

## **Bauxite Lens 204 from Brusturi-Cornet (Bihar County), dinosaur-bearing fossiliferous ore**

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After an explosion, set off as part of the commercial bauxite mining in Lens 204 at the Mine Brusturi (Cornet), two miners, Ioan Bumb and Petru Lele, were impressed to see some bonelike fragments in the bauxite. It was one of the most extraordinary discoveries in our country, on the one hand a new dinosaur-bearing fossil site and on the other hand - which is in fact a unique feature - fossil bones preserved in bauxite. After she was informed, geologist Emilia Tallodi asked the opinion of paleontologist Tiberiu Jurcsak, the head of the Natural Sciences Department of the Țării Crisurilor Museum. He came to the mine and observed the existence of numerous fragments of vertebrae and phalanges, among them some unguals, presuming they belonged to saurians. Later, it has been established that the material belonged to ornithopod dinosaurs.

Given the importance of the site, the Ministry of Mines, Oil and Geology has sent a team of geologists from the Geological and Geophysical Institute from Bucharest to the mine. In this way, some important material has been collected and a new approach of a complete study of the bauxite accumulation has started; one outcome of this is a new model of evolution at the Jurassic-Cretaceous boundary. Unfortunately, the main part of this study has been included only in reports, never being published in scientific journals.

### **General geological framework**

Bauxite, the ore of aluminium, is deposited as detrital rock on the karst surfaces. The main bauxite deposits in our country are found in the central part of the Padurea Craiului Mountains, in the karst of the limestones of the Cornet Formation. The Cornet limestones are overlaid by characaeen limestones, which are upper Neocomian in age. So, the age of the bauxite represents Lower Neocomian.

Contrary to some other opinions, the Lower Cretaceous karst was formed in several phases of corrosion and not in one phase, and its origin is phreatic not vadose (G. Pop, I. Mirza, 1977; D. Patrulius et al, 1983). This paleokarst is overlapped by some more recent cavities, dating from the Neogene, or even the Pleistocene. The morphology of the different karst cavities and the structure of the filling deposits, determine the type and the generation of the karst. The bone-bearing bauxite lens is part of the second generation of karstification. The cavity is deeper, of Aston type, and is formed exclusively on the Cornet limestone, and it is filled with large crystals of spathite and stratified boehmitic bauxite, as well as with boehmitic-kaolinitic clays. Geometrically, the lens is covered by a cavity of the first generation of the bauxite, a massive diasporic bauxite overlaid by

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\* Original citation: Marinescu, F. 1989. Lentila de bauxită 204 de la Brusturi – Cornet (Jud. Bihar), zăcământ fosilifer cu dinozauri. *Ocotirea Naturale Mediului Inconjur* 33: 125-133. Translated by Erika Posmosanu, March 2009

Upper Neocomian characean limestones. Besides the deeper position of this second generation of karst, which passed through the first karst generation with massive diasporic bauxite filling, with superficial cavities of “caguanes” type (similar to the “karst plains” of Cuba), the second generation of this karst is indicated by the mineralogy of the deposit, the presence of boemite, suggesting a less mature, subsequent deposition. The shape of the cavity is almost discoidal, with a 55 m diameter and at least 7 m height. The entire cavity is covered by large spathite crystals, like a geode, with different thicknesses. The thickness of the bauxite filling, together with the overlying yellowish-reddish kaolinite clays is minimally 3 m.

### **The bone-bearing bauxite**

In comparison with the currently exploited bauxite, which is massive with ooids, the vertebrate-bearing bauxite is red or brownish, pelleted, with intercalations of detrital bauxites, with a graded stratification. The bones, spread through the mass of the bauxite, are more abundant at the base of the lens and become rarer at higher levels (fig. 1, 2, 3).

Besides the structural differences, there are several differences in the chemical composition of the bone-bearing bauxite, which has unusually high amounts of  $\text{SiO}_2$  and  $\text{CaCO}_3$ , in comparison with the bauxite with ooids. Another mineralogical difference is that the fossil-bearing bauxite is detrital, mainly hematitic and boehmitic, while the massive bauxite is characterized by hematite and diaspor.

The high percentage of  $\text{SiO}_2$  arises from the numerous gravels of the detrital intercalations, and the same is the case with  $\text{CaCO}_3$ , whose value is given by the limestone pebbles, and from the calcite that is deposited in the fissures in the bauxite or even in the fissures in the bones.

There are several gastroliths, which are rounded elements, some of them being corroded, most probably in the stomach of the dinosaurs. The origin of the gastroliths can be proved by those which represent some metamorphic rocks, found at a very great distance from the site.

