxite complex was deposited, with its major part supplied t the redeposited detritus of the Senonian bauxite, and to a small exte mixed with the new bauxite formed up to the Eocene as well as with tl eroded material of other bauxite deposits exposed in the meantime.

The geochemical, mineralogical, textural and sedimentological featur of the Eocene bauxite considerably differ from those of the Senonia bauxite and cannot be distinguished even in those areas where the argi laceous bed with Eocene pollengrains does not exist between them. The E cene bauxite is supposed to have been transported from the nearby are into the Halimba Basin by means of areally restricted washing.

There is no essential difference between the parent rock of the Senor ian and Eocene bauxites of Halimba, which can be explained partly by th fact that the main bulk of the Eocene bauxite is represented by the re deposited material of the Senonian bauxite, and only to a small extent i made up of the bauxitic material formed during Eocene epoch.

Practical application

The study of the sedimentological features of the Halimba bauxite ha supplied useful results for the mining of bauxite and for the prediction o new deposits.

Significance of the results in mining

The Halimba Bauxite Complex as an allochtonous deposit of sedimen tary constitution is composed of bauxites of different facies, with specifi grades belonging to each facies, which can be exactly determined by geo statistical methods. Identifying each typical bauxite facies representing typical bauxite grade—both laterally and vertically—may render a help i designing the mine galleries to an optimum and thus in making the minin work more economic.

Significance of the results in mineral prediction

The Halimba bauxite is a deposit consisting of redeposited bauxit which has a distal position, i.e. an environment of accumulation distan from the source area. The precise determination of transport directions and of the parent rock enabled us to make prospective areas holding smaller re-deposited bauxite remains formed under depositional conditions analogous with those of the Halimba bauxite.

Separating the Senonian and Eocene cycles of bauxite accumulation and identifying the features of the Senonian and Eocene bauxites will allow —knowing the textural and geochemical features—to date the bauxite in those fields of exploration where bauxite formation is attached to large erosional gaps. Considering that there are great differences between the Senonian and Eocene environments of formation and accumulation of bauxite, it can be very advantageous for the prediction, at the very beginning of the exploration, if we can foretell the cycle to which a bauxite indication may belong.

The well perceptible relation between the grade and the facies of bauxite is of practical importance also. In the case of the Halimba bauxite the relation between the high-grade and the coarse grain-size may raise the idea of technological application as well. At the same time this result calls the attention to reveal the relation between the grade and facies of bauxite for other bauxite occurrences, too.

Realizing that sedimentological units i.e. bauxite facies can be identified within a single bauxite complex also, raises new aspects for bauxite exploration. Taking bauxite for a sedimentary rock instead of a "special mineral resource", the proper, selective application of the sedimentological methods can be secured.

Testing methods using large instruments (SEM and electronmicroprobe tests) may render a help in selecting the testing methods in accordance with the purposes of bauxite exploration.

The "key-profile-type" approach to the problems, by the very nature of its methods, will increase the geological knowledge to a great extent which may render a great help in bauxite exploration and the marking-out and evaluation of subsequent key profiles alike. The exact determination of palaeogeographical conditions of the accumulations of the Halimba Bauxite Formation has contributed to a great extent to the clarification of the palaeogeographical environments of deposition prevailing the beginning of Senonian time, in the present-day Transdanubian Central Range, which will also serve the exploration of other mineral resources in the same region.

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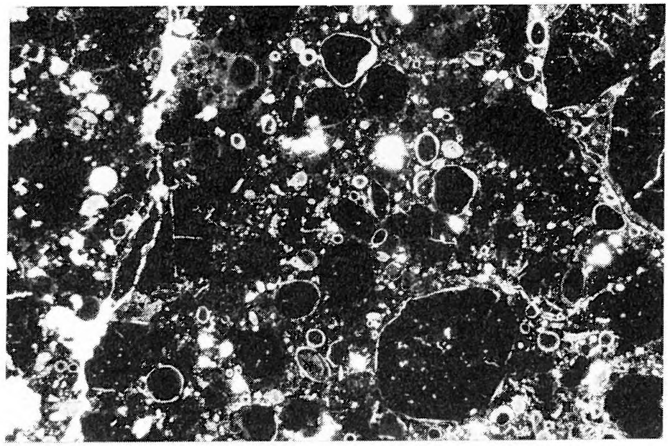
PLATES

Plate I

1 Bauxite packstone with bauxitic clasts and microgranular matrix. Th bauxitic clasts that can be bauxite pebbles (1), ooid fragments (2), ar of different size (from some tenths of mm to 5 mm), are in contac with one another in the microclastic matrix
Borehole H 529, 204.2—205.2 m, 15X

2 Bauxite packstone with ooids, mosaic structure and pelitomorphi matrix. The ooid assemblage, including a great number of ooids wit deironized rims, is medium to well sorted and is arranged densely i the pelitomorphic matrix. At some parts of the matrix, bordered by multiangular line, the Fe content is different, showing transitional de siccation, mosaic structure
Borehole H 1018, 292—293 m, 6X

3 Bauxite mudstone with ooids and bauxitic clasts, with deironized, peli tomorphic matrix. Smaller Fe-rich ooids (max. 1 mm) and larger Fe rich bauxitic clasts (max. 4 mm) being in no contact with one anothe float in the pelitomorphic deironized matrix
Borehole H 612, 310.0—312.6 m, 6X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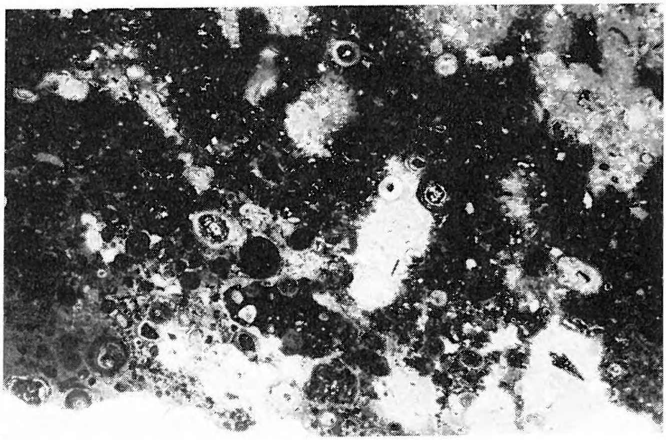
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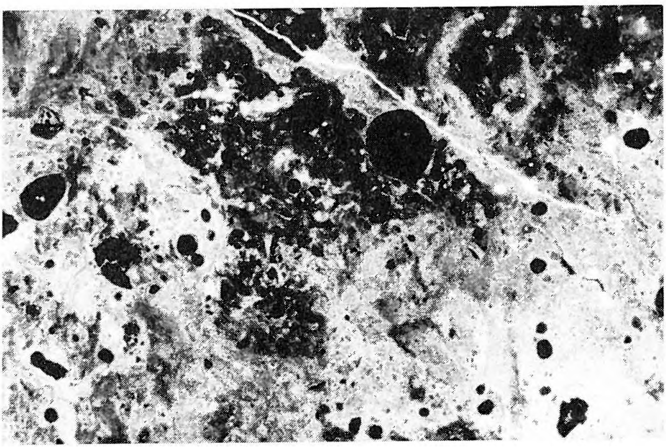
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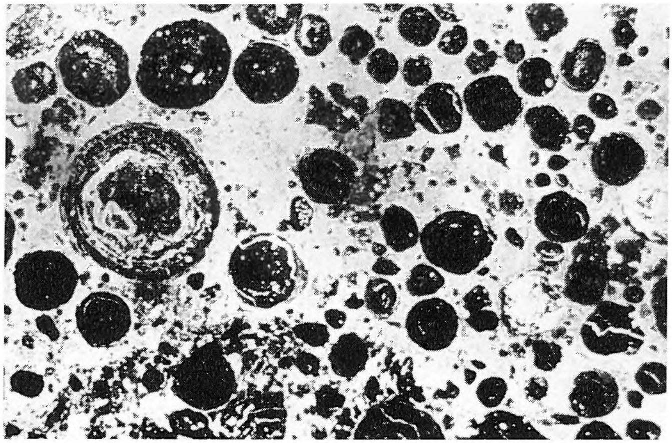
Plate II

