Bauxite

by

E. J.-Edelényi

The Sümeg area is situated on the western edge of a more or less continuous bauxite belt extending along the northern margin of the southern Bakony Mts. At present, the westernmost deposits of the paleogeographically controlled bauxite belt are known from here. An added bauxite geological significance of the area is due to the fact that, in addition to bauxites redeposited between younger formations, bauxite deposits are known to occur in two unconformity horizons. The study area belongs to the northwest part of what is called an "area with double bauxite horizon" intensively explored by the Bauxite Exploration Company.

Overlying the karstified surface of Upper Triassic formations, the bauxite bodies are partly covered by Upper Cretaceous sediments and within the same area there are local accumulations of Eocene-covered bauxites sitting in karstic dolinas of the Ugod Limestone.

Exploration history

The bauxite geological significance of the area has been known since 1929, when K. Telegdi Roth, during his prospecting for bauxite on behalf of the Geological Survey, judged the area worthy of detailed exploration, as he had found traces of bauxite on the surface of the Hauptdolomit in the Szőlő-hegy and the Nyírádi-erdő. At the base of the Upper Cretaceous, more precisely under the hippuritic limestone, he did not find any terrestrial formation. Upon exploration projects designed by E. Vadász and T. Kormos, the exploration had started in 1938 under E. Vadász' direction and the Hajnal-hegy and Szőlő-hegy deposits (lenses) thus discovered were soon stripped off. In 1945, after making traverses through the area east of Sümeg, L. Bartkó suggested the presence of a multiple of the bauxite resources known heretofore.

Shallow boreholes spudded in the course of a bauxite-exploration-oriented geological mapping by K. Barnabás in the Halimba–Sümeg area (1951) did not explore any bauxite in the vicinity of Sümeg.

Geological mapping in 1957 directed by J. Noszky detected a bauxite lens of small size in the Kozma-tag subarea. Detailed laboratory analyses of materials sampled from the Szőlő-hegy, Surgó-tag and Kozma-tag deposits were carried out by Gy. Bárdossy (1961). In terms of his results, the Al-minerals of the bauxite resting on the Ugod Limestone are represented primarily by boehmite with which gibbsite is associated in lower quantities, its chemical composition being similar to that of the bauxite from Nyírád. In his opinion, the bauxite was formed in the Turonian and then buried by Senonian formations and after the overburden had been lost to erosion to the beginning of the Eocene, it was redeposited from a rather short distance. Thus, he did not suppose any bauxite formation to have taken place at the beginning of the Eocene.

Upon geophysical measurements in the Sümeg–Csab-puszta area a large-scale exploration by the Bauxite Exploration Company was embarked upon in 1970 in an area forming the continuation of the Nyírád deposit. From the mid-sixties on, the exploration was concentrated in the northwest part of the Nagytárkány deposit and—in addition to the Eocene bauxite horizon—it discovered bauxites underlying Senonian deposits over an area of considerable size. Still going on, the exploration has resulted in the discovery of several bauxite lenses already stripped off by opencast extraction.

Earlier exploration reports on the study area dealt in varying depth with an examination of the bauxite material. In the course of practically-oriented studies, first of all the conventional chemical analyses were carried out, to which a few mineralogical analyses were added. The final exploration reports tackled the question of genesis just tangentially: the post-Upper Cretaceous bauxites were considered to have been repeatedly redeposited.

The reports made in recent years have already dealt in detail with the chemical and mineralogical compositions of the bauxite complex. The intra-deposit variation of the amounts of the "main elements" and their correlations were examined by up-to-date mathematical, computerized techniques and great attention was paid to studying the geological features of the beds immediately overlying the Eocene bauxite sequence.

Lithological, lithostratigraphic and paleogeographic studies of rocks overlying the Upper Cretaceous bauxite sequence were performed by J. Knauer and Mária Gellai (1978) and M. Gellai and F. Ludas (1983), respectively. An analysis of the relationship between the Eocene bauxite and the formations overlying it was carried out by K. Tóth (1980).