### **Paleontological exploitation**

This activity began with the evacuation and selection of all the material that resulted from blasting (fig. 4). The material has been washed. Then the necessity of systematic paleontological digging was taken into account, in parallel with other geological studies. The use of blasting has been recommended in a report (Marinescu, 1979), followed by washing; screen washing was proposed. Due to the fragile nature of the material, we considered this process to be inadequate: the bauxite itself is highly affected by diacalse [= fracture], in two directions. Excavating the bauxite by blasting will lead to much more crumbling of the material, destroying all the fragile parts. Even pneumatic hammers, which we tried to use, are too destructive. The only possible method for digging is the use of hammers and chisels; although the efficiency is rather low, but the quality of the specimens recommends this method. Maybe the use of a small pneumatic hammer would

increase efficiency, but lacking that, we used the geological hammer, chisels and a bigger, 5 kg sledge hammer. Thus, we managed to collect some complete vertebrae, skull fragments, teeth and other delicate specimens.

### **Paleontological content**

Besides the vertebrate remains, we recovered a brachiopod fragment and one bivalve, probable a caprotinid. Their preservation is very poor. The brachiopod fragment represents only the part with the pedicle opening, delthyrium and the external ribbed surface, which is similar to a rhynchonellid. The presumed caprotinid has preserved only its right valve, it has a lamellar structure, preserving dentition. The bauxitic material is so fine, making it impossible to remove it, so determination of the species is impossible, as well. Some characean fragments and an ostracod have been found, both indeterminate fragments.

The vertebrate remains are isolated (table I, fig. 5-14); they were not found in any connection (excepting two sacral vertebra, which are fused). In two cases, we found two phalanges in close vicinity, which seem to belong to the same individual because of their appropriate size. The majority of bones are found with their axes parallel to bedding. Bones are rare in the coarser intercalations; they can be found especially in the pelitic strata, as if they were transported from the surface together with the bauxitic mud. In cases where specimens are immediately on top of the coarser detrital strata, the bones are slightly sunk in, and coated by a fine, pelitic cover. It is clear that these bones had sunk by falling under their own weight in the unconsolidated, maybe even thixotropic sediment. This means that the bones have been brought together with a substantial quantity of fine detritus, which has been deposited gradually, the bones accumulating more rapidly through gravity.

The osteological material came from numerous individuals, disarticulated at the surface. The mixture of bones is heterogenous, with specimens of different sizes, some of them showing signs of transportation, meanwhile others are perfectly preserved; sometimes older diaclasses sectioned the longer bones, and some of the vertebrae are slightly deformed. The most frequent bones are vertebrae, phalanges and metapodial bones, an apparently normal situation relative to the frequency of other parts of the skeleton, but their amount is striking. Lots of the vertebrae lack their neural arches, showing that they were only slightly fused to the centra. The absence of the long bones is striking as well (we have found only diaphyseal fragments). It is presumed that transportation of bones is due to floods, which could not transport the entire body or articulated parts of the skeleton. We imagine that the material comes from a sort of cemetery, which has been visited previously by scavengers, the transportation of the bones being after a period of disintegration of soft parts. It is possible that fragments of tendons and cartilage still existed on the bone, or marrow in the vertebral arches, because those were replaced by secondary calcite. Other bones present signs of erosion and corrosion due to the surface water. There is no sign of bones of predators (teeth, ungual phalanges). It is possible that this "cemetery" was close to a marshy area, in which some animals perhaps drowned; this idea is supported by the evidence of characean and ostracod fragments; the variety of

sizes of the same anatomical elements and the high number of gastroliths indicate, as well, the high number of individuals. At the same time, this “cemetery” did not exist for a long time, given the great number of bones at the base of the deposit and a decreasing number of bones in the upper part of the deposit. According to the size of the vertebrae, the length of the animals would have been 2.5 – 3.5 m; so, some of the long bones would have attained several tens of centimeters in length. There is an indication of some larger material. In this case we can presume that the accumulation of the skeletal remains was selective, assembling at the entrance of a natural shaft (a vertical cave) in an excavation of Ashton type, where the entrance was blocked by trees or gravel, working like a filter. This would explain the absence of larger bones and skulls (of which only some isolated fragments have been found). The abundance of skeletal fragments in a certain part of the cavern is striking; meanwhile in the opposite part they are rare. This could also indicate the existence of an opening through which the cavern was supplied by sediments. Judging from the collected material, as well as the list and papers published by Jurcsak (1979, 1982, 1982-1983) and other authors, the paleontological material represents a reduced number of species. I have already made some small comments already in Patruşiu et al. (1983). What we want to emphasize now is the great amount of material provided by a single group of ornithomimid dinosaurs, belonging to the family Iguanodontidae. Among several thousands of bones, none of them come from predators, although some chewing marks have been reported on some bones. Regarding crocodiles (Jurcsak and Popa, 1978), they are not present at all, and the environmental conditions would not indicate their presence anyway. In the absence of a full description of the entire material known up to now (Marinescu, 1981; Patruşiu et al., 1983) we think that the major part of the osteological material came from an iguanodontid, probably an endemic form, after the isolation of the territory where they lived. Some anatomical elements (fused sacral vertebrae, some other vertebrae, neural arches weakly fused to the centra) would indicate a more primitive form or a form that would have been isolated from the original form at a less advanced moment, preserving this kind of characters. It seems to be an endemic genus derived from *Camptosaurus*; at the same time, the dentition, with fine and frequent denticles on the margin of maxillary teeth, indicates an advanced form. We can think that this form populated the entire territory of land then in Bihor – Padurea Craiului. The area where they lived was extended, judging from the fragments of metamorphic and igneous rocks used as gastroliths, their origin was at a distance of minimally 60-70 km. Their considerably lower abundance in comparison with limestone gastroliths is normal, due to the long distances, as they were gradually replaced by elements from their closer vicinity. This form should be named *Bihariosaurus bauxiticus*, in order to emphasize its endemic nature and the material in which it was discovered.