1 Bauxite wackestone with ooids and deironized pelitomorphic matri: The Fe-rich ooids with diameter ranging from 2 to 4 mm are arrange in the pelitomorphic deironized matrix without any contact. A fe bauxitic clasts also occur, but their amount is negligible as compare to ooids
Borehole H 651, 260.4—261.4 m, 6X

2 Bauxite packstone with ooids and extraclast, with pelitomorphi matrix. The Fe-rich ooids are fairly well sorted, and about 0.5 mı large, whereas the carbonate rock detrital grains may attain even mm. All of them form the bauxite in a dense arrangement
Borehole H 1632, 203.8—204.8 m, II N, 6X

3 Bauxite mudstone with carbonate matrix and ooids. The matrix of th bauxitic rock is argillaceous carbonate siltstone, in which well-sorte deironized to different extent ooids with size of about 1 mm are foun according to a scattered pattern
Borehole H 507, 353.2—353.6 m, 6X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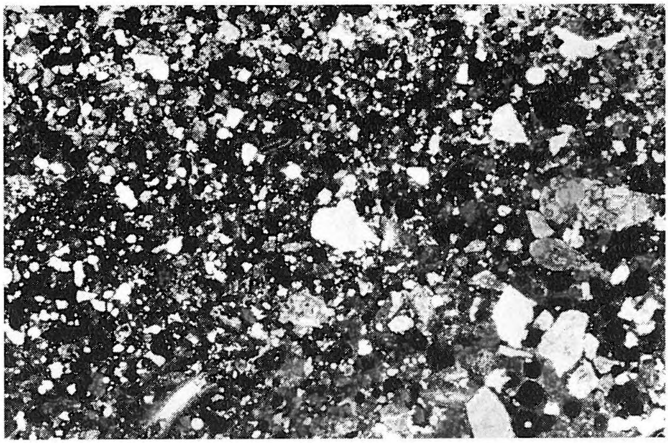
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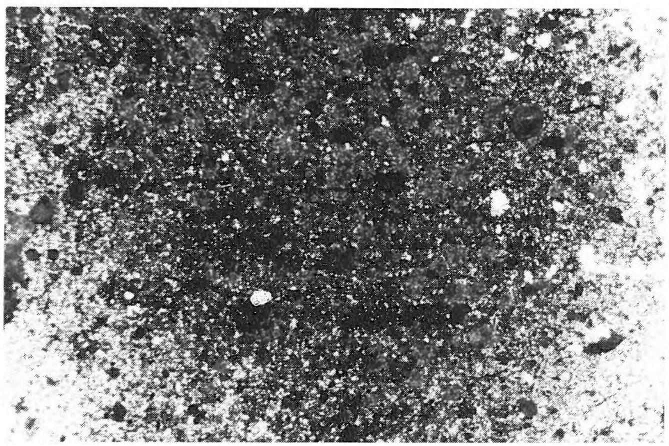
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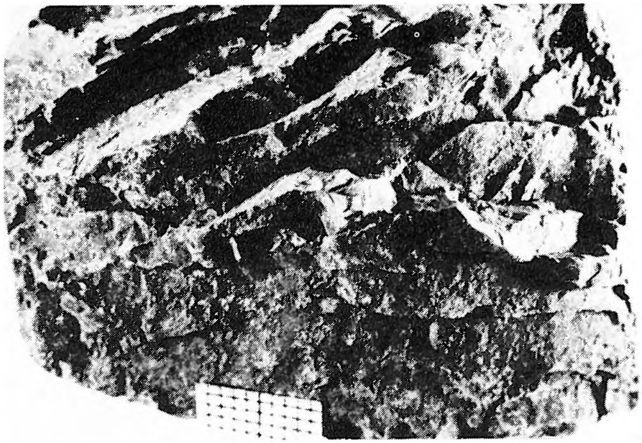
Plate III

Bauxite of channel bar facies is shown here. The most important criteria c
channel bar facies are as follows: packstone texture with ooids and/c
bauxitic clasts, cross-bedding, and arcuate string-like microlamination

1 Cross-bedded high-grade bauxite of channel bar facies
Borehole H 641, 316.5—317.5 m

2 Bauxite of channel bar facies, including arcuate and string-like micr(
laminae
Borehole H 942, 254—255 m

3 Photomicrograph of a bauxite of channel bar facies: a set of fine
grained and coarse-grained, arcuate microlaminae with ooid and bau›
itic clast content
Borehole H 529, 213.2—214.2 m, 14X



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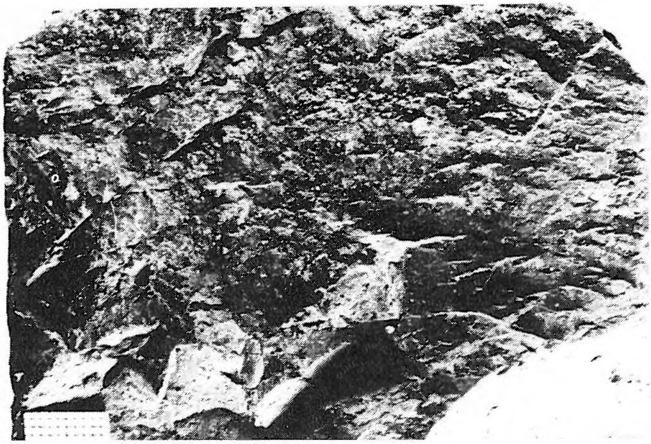

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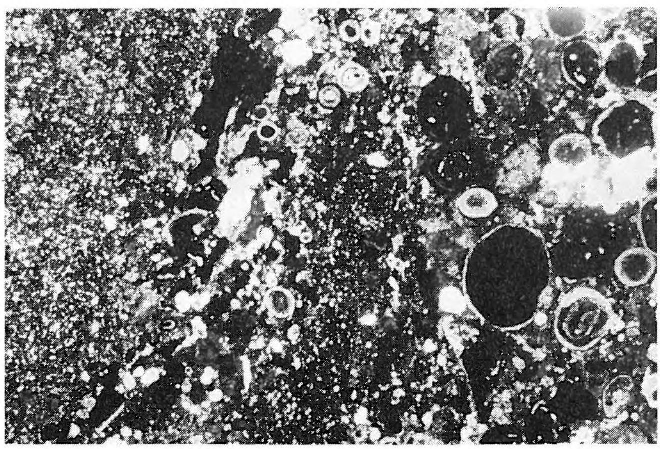