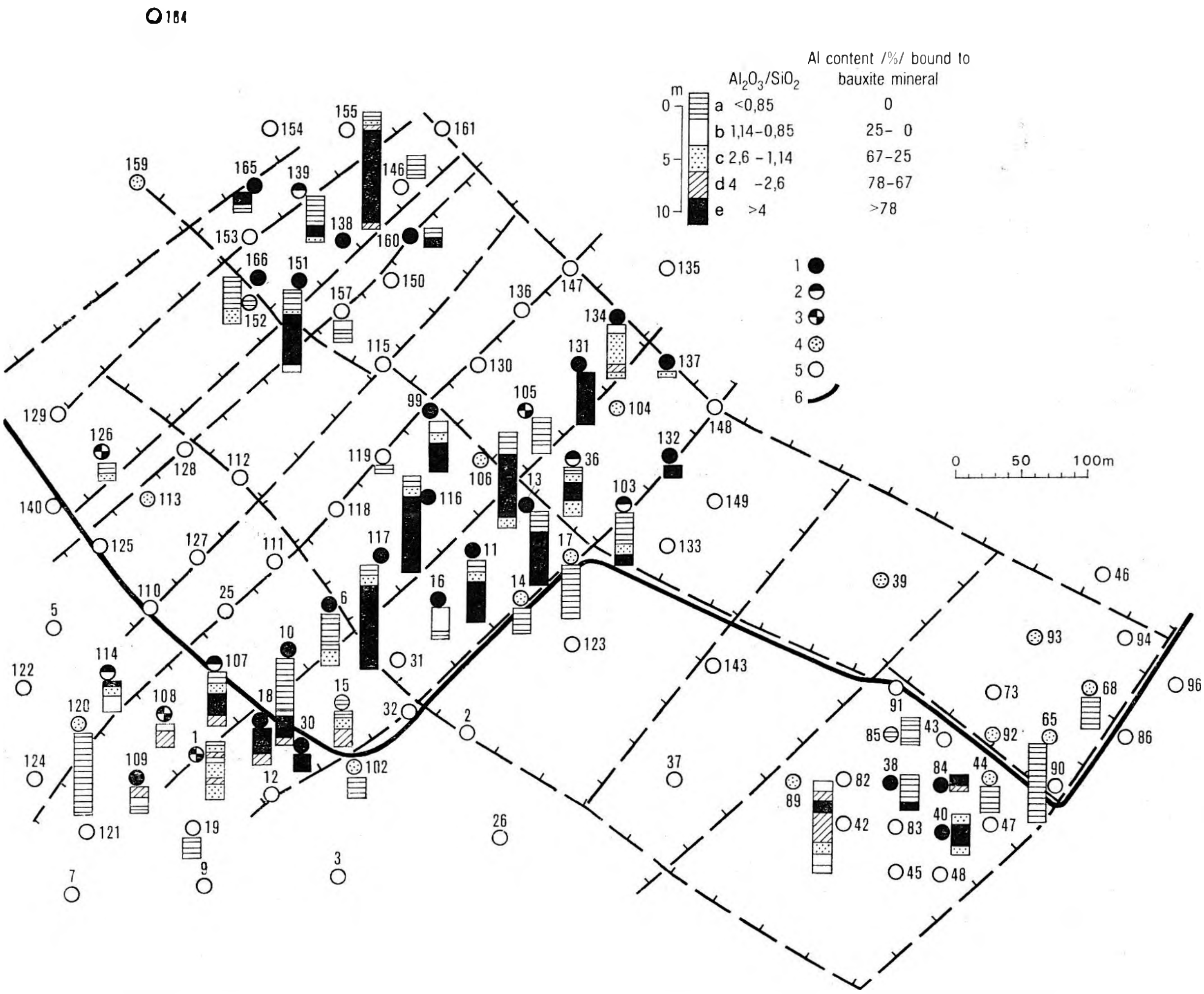

Fig. 63. Structure of the bauxite lenses of Kozma-tag (based on boreholes labelled Ck)
a) clay, *b)* bauxite clay, *c—d)* argillaceous bauxite, *e)* bauxite. — Bauxite lens: 1. its central part, 2. its transitional zone, 3. its marginal zone; 4. argillaceous zone surrounding the bauxite lens, 5. no bauxite cut in the borehole, 6. southern boundary of extension of the Eocene

The other important subarea is the vicinity of Csab-puszta, where several lenses are known, a few of which, rather small in size, occur still within the study area. In these lenses the maximal thickness of the bauxite exceeds ten metres, being even more in the lenses outside the study area. Here the bauxite sequence locally contains some interbedded layers of carbonaceous clay. Its immediate overburden is constituted, according to the data available, by light grey to greenish-grey marls with interbedded conglomerate layers which are overlain by the Ajka Formation.

The weight percentages of the main components of the bauxite-bearing sediments are shown by the results of their chemical analysis for five components (Al_2O_3, SiO_2, Fe_2O_3, TiO_2 and loss on ignition). Although the given sections are characterized by a variation of the main chemical components, they are suitable for a comparison of the particular sequences, but they give little reference to the genesis. Most essential feature of the bauxite-bearing sediments giving the greatest number of clues to an understanding of the genetic circumstances is, in our opinion, the progress of the bauxitization process. Information on this is provided, if the formation of the bauxite minerals from clay minerals be postulated, by the proportion of Al bonded to clay minerals or bauxite minerals, respectively.

In the lenses of Csab-puszta it is often a grey or yellow argillaceous rock that occurs at the base of the bauxite sequence. It is overlain by bauxitic clays or argillaceous bauxite in which the total Al content in an oxy-hydroxide form attains a maximum of 25% or 78%, respectively. This is followed, higher up the profile, by the bauxite part of the bauxite complex in which more than 75% of the total Al content is connected with bauxite minerals. The thickness of this subunit is generally proportional to the thickness of the whole bauxite sequence and at the top of the sequence again a thin subunit of lower bauxite content can be observed.

According to the mineralogical analyses performed by the Bauxite Exploration Company, the predominant bauxite mineral is boehmite, while gibbsite occurs in subordinate quantities. The mineralogical composition has been computed by means of the method proposed by Gy. Bárdossy (1961) from the chemical composition of the material of a few boreholes for which the results of mineralogical analyses have not been available. The calculation method is based on the assumption that the total SiO_2 present in a particular sample is connected with clay minerals. By calculating the clay mineral content of a sample the proportion of Al bonded to clay- or bauxite minerals, respectively, as compared to the total aluminium content can be determined. The ratio of Al bonded to bauxite minerals to the ("free") water deriving from the loss on ignition (i.e. not connected with clay minerals) gives information on the oxy-hydroxide or trihydrate character of the bauxite minerals, i.e. on the gibbsite: boehmite ratio.

According to our calculations too, boehmite is the predominant bauxite mineral, but gibbsite is present in a considerable amount, too. In some places, in the upper part of the sequence, both occur in nearly equal proportions. The material of boreholes located on the margins of the lens is characterized first of all by the prevalence of gibbsite.

Nyírád Bauxite Formation

In the Sümeg area the Eocene-covered bauxite deposits are of greater importance as compared to the case of the Halimba Formation.

The Nyírád Bauxite Formation includes the occurrences at Csab-puszta in the northeast part of the study area which show partly the same areal extension as the Upper Cretaceous bauxite occurring there. On the edge of the study area is the bauxite lens Csab-puszta-I in which the substratum of the bauxite is constituted by the Ugod Limestone and which is overlain, in a thickness of a maximum of 10 m, by pebbles, argillaceous pebbles and conglomerates belonging to the Oligo-Miocene Csatka Formation. The greatest thickness of the bauxite sequence is observed in the boreholes located at the centre of the lens, composed overwhelmingly of bauxite. In some places, a thin bed of bauxitic clay and argillaceous bauxite occurs at the base of the section. In the boreholes a thin bed of argillaceous bauxite, followed by clays, can be generally found. In the boreholes put down to the east or west of the central zone the thickness of the bauxite sequence is considerably smaller. Here the most strongly bauxitized rock in the sections is bauxitic clay, but its quantity is subordinate, being overwhelmed by clays. In boreholes located on the edges of the lens it is already but a thin clay bed that has replaced the bauxite sequence.

