AN ISOLATED OLISTOLITH IN THE CIUCAŞ CONGLOMERATES (ALBIAN, CARPATHIAN BEND). ESSAY ON SEDIMENTOGENETIC SIGNIFICANCE

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Abstract. In the eastern part of the Ciucaș Mountains (Carpathian Bend area) an 18 m long limestone block was located. Unlike the numerous Albian Bucegi olistoliths included in shallow-waters shelf sediments, this is the first olistolith identified in the Albian deep sea fan sediments from the Carpathian Bend area. Structureless rudites are embedding the Ciucaș olistolith, suggesting that rudites and olistolith were transported together due to sediment gravity flow processes. Two Ciucaș olistolith provenance hypotheses are discussed including a local or a distal source area.

Key words: limestone block, olistolith, gravity flow, Albian, Carpathian Bend

1. INTRODUCTION

Olistolith occurrence is frequent in the Lower Cretaceous deposits from the Carpathian Bend area. The olistolith-bearing shallow water Albian deposits from the Bucegi Mountains are presently the most investigated. So far, no olistolith was reported from the deep-sea fan Albian conglomerates in the Carpathian Bend zone. This is why the finding of an isolated and distal olistolith in the deep-water Ciucaș Albian Conglomerates requires scientists awareness.

*Purpose***.** The objective of the present paper is the description and interpretation of the exotic limestone block located in the Ciucaș conglomerates, an isolated olistolith included in deep-water deposits.

Study area. The investigations presented in this paper were carried out in the Ciucaș Mountains from the Carpathian Bend area, in the southernmost part of the Eastern Carpathians (Fig. 1). The investigated area is located in the northern Prahova County, at the boundary with the Brașov County.

Method. The Ciucaș conglomerates are currently investigated by facies aspects mapping. This is done especially along the mountain crests, where the exposures are extensive and cleaner. The olistolith was located while this study was carried out.

The main sedimentary features of the olistolith-bearing conglomerates, grain-size evaluation (clasts, megaclasts, matrix) and primary sedimentary structures were observed on the field and further examined on photographic images.

Special attention was granted to the sedimentary features with genetic significance for the Ciucaș olistolith dynamics and provenance, especially to the relationship of the olistolith with the embedding rudites.

2. GEOLOGICAL BACKGROUND

The Ciucaș Conglomerates, together with the other Albian conglomerates from the Carpathian Bend area, are the marginal, coarse-grained facies of the turbiditic deposits from the internal flysch zone of the Eastern Carpathians.

The Lower Cretaceous sedimentary succession that include the Ciucaș conglomerates begins with the Sinaia Formation (Late Tithonian - Hauterivian) (Melinte and Jipa, 2005) (Fig. 2a). This is the first coarsening upward cycle of the Carpathian Bend Early Cretaceous. The second Lower Cretaceous cycle refers to the Moroeni Formation (Barremian - Early Al-