3

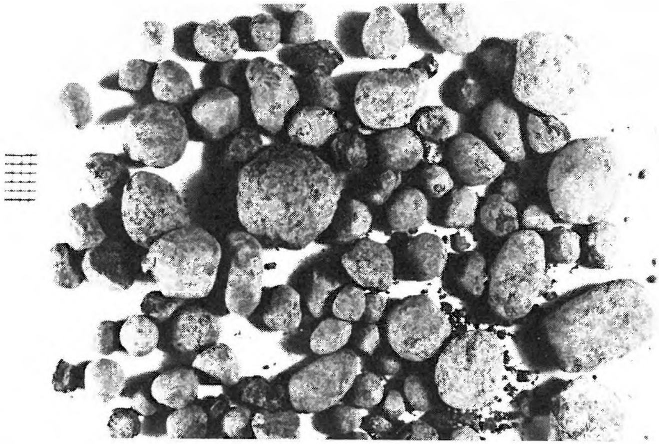
Plate IV

Different types of channel load facies. Main criteria of this facies are a follows: unsorted, coarse-grained, packstone-textured with ooids and/o bauxitic clasts

1 Bauxite of channel load facies, consisting of medium-to-well rounde bauxite pebbles, with loose matrix. (Only a very low amount has re mained from the small amount of loose matrix.)
Borehole H 694, 332.9—334.1 m

2 Coarse-grained, bauxite-pebble-bearing bauxite, of a facies of unsorte channel load
Borehole H 640, 329.5—330.3 m

3 Photomicrograph of a bauxite of channel load facies showing pack stone bauxite with ooids and bauxitic clasts and microclastic matrix
Borehole H 549, 190.1—191.1 m, 15X



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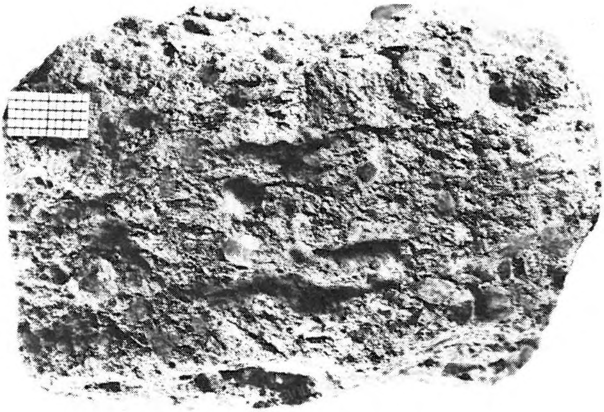

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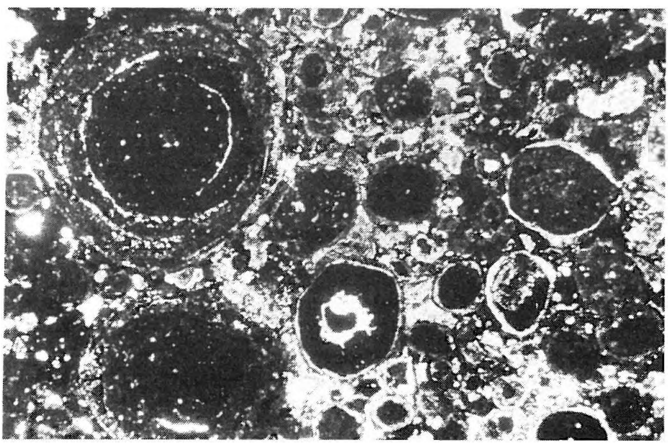

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Plate V

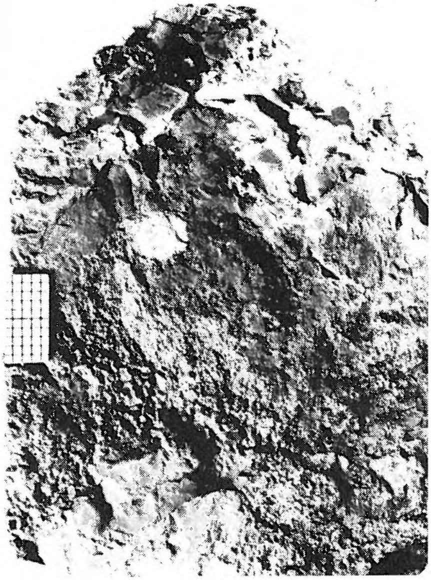
Different types of bauxite of flood plain facies

1 Bauxite of flood plain facies, with pelitomorphic matrix, and mediun -to-well sorted bauxitic clasts with a diameter of approx. 1 mm
Borehole H 1018, 311.0—311.5 m

2 Bauxite mudstone of oolitic, pelitomorphic matrix, deironized in mosaic-like form, which is very characteristic of the flood plain faci
Borehole H 350, 179.4—179.9 m, 15X

3 Bauxite of flood plain facies has, in some cases, graded lamination
Borehole H 642, 277—278 m

4 Photomicrograph of packstone bauxite of flood plain facies, wit graded lamination and ooids
Borehole H 567, 250.2—251.2 m, 15X



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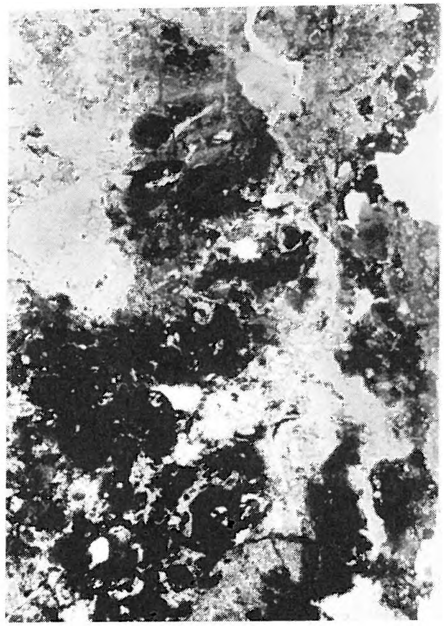

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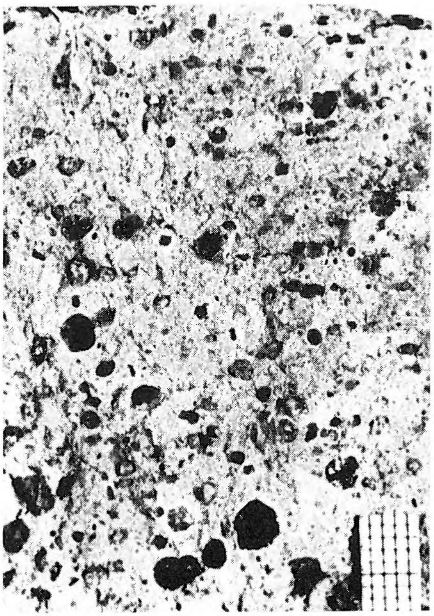

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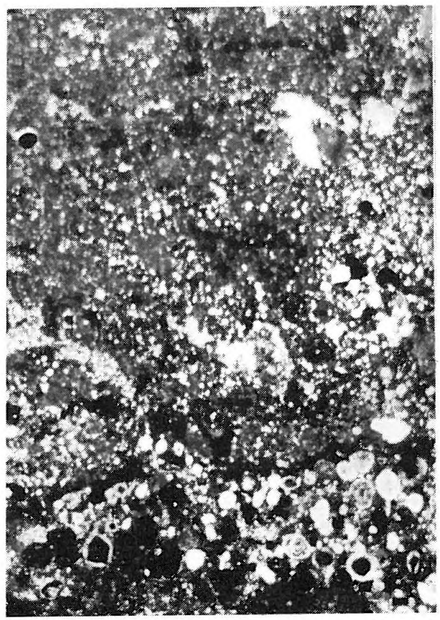