The mineralogical composition may be outlined—partly in the light of calculations from the chemical analyses—as follows:

In the boreholes giving the thickest section the bauxite minerals are represented by boehmite

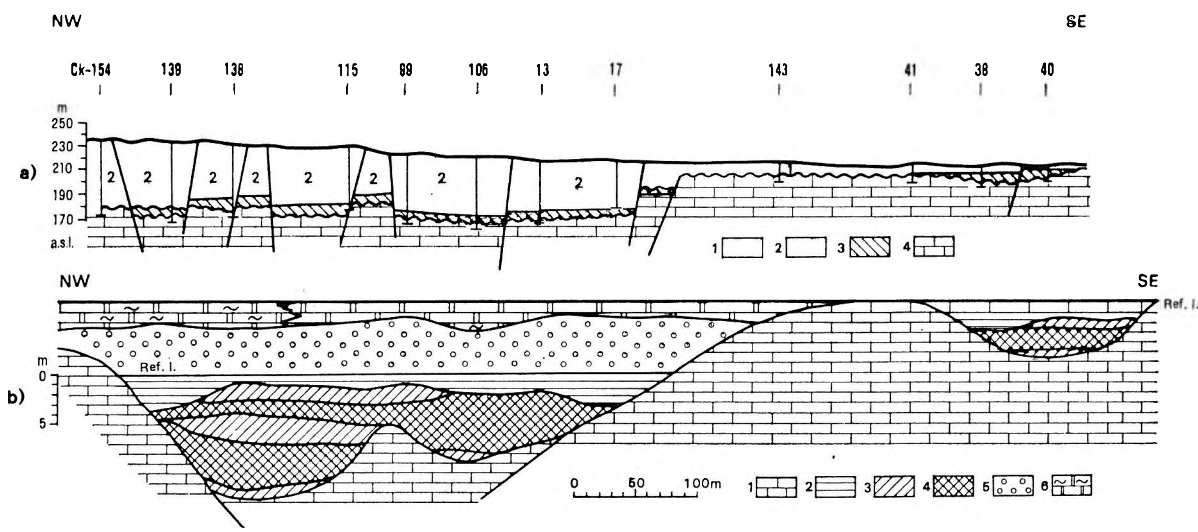

Fig. 64. Profiles across the bauxite lenses of Kozma-tag (*a*) present-day situation, *b)* reconstructed image as of Middle Eocene time)

Profile a): 1. Oligo-Miocene Csatka Fm., 2. Middle Eocene, 3. bauxite sequence, 4. Upper Cretaceous Ugod Limestone Fm. — *Profile b):* 1. Upper Cretaceous Ugod Limestone Fm., 2. clay, 3. argillaceous clay, 4. bauxite, 5. Middle Eocene Haraszt Member, 6. Middle Eocene Szőc Limestone Fm. (represented by limestone and/or calcareous marl). — *Ref.l.* reference level: top of the bauxite sequence and gibbsite, and, in general, a slight prevalence of gibbsite is conspicuous throughout the sequence. The mineralogical composition of the bauxite-bearing part of boreholes of marginal position is similar. In some sequences of maximal thickness the lower two-thirds of the sequence still show the predominance of boehmite, but at the top exclusively gibbsite occurs.

Very important from the bauxite geological viewpoint is the Kozma-tag subarea, where more than ten bauxite lenses are known. The two largest lenses within the study area (Fig. 62) show the following characteristics: the bauxite in both lenses is underlain by the Ugod Limestone, but the original Eocene-overlying beds are preserved in the northern part of the lenses only. The bauxite in the larger lens farther west is underlain by gravels and conglomerates from the argillaceous matrix of which *Miliolina* is often recorded. Its thickness varies between 3 and 11 m. Above this, in the northwestern part of the lens, argillaceous limestones occur in a few metres of vertical distance, while in the southeast it is immediately the limestone beds of the Szőc Formation that follow. On the other, smaller lens the immediate overburden is represented by the Szőc Formation. In the southern part of the lenses the bauxite is covered by Miocene gravels or Pannonian formations, respectively.

The maximal thickness of the bauxite sequence in these two lenses is 11 m. The thickness of the bauxite and the overburden formations and the geological features of the latter are shown in Fig. 62, the geology of the bauxite sequence being illustrated by Fig. 63. In the central part of the larger lens the overwhelming part of the sections is represented by bauxite in which the Al content is fixed in more than 78% in bauxite minerals, the percentage of "free" aluminium in most cases being above 91%. The sequences composed for the most part of bauxite show a high Al_2O_3 and a low SiO_2 at the very base of the section already, but in some places—almost exclusively in boreholes located in the zone of transition to the edge of the lens—the basal half metre to one metre and a half is constituted by argillaceous bauxite. In the upper part of the bauxite sequence a reduction in Al_2O_3 and an increase in SiO_2 are conspicuous; the uppermost one or two metres being composed of clays.

The transition is generally continuous and the bauxite is overlain by half to one metre of argillaceous bauxite. The sharp change in lithology observable without any transition in some profiles appears to us to be just an apparent phenomenon due to formation thicknesses smaller than the density of sampling (in these boreholes the analyses were carried out at 1 m intervals).

In some boreholes even the very top of the bauxite sequence is represented by bauxite. As evidenced by the profiles plotted, however, these boreholes have not exposed the upper part of the bauxite sequence owing to tectonic causes. In the southern part of the lens, in turn, there are a few boreholes indicating that the upper part of the bauxite sequence is lost to erosion, as the bauxite of good quality is overlain by the Oligo-Miocene Csatka Formation rather than by an Eocene bedrock.