Besides that, according to the aspects of some of the vertebrae, another form existed which belonged to the genus *Iguanodon*, and pterosaurs and even birds were reported.

### **Paleogeographical considerations**

The region where the mentioned forms have been discovered was considered a paleogeographically isolated territory. Bauxite formation and accumulation required a

characteristic climate and karst development. Similar conditions, relatively close by, were observed in the Dinaric regions (in the South) and in Villany (in the west); but the closest areas with dinosaur remains are in the west, in southern France, Belgium and in southern England, and in the Caucasian region to the east. Even such animals migrated from island to island, the closest territory would have been the Caucasian region, with access along the Pontide. Access to Africa (Tendaguru) would have been even more difficult than today, even if the Dinarides could have allowed movement to and from the south. The route to the west would be a possibility, if the deep Alpine fossa had not separated the carbonate platform. In any case, in paleogeographical interpretations it is important to consider this information as well.

### **Scientific importance**

As I said, the Cornet discovery is one of the most important discoveries of the last decades, and its importance extends beyond the boundary of our country. The paleontological discovery enriches the Lower Cretaceous dinosaur record of Europe, and completes with new elements the paleogeography of these animals; new perspectives are opened in order to understand the presence and maybe the phylogeny of vertebrate fossils from the Upper Cretaceous of Hațeg or Dobrogea. The discovery of these terrestrial vertebrates in a deposit that was formerly considered as unsuited for bone preservation is also an exquisite novelty.

One of the results of this discovery was to intensify the study of bauxite deposits in this area, leading to interesting conclusions regarding the origin of the bauxites (D. Patrulius, in Marinescu, 1979, 1980). All these elements require the protection of this unique site.

### **Mode of protection and conservation**

The management of the mining company (director ing. Emil Fechete), with the agreement of the General Geological Direction of the Ministry of Mines, Oil and Geology, has stopped the exploitation of the bauxite in that lens, understanding the importance of the site. Direct access has been opened in order to avoid interference with the normal mining activity, and access was allowed only for authorized specialists. With all these measures there are several problems: the fossil-bearing deposit is located underground, in a mine, and assurance of the safety of personnel requires some measures. Moreover, the site is under the hydrostatic level of the Mnierii Valley, which would require regular pumping of the water. As long as the Mining company is operating the mine, this activity is routine; but after the end of exploitation activities of the mine the pumps would have to operate only for this site. Plus, in the interval from 1978 to now, some fissures have appeared, increasing risks of access, as with all unused mines. In this case, the current maintenance costs are higher than for other paleontological protected areas, with outcrops.

The study of the bauxite deposit brings new elements for the hypothesis of different moments of fossil karst in the region. The galleries of the mining system of Lens 204 show this point of view, like reading a book. The conservation of these galleries, even

after exploitation of the bauxite is complete, would be of great interest for students and researchers, as well as a public tourist attraction. If we add the existence of a Jurassic reef in the neighborhood, which is unique in our country, we would create a more complex geological protected area with particular interest. For these considerations, the help of the Ministry of Mines, Oil and Geology, as well as the Mining Company Dobresti, is indispensable in order to reinforce and maintain the mine. The high geological interest of these sites, leave us hope that the Ministry of Mines, Oil and Geology will be able to achieve these aims. Given the worldwide importance of this protected area, we propose the Geological Museum as direct supervisor of the site, in collaboration with the Commission for Natural Monuments. Thus, access and rational scientific exploitation, as well as maintenance of the site would be best assured by these institutions, with the support of the Mining Company. This kind of collaboration would be a world first and would be an example to follow in our country for conservation of geological values of special importance.