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Plate VI

The well-sorted grains of bauxite of flood basin facies form, in most cases parallel microlaminae

1—2 Laminated, fine-grained bauxite of flood basin facies
Borehole H 642, 272.2—273.2 m

3 Photomicrograph of a fairly well sorted packstone bauxite of flood basin facies, with ooids and bauxitic clasts. Grain size is max. 0.2 mm
Borehole H 529, 219.1—220.2 m, 15X

4 Microlaminated, extraclastic-oolitic bauxite packstone of flood basin facies
Borehole H 571, 251.7—255.7 m, 6X

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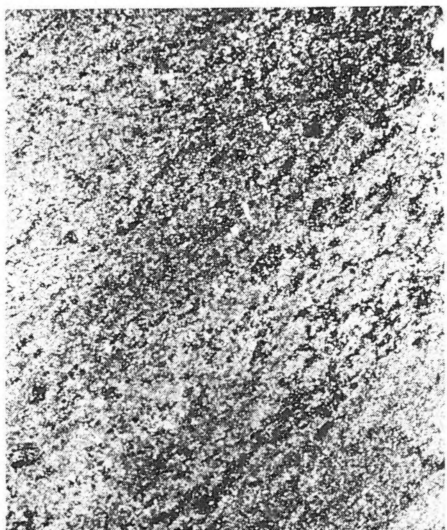

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Plate VII

1 At the middle part (from 215.2 to 216.2 m) of borehole section H 52[cut off] bauxitic clasts form arcuate, string-like microlayers in the microclas[cut off] tic matrix. This kind of arrangement is characteristic of the channe[cut off] bar facies
6X

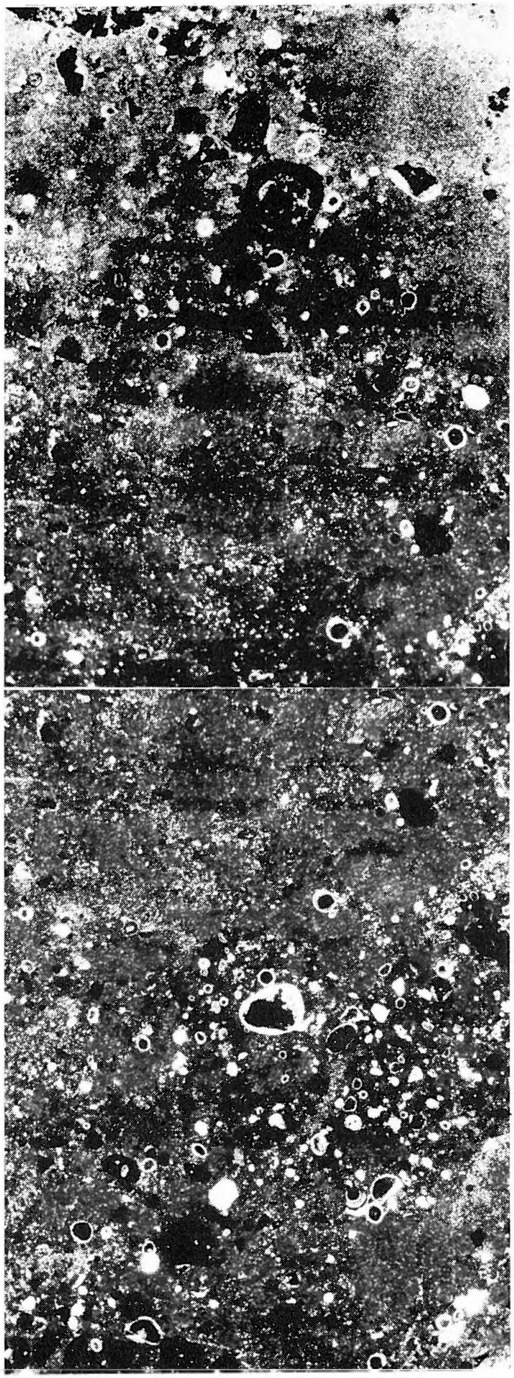

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Plate VIII

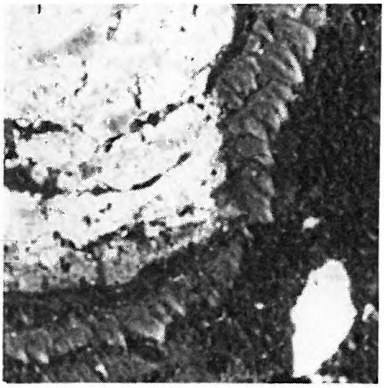
1 A compositional electron microprobe image showing a detail of an Fe rich ooid with Mn and Ca content
Borehole H 529, 206.2—208.2 m, 300X

2 Fe X-ray photo corresponding to Fig. 1

3 Mn X-ray photo corresponding to Fig. 1

4 Ca X-ray photo corresponding to Fig. 1

As shown by microanalyses, the bauxitic clasts of the Halimba bauxite ar rich in Fe and have Al content and always contain more or less Mn and/o Ca, in addition to Ti



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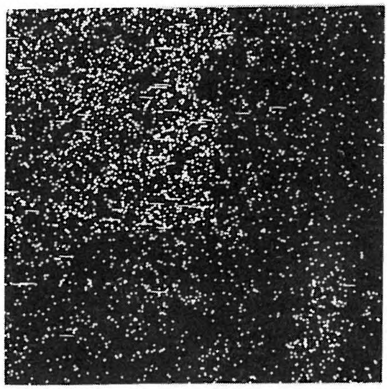

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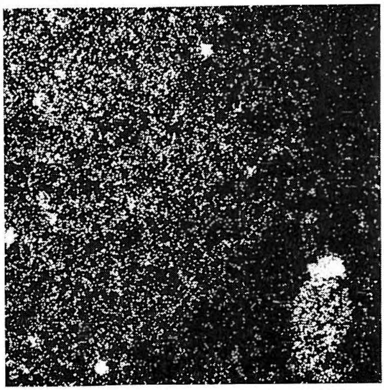

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Plate IX

1 A compositional electron microprobe image. A small detrital grai with Mn-Ni-Co-Fe content
Borehole H 529, 212.2—213.2 m, 300X

2 Fe X-ray photo corresponding to Fig. 1

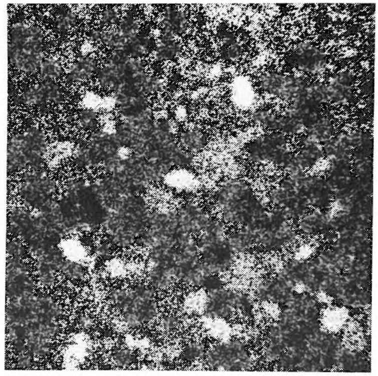
3 Mn X-ray photo corresponding to Fig 1

4 Ni X-ray photo corresponding to Fig. 1

5 Co X-ray photo corresponding to Fig. 1

In the channel bar facies complex the Mn-rich extraclasts with considerabl Ni and Co content are frequent. The arrangement of them is generall resembling a string of grains exhibiting the features of channel bar facie even in micro-size also