That the lens is heavily affected by tectonic deformation was already mentioned. Consequently, the structure and lithology of the original deposit's marginal part can be studied primarily on the southeast side, but, as indicated by some boreholes, a similar makeup is to be expected on the northwest side as well. On the southeast side the central part of the lens is accompanied by a strip of a hundred to a hundred and fifty metres width in which no bauxite can be found. The most desilicified rock variety itself is merely an argillaceous bauxite. In rocks of this kind, as a rule, 25 to 67%, less frequently, 67 to 78%, of the aluminium content is linked to bauxite minerals. The sequences show geological features similar to those in the central part.

In some boreholes, sections showing a transition between the geological pattern typical of the deposit's centre and of its marginal zone can also be observed.

Over much of the southeast lens of considerably smaller size, the Eocene overburden is lost to erosion, the bauxite sequence being covered by Oligo-Miocene gravels. Denudation has removed a large part of the bauxite lens itself, the denudation boundary being located in the central part of the lens (Fig. 62). The geological features observable in the larger lens are recognizable here too and a bauxite body of essentially smaller original extension and thickness can be delineated (Fig. 62 and 63).

Mineralogical analyses from these two Kozma-tag deposits have been made in a low number, so that the mineralogical composition that we can discuss here is primarily one calculated from the relevant chemical analyses. From among the bauxite minerals, gibbsite and boehmite can be found throughout the two lenses, but the prevalence of gibbsite is characteristic. No vertical trend in the section is observable. What is conspicuous laterally is that in the boreholes of the marginal zone the predominance of gibbsite is more significant than it is in the case of the profiles from the central part. On the basis of the few mineralogical analyses the clay minerals are represented by kaolinite, except for the upper part of the profiles, where montmorillonite appears and, less frequently, illite was observed, too. Fe-minerals are usually represented by hematite, goethite was observed in such samples in which gibbsite was present in a considerable quantity, too.

From the material of the lenses the Bauxite Exploratory Company made some spectral analyses as well. None of the trace elements shows any marked deviation compared with other Hungarian bauxite deposits.

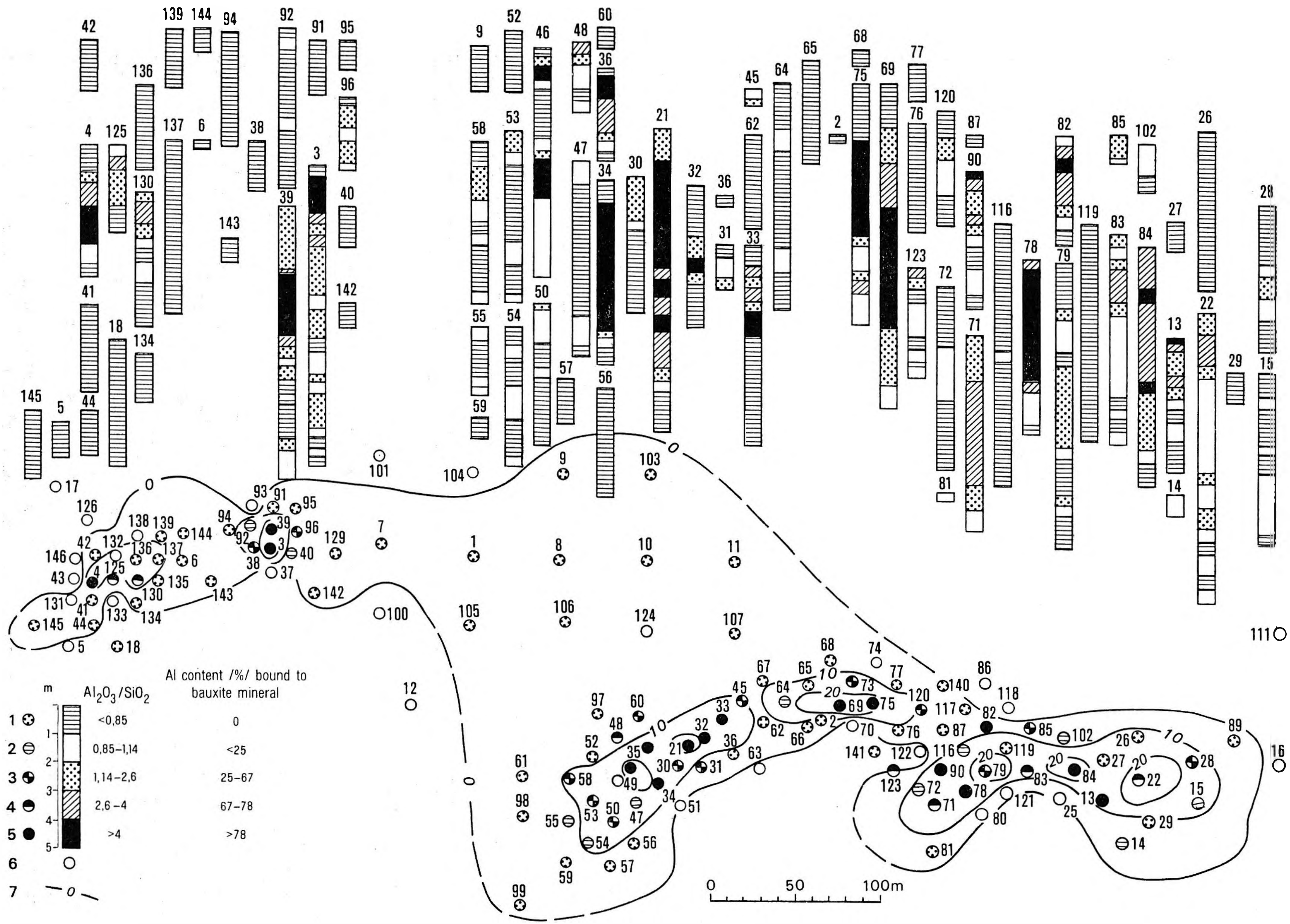

Fig. 65. Thickness and geological features of the bauxite lens in the lens of Surgó-tag (based on the boreholes labelled Sg)