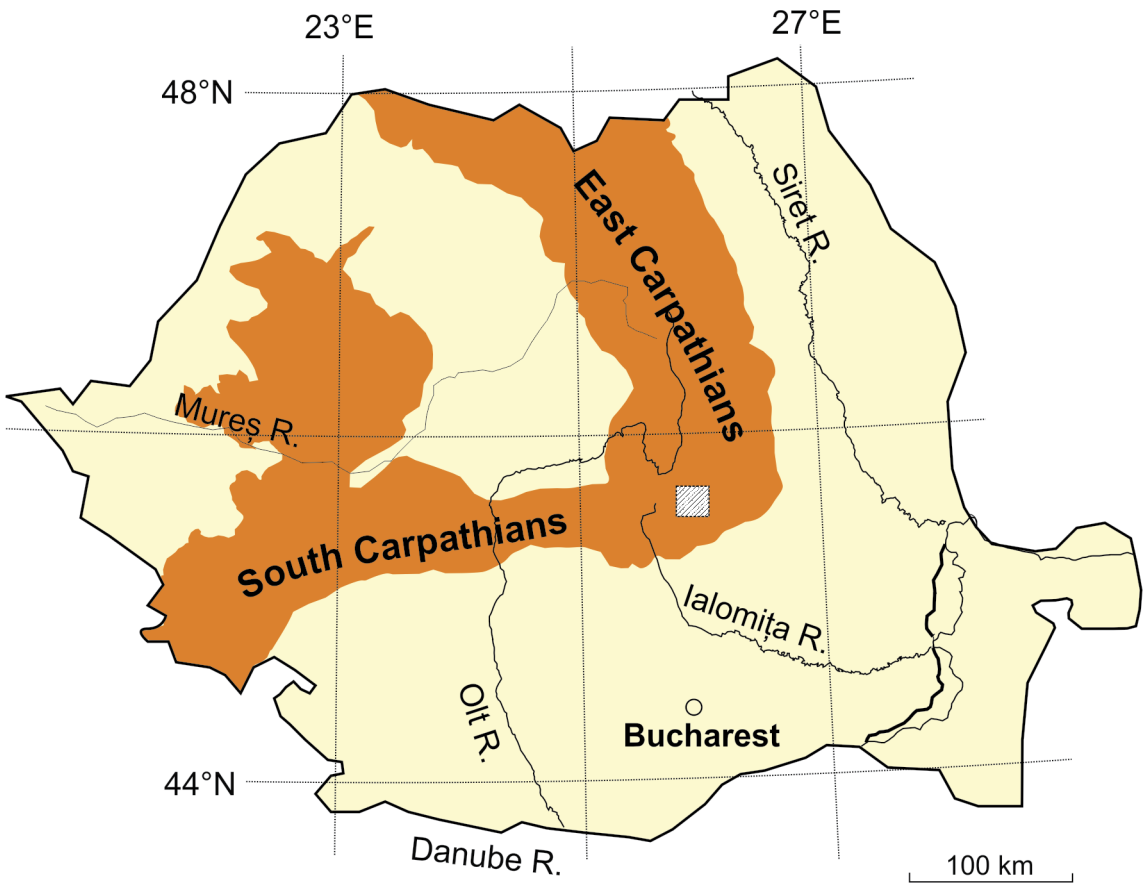

Fig. 1. Study area location, in the Carpathian Bend zone, România

bian). The overlying Bucegi Formation (Albian) is individualized by its basal disconformity, but makes up the top of the second coarsening upward Lower Cretaceous cycle.

The Bucegi Formation shows the most complete Albian conglomerates succession, and all the Albian Carpathian Bend conglomerates are referred to it. The three members traditional succession scheme is modified in this paper (Fig. 2b). The Bucegi Lower Member is the thickest ruditic series and it is the equivalent of the Ciucaș, Postăvaru - Piatra Mare, Persani, Baraolt and Codlea Albian conglomerates occurring in the Carpathian Bend area.

No fossil remains are known from the Ciucaș conglomerates. The Albian age was assigned to the Ciucaș conglomerates, as they overlie Late Aptian deposits and are overlaid by Vraconian - Cenomanian deposits (Popescu, 1958).

The limestone bodies occurrence at the base of the Ciucaș conglomerates, considered of Late Jurassic age and in tectonic position, was first reported by Preda (1939). Filipescu (1953) concluded the limestone bodies are *in situ* and contain Barremian - Aptian Urgonian-type fauna. Popescu (1958) mapped eight limestone bodies in the southern Ciucaș Mountains (Fig. 3a) and specified their occurrence in basal Ciucaș conglomerates, 40 m above the base (Fig. 3b).

According to Popescu (1958), the Ciucaș Albian conglomerates and their Aptian underlying deposits are overthrusting Upper Cretaceous deposits. This tectonic feature, named the Bratocea Nappe by Popescu (1958), is part of the Ceahlău tectonic (Outer Dacide) (Săndulescu, 1984).