1



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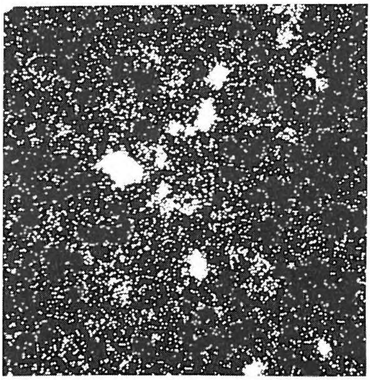

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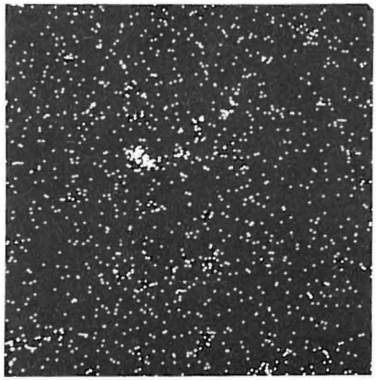

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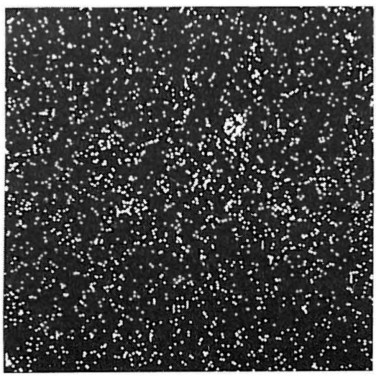

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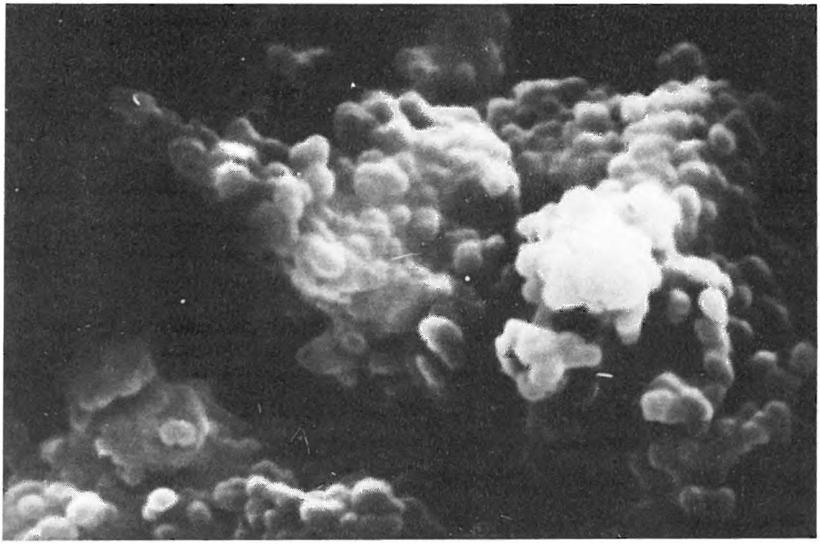
Plate X

SEM patterns of grains and matrix of the Halimba bauxite

1 Matrix with aggregate. Aggregates are composed of 0.2—0.3 μn isometric mineral plates linked with one another through plate-to-plat joint. Gaps of 1—3 μm as well as cavities larger than this range ma occur also
Borehole H 529, 10,000X

2 The aggregates the grains are composed of, are smaller than the one composing the matrix, and have a tighter fitting. Their size range from 1 to 2 μm, the gaps and cavities among them are smaller. Orien tated arrangement can also be observed sporadically
Borehole H 529, 10,000X



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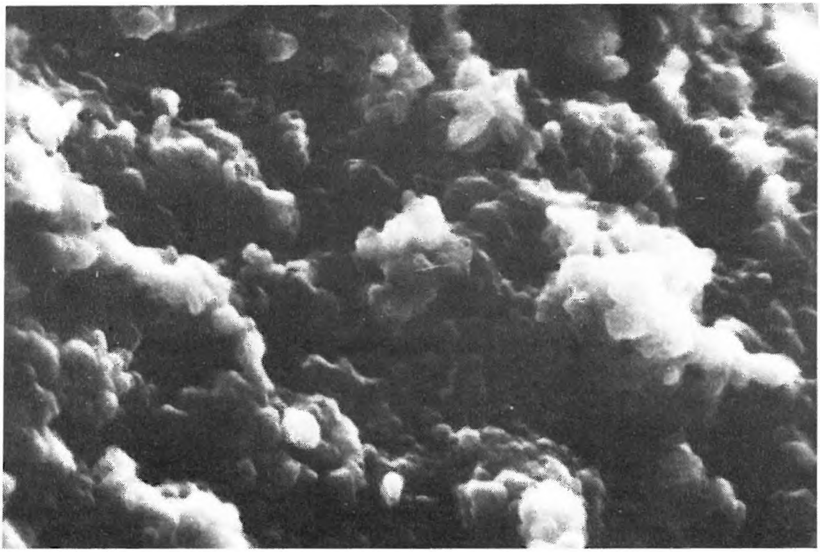

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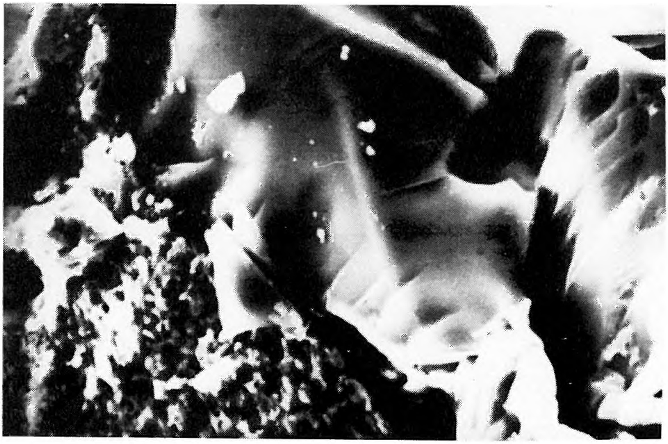
Plate XI

Gel precipitations, probably of diagenetic origin, occur frequently in the upper part of flood plain facies drilled by borehole H 529

1 A SEM pattern of gel structure that is very frequent in the upper-situated bauxite of flood plain facies
Borehole H 529, 500X

2 Point analysis of a material of gel structure, using an EDAX (energy-dispersive) micro-analyzer



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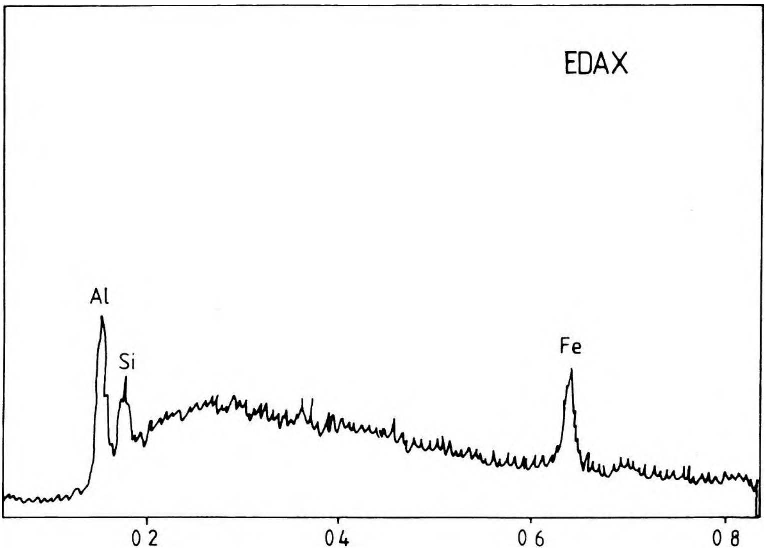