1. Clay, 2. bauxitic clay, 3—4. argillaceous bauxite, 5. bauxite, 6. no bauxite cut in the borehole, 7. thickness of the bauxite sequence (m)

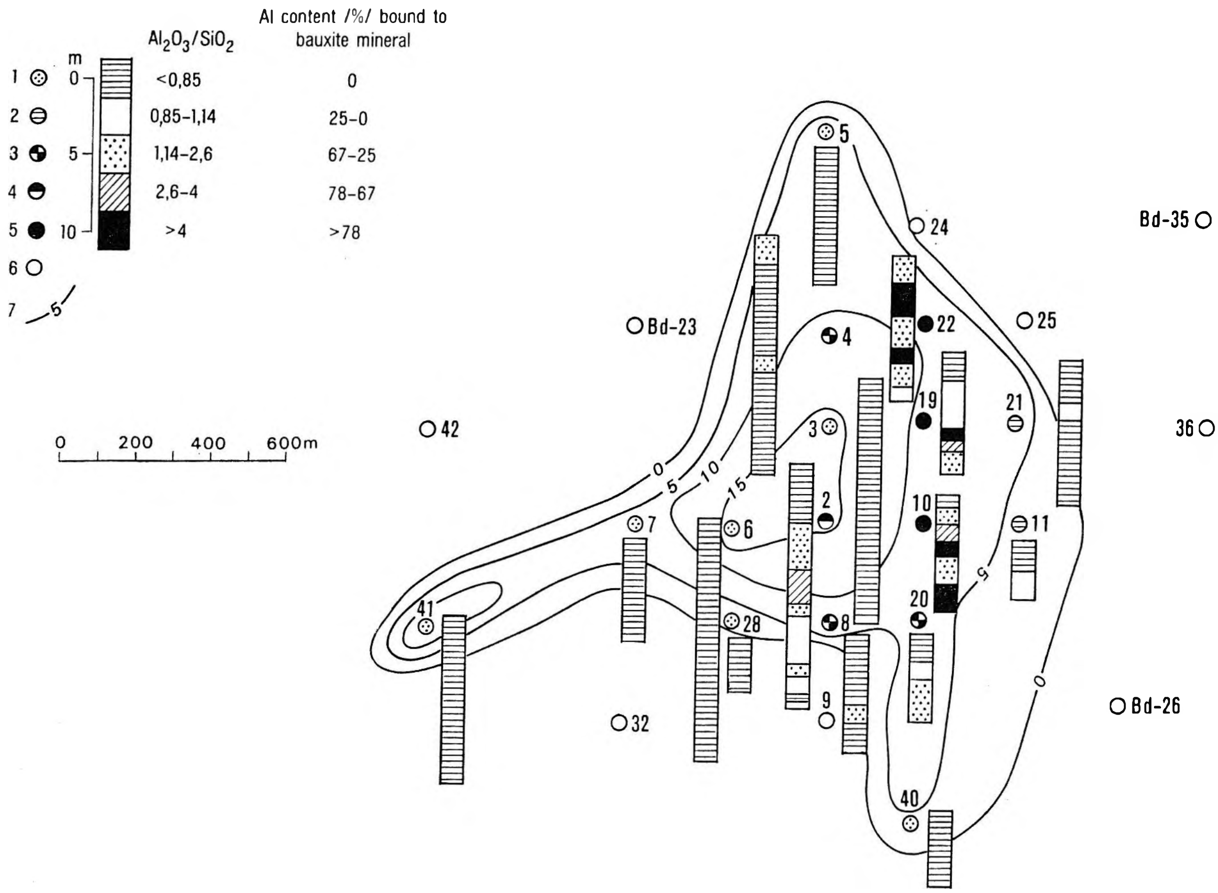

Fig. 66. Thickness and geological features of the bauxite lens of Bárdió-tag

(For other symbols, see Fig. 65.)

As far as the relationship between the geological features of the bauxite body and its overburden are concerned, the fact is that the greatest thickness of the bauxite sequence and, consequently, the best quality has evolved in that subarea, where above the Eocene conglomerate directly covering the bauxite, calcareous marl beds are deposited. The marginal zone coincides for the most part with that zone, where the gravels are directly overlain by limestones (Szőc Formation). A bauxite of more reduced thickness and poorer quality is found in the southeast subarea, where the bauxite sequence is immediately overlain by limestone beds (Fig. 64).

The formation includes the bauxite stripped off in the 1940's by open-pit mining in the József I mine the geological features of which can be formulated primarily in the light of data from the literature (E. VADÁSZ 1946, GY. BÁRDOSSY 1961). The bauxite sequence is underlain by the Ugod Limestone and overlain, in the western part of the deposit, by Eocene sandy clay and sand above which the Szőc Formation occurs. (The Eocene sequence in the eastern part of the lens is lost to erosion, the overburden here being composed of Quaternary formations.) The thickness of the bauxite sequence in the central part of the lens was 7 to 10 m. In terms of descriptions, the bauxite was situated above a few metres of bauxitic clay and argillaceous bauxite and was overlain again by an argillaceous bauxite attaining a maximum of 1 m in thickness. In the lower part of the section, from among the bauxite minerals, gibbsite and boehmite were present in equal quantities, but in the bauxite and the argillaceous bauxite of the upper part a remarkable boehmite prevalence was conspicuous.

Similar geological features are quoted from the József II—a bauxite deposit stripped off similarly. The only difference is restricted to one feature, the original Eocene overburden being completely lost to erosion and the bauxite having been covered by Quaternary sediments.

The last two lenses are situated in karstic dolinas formed along a NE-SW trending line of tectonic control. The same line is joined by the fissure in the Gerinc quarry, a fissure filled with bauxitic clay which is overlain by Eocene formations confined to a patch that has escaped denudation (Plate XLIII, Fig. 1).