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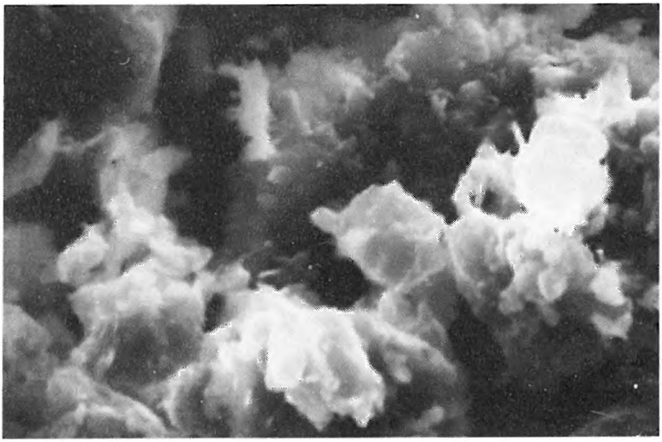
Plate XII

Kaolinite crystals of bundle structure, reflecting resilicification effects in the bauxite matrix

1 Slightly-crystalline kaolinite plates sporadically occurring in the matrix, as well as the bundle structure formed by them
Borehole H 529, 2000X

2 Point analysis of kaolinite crystals, using EDAX (energy-dispersive) micro-analyzer



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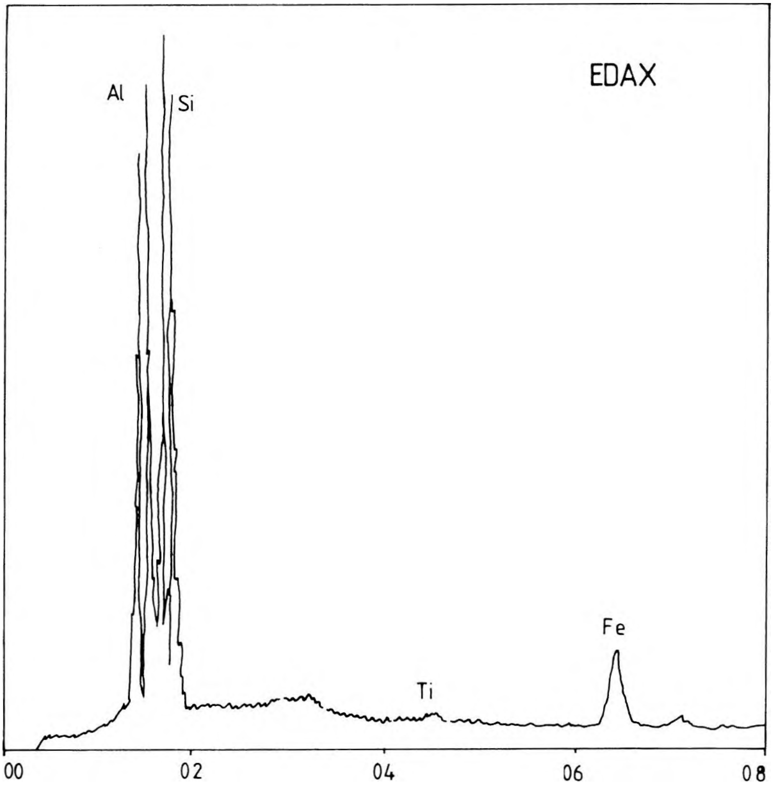

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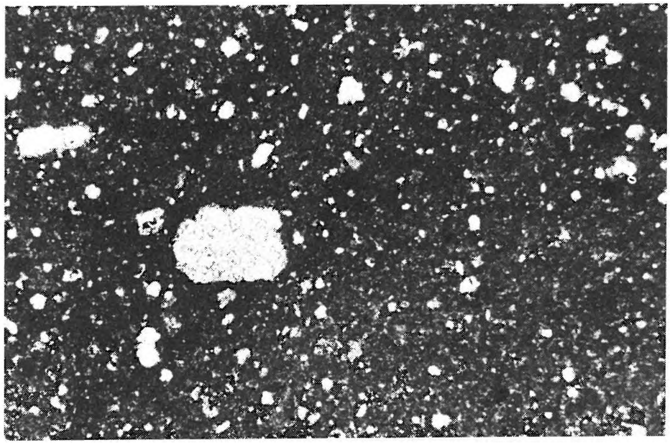
Plate XIII

Characteristic bauxite facies as drilled by borehole H 851

1 Bauxite mudstone with extraclast, from the lower-situated flood basi facies, of borehole H 851 (322.7—324.0 m), 6X

2 Packstone bauxite with extraclast and bauxitic clast. Carbonate grain are angular or slightly rounded
Borehole H 851, 299—300 m, 6X

3 A textural element originating from the syngenetic slumping o deposits: the bauxite with oolitic bauxite clast-bearing and pelitomor phic matrix, found at the top, slumped into the bauxite packstone witl slightly consolidated extraclast, found at a lower level (due to lack o space the figure has been rotated by 90°)
Borehole H 851, 309.3—310.3 m, 6X



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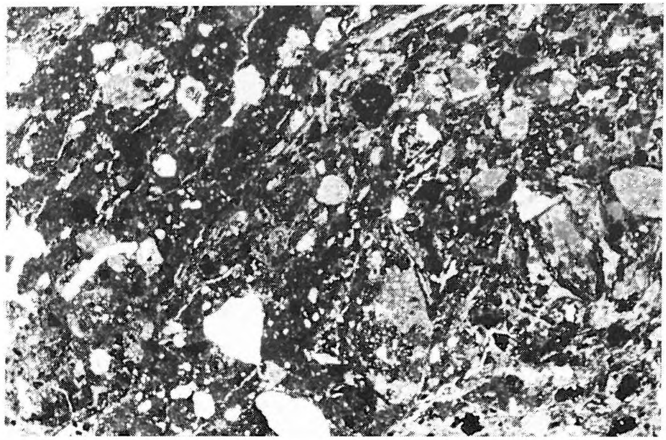

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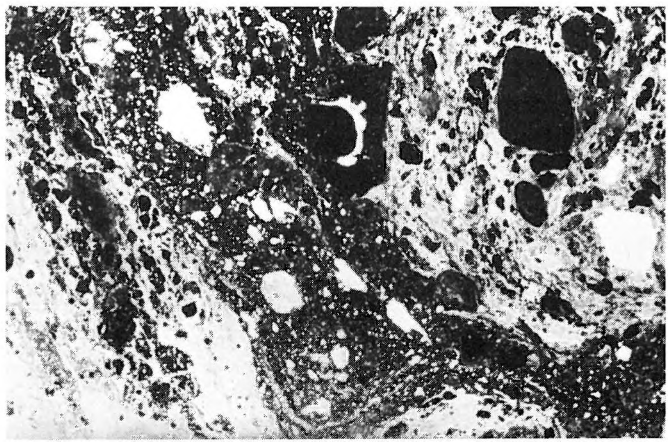

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Plate XIV

Electron-microprobe analysis of the bauxite of channel load facies from borehole H 640

1 Compositional electron-microprobe image. Fe-rich crust-like segregation with Ti content (? leucoxene) in a matrix with Al-Fe-Si content
Borehole H 640, 300X

2 Ti_K X-ray photo corresponding to Fig. 1

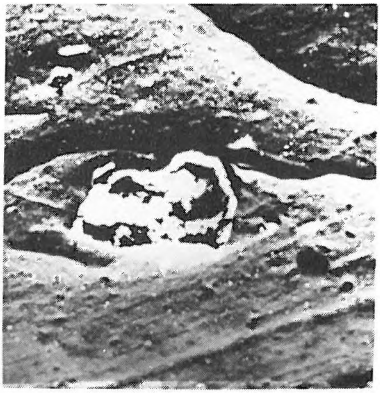
3 Fe_K X-ray photo corresponding to Fig. 1

4 Si_K X-ray photo corresponding to Fig. 1

Pyrite segregations are frequent in the bauxite of flood basin facies exhibiting paludal features also, found at the middle part of borehole section H 640

5 Compositional electron image showing a pyrite pile found in the argillaceous dolomite siltstone
Borehole H 640, 300X

6 S_K X-ray photo corresponding to Fig. 5



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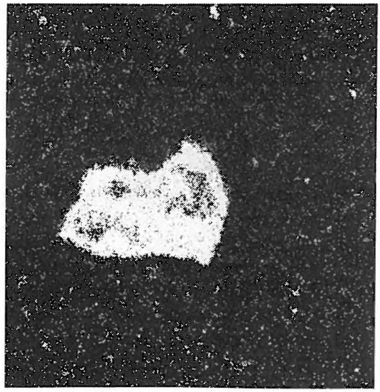

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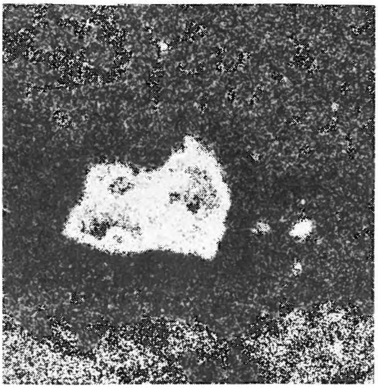

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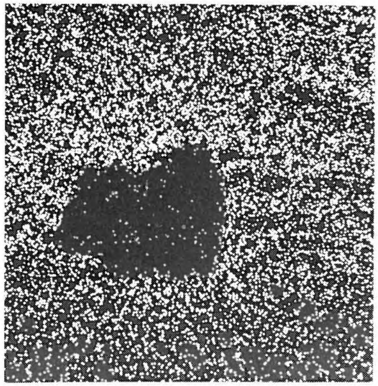

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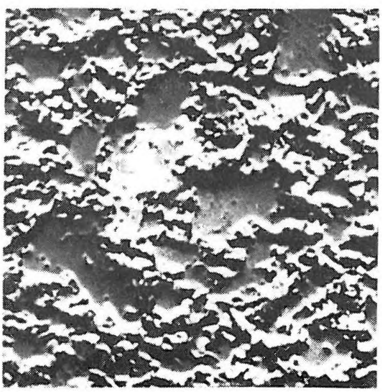

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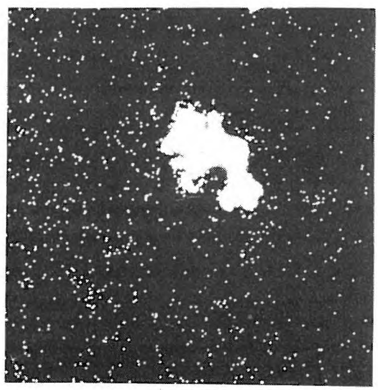

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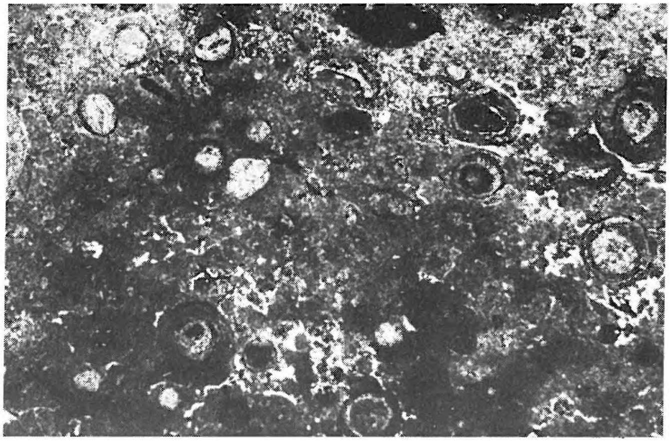
Plate XV

Several textural patterns characterizing the bauxite of flood plain facie
from borehole H 509

1 Bauxite wackestone with ooids and pelitomorphic matrix. The ooid and their detritus are seen on the top to the right in the picture, wit orientated arrangement
Borehole H 509, 301.1—302.1 m, 15X

2 Bauxite wackestone of oolitic and mosaic structure with syngeneti desiccation cracks. It can be observed in the picture that the matrix i deironized along the cracks caused by desiccation. These cracks ar filled, with tight fitting, by small ooids and bauxitic clasts of bauxit material that came in a subsequent phase of bauxite input
Borehole H 509, 287.9—288.9 m, 6X

3 Another similar detail of the former depth interval (magnificatio 15X). The laminated arrangement of micro-ooids flown into the crack caused by desiccation are well visible



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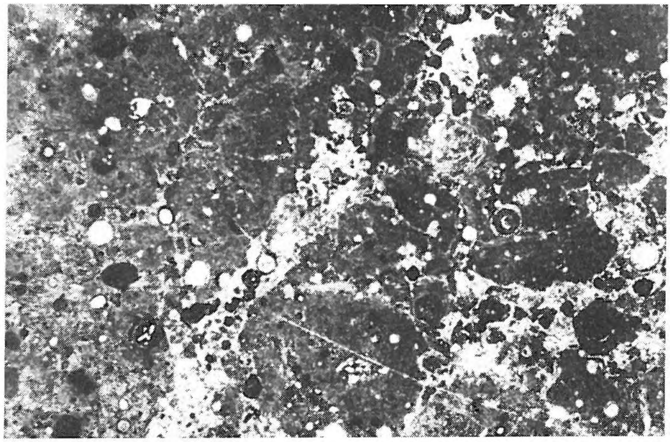

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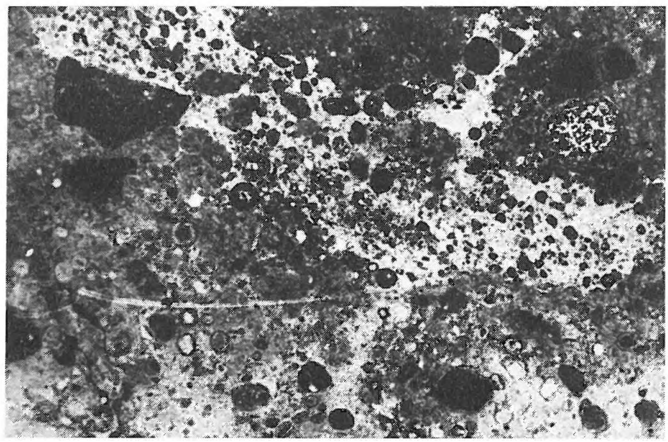