The bauxite lens of Surgó-tag lies in a NE-SW oriented depression of tectonic control (Plate XLIII, Fig. 2). The bauxite sequence is underlain by sandy clay and gravels, less frequently, by conglomerates. These formations, however, attain only a few metres in thickness (an average of 1 to 2 m and a maximum of 6 m). The sequence is overlain, as a rule, by a little sandy, less frequently, gravelly, clays. The sandy clays, as a rule, are directly superimposed to the sequence. In some boreholes, however, the immediate overburden is constituted by gravels. In the upper part of the bauxite sequence thin sand and gravel intercalations were often observed.

The bauxite sequence of the lens of Surgó-tag is composed predominantly of clays, bauxitic clays and argillaceous bauxites. Bauxite is found in a few boreholes only, locally interrupted by strips of varying thickness and lower quality (Fig. 65). Under and above the bauxite-composed interval there is some argillaceous bauxite or, less frequently, some bauxitic clay, but in some places the immediate overburden is clay. The boreholes, which have penetrated bauxite too, do not fall in the thickest parts of the lens. The boreholes put down in the immediate vicinity of these have exposed argillaceous bauxite or bauxitic clay, but in some places only rocks free from bauxite minerals were cut by the drill. The mineralogical composition of the lens, as inferred from chemical analyses, has yielded the following characteristics: gibbsite and boehmite are present throughout the bauxite sequence. In the bauxite rock type, as a rule, the prevalence of boehmite is characteristic: the argillaceous bauxite and the bauxitic clay show alternatively now the prevalence of gibbsite, now that of boehmite, the alternation in some sections being quite frequent (locally at intervals of 0.5 to 1 m).

The X-ray analyses performed by the Bauxite Exploration Company have shown the almost exclusive presence of boehmite and only traces of gibbsite. The discrepancy between the calculated and observed gibbsite quantities seems to be due to the fact that during the chemical analysis generally no CaO determination was carried out. Consequently, the analysts were unable to take into consideration the CO_2 bonded to calcite from the loss on ignition and so the calculated gibbsite quantity gave a value that was higher than the factual one.

Judging by the results of spectral analysis, in the trace element content there is no note-worthy difference as compared to the other Hungarian bauxites. Relating to the bauxite of the Nyírád–Nagytárkány area, the BeO, Ga_2O_3, ZrO_2, CuO and Cr_2O_3 contents are a little bit lower here. As shown by analyses for impurities, CaO, MgO, P_2O_5 and S are present in very low quantities.

The Bárdió-tag lens is likewise situated in a tectonically pre-formed dolina of the Hauptdolomit (Fig. 66). It is overlain, in a thickness of a few metres—a maximum of 27 m—by Oligocene to Lower Miocene formations. The lens was stripped off by openwork and, as a result of those efforts, the beds of the overburden could be readily studied. The bauxite is directly overlain by coarse abrasion conglomerates of Badenian age followed, in turn, by 3 to 4 m of gravels that are overlain by the Fertőrákos Limestone Formation.

The bauxite sequence varies in thickness and quality, rock detritus, sand and gravel intercalations being quite frequent. The texture indicates quite clearly the presence of redeposition, as bauxite debris of varying grain size (0.5 to 10 cm in diameter) are observable in a matrix composed of clay and bauxitic clay.

The sequence is composed for the most part of argillaceous rocks, while rock that may be identified with bauxite occurs in a low thickness, in a few boreholes only. The bauxite subunits within the sequence are distributed at random, being interrupted as a rule by intervals characterized by a bauxite of lower quality. Under and above the bauxite there are ordinarily argillaceous bauxite accumulations, though, in the immediate overburden, bauxitic clay occurs, too. No mineralogical analysis of the rock material has so far been carried out. The predominant bauxite mineral is, as inferred from the chemical analyses, boehmite, though gibbsite occurs throughout the sequence too, moreover, in some places—generally in the lower parts of the sections within the argillaceous bauxite or bauxitic clay deposited there—it may even acquire a marked prevalence. In some places, the amount of CaO is rather high (1 to 7%).

Between the Városi-erdő and the Szőlőhegy, in the Nyelőke subarea, 2.2 m of dolomite was exposed in the borehole Süt-11, overlain by a bauxite that is covered by Pannonian formations. The bauxite mineral is predominantly boehmite, subordinately gibbsite. The ore is overlain by 4 m of variegated, a little-bit sandy clay which then grades into sandy clays.

Paleoenvironment

Having reviewed the major bauxite occurrences in the Sümeg area, now in the light of the mode of superposition, the geological features and the spatial characteristics of the bauxite sequence, we may conclude that in the study area bauxite formation took place in two periods—the Late Cretaceous and the Eocene; consequently, at that time the accumulation of the bauxite's source material and the bauxitization process took place too. Bauxitic rock types would accumulate even later, but then the process would be restricted to removal of earlier-deposited, bauxites from their original site and their reaccumulation.

According to the karstic bauxite accumulation model of the Transdanubian Central Range, a model accepted by the majority of the specialists, the source material of the bauxite was a product of lateritic weathering of magmatic and metamorphic rocks exposed to a humid, tropical to subtropical climate.

In the Transdanubian Central Range's tectonic zone, Paleozoic formations suitable for lateritization were exposed on the margins of a syncline produced by the Austrian and pre-Gosau movements of the main Alpine folding phase, having been uplifted to hundreds of m of altitude a.s.l. Well-known climatic prerequisites for lateritization are mean annual temperatures of 20 to 26 °C, 1,500 mm of annual precipitation and an alternation of a rainy season with a drier one of 1 to 4-months duration (Gy. Bárdossy 1977). According to the results of palynological analyses (F. Góczán 1973) and the isotopic paleotemperature measurements (I. Cornides et al. 1975), the climatic conditions were suitable for this pupose in Albian, Santonian and Campanian and then in Paleocene to Early Eocene times when the area involved belonged to a tropical-subtropical climatic zone with one precipitation maximum.

In accordance with the synclinal structure, a zone of lower topographic position, a few tens of km wide, composed of Mesozoic sedimentary rocks was adhering to the marginal zone. In that zone no younger Mesozoic formations had been formed or, if they had, so they were removed by an intensive denudation and Upper Triassic limestones and dolomites liable to karstification were exposed to daylight and their karstification progressed considerably owing to the favourable climatic conditions.

The laterite material from the flanks was transported upon continuous erosion towards the centre of the syncline, to the deeper-situated areas, and was accumulated in the karstic traps of the carbonate subarea. The carbonate substratum provided the prerequisites for the desilicification and Al-enrichment processes, and for the development of an oxidative Eh, a slightly alkaline pH and a good drainage of the water. Naturally, since the area was a kind of denudation terrain, continuous denudation removed from it even the bauxites already accumulated. However, upon epeirogenic subsidence, this denudation terrain gradually became an area of accumulation. Its central zone, that was deepest even originally, became first a terrestrial sedimentary basin and then gradually developed into a marine one. This succession of processes led to completion of the bauxite accumulation process and, at the same time, to the burial of the bauxite bodies. Deposits belonging to the oldest, Albian, bauxite generation horizon known from the Transdanubian Central Range cannot be detected in the study area. This is due to the absence of formations of the Albian cycle to the west of Padragkút. Thus, even if an accumulation of bauxites did take place at the beginning of the Albian, the resulting deposits seem to have been lost to intensive pre-Late Cretaceous denudation.

The oldest bauxite horizon detectable in the Sümeg area is the Halimba Bauxite Formation appearing at the base of the Late Cretaceous sedimentary cycle.

The general sedimentation circumstances that evolved at the beginning of the Senonian are discussed in detail in the chapter devoted to the Upper Cretaceous formations. In the same chapter, the relation of the bauxite to the other basal Senonian formations are analyzed, too. The relations of the Halimba Formation, the terrestrial sediments and the Ajka Formation suggest that the bauxite was deposited simultaneously with the terrestrial and paludal formations generated in the initial, heavily oscillative, period of the Senonian cycle, but its deposition took place under different conditions at the time of a minor, local regression. The sedimentary material of lateritic origin, that had reached to a bauxitization phase impossible to determine exactly, seems to have been transported to its final site of accumulation by intermittent water flows or torrential streams. The mode of transport of the material being not exactly known, it may have been transported in form of a kind of mud-flows or colloidal solutions.

In the local sedimentary basin the bauxitization continued and came to completion and the final minerological composition of the rock was attained. That these processes played an important role is indicated by the trends of variation in composition. The bauxitization process progressed at the most rapid rate in the central part of the local sedimentary basin, where the basin was deepest and the accumulated sediment thickest.

In these places, as a rule, the sections are composed as a whole of the bauxite rock type. On the margins of the sedimentary basin the argillaceous bauxite to bauxitic clay facies indicates that there the bauxitization process was less complete. Given the relatively small size of the sedimentary basin, the conditions for bauxitization seem to have been identical in both the central and the marginal parts of the basin. The only essential difference is supposed to have consisted in the span of time during which the bauxitization process had to take place. The material of reduced thickness on the edges of the lens—both after the arrival of the material and the subsequent tropical rains—seems to have been emplaced during a shorter span of time than it was the case with the central part of considerable thickness. In other words, the possibility for bauxitization on the margins ceased to exist sooner. (Recently, some laboratory experiments have called attention to the important role played by the time factor in the bauxitization process too: see Gy. Bárdossy 1977.) The predominantly boehmitic, subordinately gibbsitic, composition of the bauxite sequence indicates that the bauxitization process must have taken place under less oxidative conditions and in a less efficient regime of drainage. The predominance of gibbsite on the lens margins too suggests that these parts must have been better drained. In Beneslavski's opinion (in Gy. Bárdossy 1977), if the source material is an amorphous, complex Al-Fe-Ti-Si gel, so mainly cryptocrystalline boehmite is formed.

The thin layer composed of clay minerals at the base of the bauxite sequence seems to have been formed in that part of the sedimentary basin underlying the groundwater table, where the drainage of the solutions was not granted and the bauxitization process in the reductive environment could not evolve. The presence of more oxidative conditions and better drainage in the upper part of the sedimentary basin is indicated by the fact that the gibbsite: boehmite ratio increases as one proceeds upwards in the sections. On top of that, after burial of the bauxite, the infiltrating groundwater provided possibilities even for the hydratation of boehmite. The bauxite formation in the study area was put an end by a minor latest Santonian transgression, as the permanent water coverage cancelled the conditions favourable for bauxitization. The differential movements that can be revealed in the subsequent history of the study area did not cause anymore a regression that might have again enabled the formation of bauxite enduring the Late Cretaceous. Only a redeposition of debris from the earlier-formed bauxite could take place during the formation of the "Kozma-tag member" (M. Gellai–F. Ludas 1983).

The tectonic movements that closed the Late Cretaceous sedimentary cycle resulted in a new phase of emergence and erosion during which, on the margins, a part of the Senonian sediments was removed and even the Ugod Limestone of good karstification characteristics was exposed. At the beginning of the new—Eocene—sedimentary cycle, the conditions necessary for bauxite formation were again available, similarly to the case of the initial period of the Senonian sedimentary cycle. The temperature—after a cold spell at the end of the Senonian—rose again to the proper level (F. Góczán 1973). In the Kozma-tag subarea, on the basis of the oldest Eocene formations covering the bauxite (conglomerate member and Szőc Limestone, respectively), a deeper-situated northeast subarea and a relatively elevated, southwest subarea can be outlined. The difference in altitude between the two subareas may not have been too much in absolute values, but from the viewpoint of accumulation of bauxitic sediments it did play a decisive role. A particularly important role may be ascribed to the NE-SW-oriented faults separating the two subareas, because the bauxite-accumulating karstic depressions were formed primarily along them. The material on the way of bauxitization was probably transported from the relatively elevated limb that lay to the south to southeast, the transportation medium having been represented by intermittent streams or intensive sheetwash. The bulk of the bauxite accumulated in the dolinas was not a redeposited product formed in a bauxitization period. The character of constitution of the deposit and the trends of variation in the mineralogical composition suggest that the sediment transported into the dolinas was considerably altered, bauxitized, after being deposited there (Kozma-tag).