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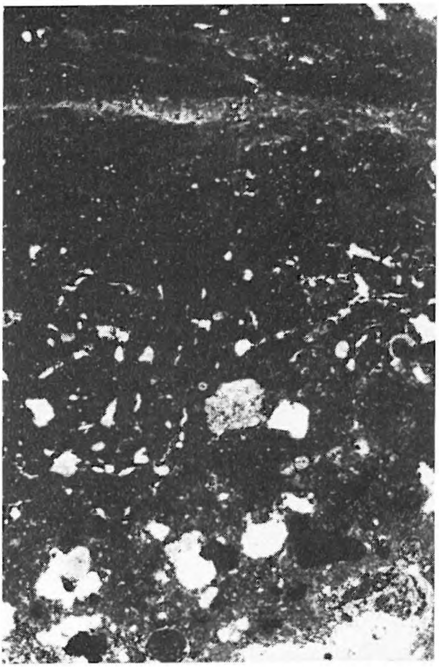
Plate XVI

1 Bauxite wackestone with ooids and bauxitic clasts, from the bauxite o flood plain facies of borehole H 350, where grains exhibit slightl graded lamination
195.4—195.9 m, 15X

2 Carbonate and sulphate impregnations exhibiting the traces of later so lutional migrations that are frequent in an interval ranging from 169.' to 178.0 m of borehole H 350, 6X

3 Bauxite packstone with ooids and bauxitic clast, also with well-segre gated ooids of "Iharkút type", the occurrence of which is frequent a the upper, reworked part of the borehole section
Borehole H 350, 172.9—173.4 m, 6X



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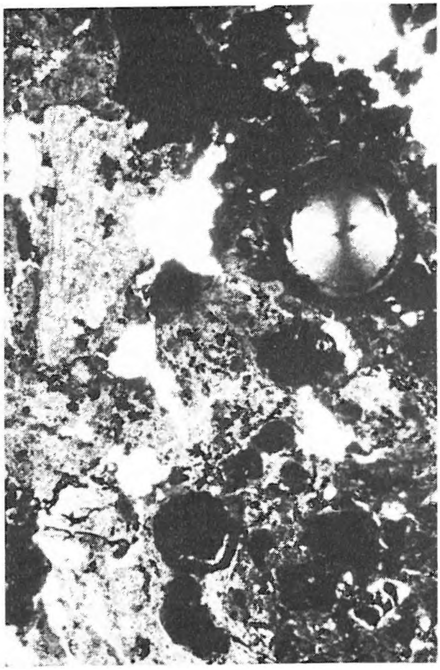

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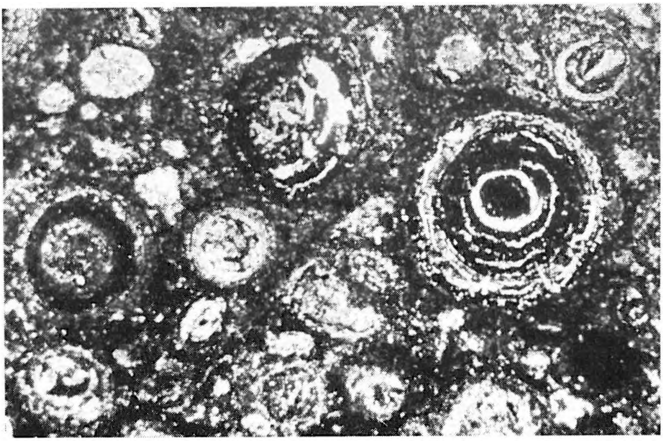

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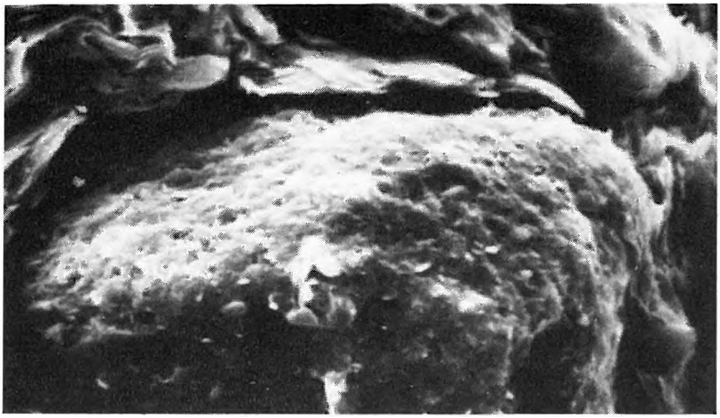
Plate XVII

1 A SEM pattern showing Cretaceous bauxite from borehole H 57 (246.8—247.9 m). The ooid that can be seen in the middle of the pic ture is rich in Fe (see the curve of analysis on Fig. 12), has a compac texture, smooth surface and is rounded. The matrix exhibits a startin crystallization and is gel-like, rich in Si and argillaceous. Their contac surface shows that they were moved near one another by transporta tion
10,000X

2 A SEM pattern of Eocene bauxite from borehole H 570 (224.0—225. m). The matrix is argillaceous, but no kaolinite crystals were formec It has a lower Si content. Grains have a compact texture and roundec smooth surfaces. Their contact surface shows that they were move near one another by transportation
10,000X

3 A micrograph of Eocene bauxite, made under optical microscope bauxite wackestone mosaic texture, with ooids and bauxitic clasts
6X

Fe-rich, well-sorted accretional ooids and bauxitic clasts of Halimba typ are arranged in a laminated way in the pelitomorphic matrix indicatin mosaic structure



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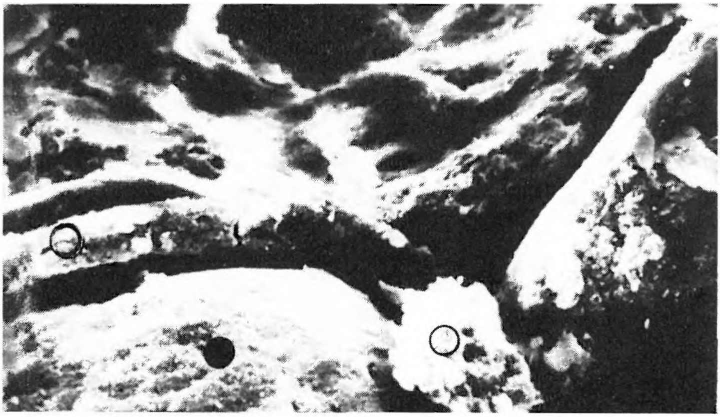

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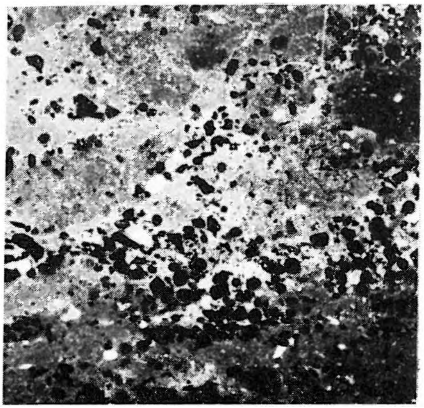

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