In the more elevated subarea a less significant bauxite accumulation seems to have taken place, the bulk of the material having been transported to the deeper subarea owing to the difference in altitude. After accumulation, prior to inundation or dessication, respectively, a desilicification, i.e. aluminium concentration process set in. In each sedimentary basin the most intensive accumulation of bauxite occurred in the central part, where the sediment was the thickest. In basin parts with small thickness of sediment a more rapid dessication left less time for the bauxitization process to take place in full. A more rapid percolation and elutriation is suggested by the gibbsite-dominated composition on the margins of the profile, too.

The mineralogical composition of the Eocene bauxite indicates that this was formed under more oxidative circumstances than it had been the case with the Senonian bauxite, as the bauxite minerals are represented by gibbsite and boehmite present in nearly equal proportions.

A continued subsidence of what is now the study area led to a transgression of the sea: detrital sedimentation set in and the conditions for bauxitization ceased to be available. After Eocene time, circumstances suitable for bauxitization have never evolved anymore. In the periods of emergence, of course, sizeable amounts of bauxite may have been lost to erosion or, respectively, partly accumulated in the dolinas of the Upper Triassic and Upper Cretaceous rocks exposed. Such a redeposition must have taken place before the Badenian transgression (Bárdió-tag, Surgó-tag), but red clay sediments deriving from bauxites can be found both above the Badenian sediments and below the Lower Pannonian beds.

BIBLIOGRAPHY

Barnabás K. 1951: Jelentés az 1950. évben Magyarországon a Halimba–Nyírád–Sümeg körzetben végzett bauxitkutató munkálatokról. — Data Base of the Hung. Geol. Inst. Manuscript.

Baross G.–Károly Gy.–Mátéfi T.–Molnár P. 1980: Bauxitkutatási eredmények, további feladatok. — A „Bauxitkutatási szakmai napok" előadásai. Spec. publ. MAT. Budapest.

Bárdossy Gy. 1961a: A Sümeg környéki bauxit. (The bauxite of the surroundings of Sümeg.) — Bány. Lapok 7.

Bárdossy Gy. 1961b: A magyar bauxit geokémiai vizsgálata. (Examen géochimique des bauxites hongroises.) — Földt. Int. Alk. Kiadv.

Bárdossy Gy. 1977: Karsztbauxitok. — Akad. Kiadó, Budapest.

Bárdossy Gy. 1981: Karstovye boksity. — Moscow.

Cornides I.–Császár G.–Haas J.–Jocháné Edelényi E. 1975: Oxigén izotópos hőmérséklet mérések a Dunántúl mezozóos képződményeiből. (Temperatur measurements of Transdanubian Mesozoic rocks by the oxygen isotope method.) — Földt. Közl. 109 (1).

Czabalay L.–Gellai M. 1981: Szenon csigák csabrendeki bauxitkutató fúrásokból. (Senonian Gastropods from bauxite exploration boreholes of Csabrendek.) — Földt. Közl. 111 (2).

Gedeon T. 1933: Adatok a sümegi bauxitelőforduláshoz. (Daten zur Kenntnis des Bauxitvorkommen in der Gegend von Sümeg.) — Földt. Közl. 63.

Gellai M.–Ludas F-né 1983: Adatok az Ugodi Mészkő Formáció és a Jákói Márga Formáció bázisrétegeinek megismeréséhez. — Földt. Közl. 113 (2).

Góczán F. 1973: Comparative palynology and the paleoclimate of bauxite formation. — Ősl. Viták 21.

Knauer J.–Gellai M.-B. 1978: A szenon képződmények elrendeződése és kapcsolata az ősdomborzattal a sümegkáptalanfai bauxitkutatási területen. (Arrangement of the Senonian formations in the Sümeg–Káptalanfa bauxite-exploration area and their relationships with the paleorelief.) — Földt. Közl. 108 (4).

Ludas F.-né–Gáspár J. 1972: Jelentés a Sümeg–Bárdió-tag I. sz. bauxitlencsén végzett kutatás és készletszámítás eredményeiről. — Data Base of the BKV. Manuscript.

Noszky J. 1958: Jelentés a "Bakonyi Csoport" 1957. évi Sümeg és Csabrendek környéki térképezési munkájáról. I. — Data Base of the Hung. Geol. Inst. Manuscript.

Péter Z.–Ludas F.-né–Szabó E.–R. Szabó I. 1982: Jelentés a Csabpuszta VII–VIII., valamint a Kozma-tag IX/1. és X/1. sz. bauxitlencséken végzett kutatás és készletszámítás eredményeiről. — Data Base of the BKV. Manuscript.

R. Szabó I. 1971: Jelentés a Sümeg–Surgó-tag I., II. és III. sz. bauxitlencséken végzett kutatómunkálatok és készletszámítás eredményeiről. — Data Base of the BKV. Manuscript.

Telegdi Roth K. 1937: Jelentés az 1930. és 1931. években a Bakony hegységben és a Villányi-hegységben végzett bauxitkutatásokról. (Bericht über die in den Jahren 1930–31. im Bakony- und im Villányer-Gebirge durchgeführten Bauxitforschungen.) — Rélations Ann. Inst. Geol. Hung. (1929–32).

Tóth Á.—Ludas F.-né 1972: Jelentés a sümeg–kozmatagi bauxitelőfordulás I., II. sz. lencséjén végzett kutatómunkálatok és készletszámítás eredményeiről. — Data Base of the BKV. Manuscript.

Tóth K. 1980: Összefüggések a bauxit előfordulása és a közvetlen fedő eocén rétegek kifejlődése között. (Interrelations between the Occurrence of Bauxite and the Facies of the Immediately Overlying Eocene Beds.) — Ált. Földt. Szemle 14.

Vadász E. 1946: A magyar bauxitelőfordulások földtani alkata. (Die geologische Entwicklung und das Alter der Ungarischen Bauxitvorkommen.) — Ann. Inst. Geol. Publ. Hung. 37 (2).