3. DATA PRESENTATION

Ciucaș olistolith location. The limestone block, representing the subject of the present paper, is located in the eastern part of the Ciucaș Mountains, in the area of the Stanei River upper watercourse, eastward from the Gropsoarele saddle (Fig. 4a).

In the Ciucaș Albian deposits areal, the olistolith is positioned in the south-eastern part, enclosed in the Albian conglomerates (Fig. 4b).

Occurring in a high position in the succession of the Ciucaș conglomerates the described limestone block is quite different from the *in situ* limestone bodies at the base of the conglomerates.

Limestone block description. The Ciucaș olistolith appears as an elongated, 18 m long body (Fig. 5). Its visible thickness is 4 m.

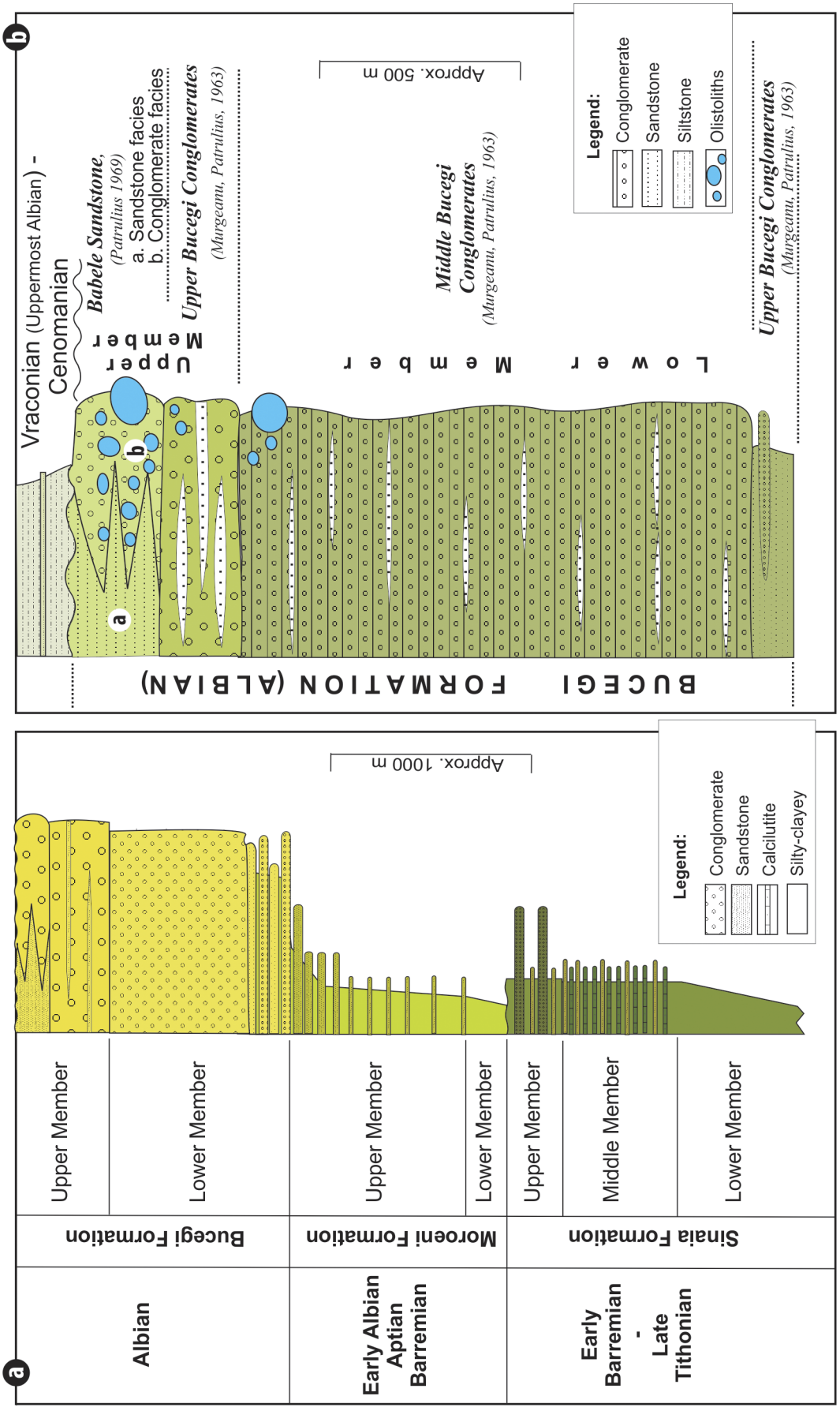

Fig. 2. Carpathian Bend Lower Cretaceous lithostratigraphy. Data partially from Melinte and Jipa (2005) and Jipa *et al.* (2013)

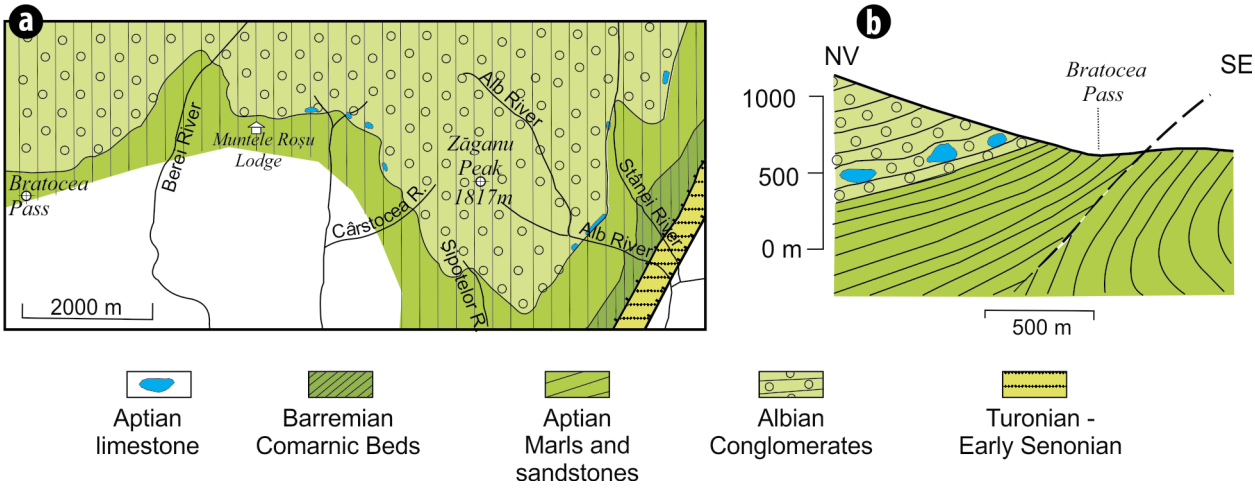

Fig. 3. Geological setting in the southern part of the Ciucaș Mountains (after Popescu, 1958). Note the limestone bodies occurrence at the base of the Ciucaș conglomerates.

The yellowish, micritic limestone shows crude bedding in the upper part (Fig. 6) and appears massive in the lower part. The separation surfaces in the upper part are roughly parallel to each other and conform to the general structure of the conglomerates. They are regarded as bedding surfaces, but there are no intercalations to certify this quality.

The visible shape of the limestone block is irregular, with uneven outline both in the stratified and massive parts (Fig. 5).

Presently, there is no information on the limestone age. It could be either Barremian - Aptian or Late Jurassic.

Limestone block - conglomerates relationship. The limestone block appears embedded in Albian conglomerates. The ruditic deposits occur both bellow and above the limestone block.

The limestone - conglomerate boundary is uneven, with frequent 10 - 20 cm irregularities (Fig. 7a, b).

The conglomerate textural aspect is the same at the contact with the limestone block and away from the block.

The olistolith-bearing conglomerates. The conglomerates overlying the limestone are visible in a small, insufficiently clear outcrop. Significant information is offered by the conglomerates at the base of the limestone block.

Uniformity is the most evident characteristic of olistolith-bearing conglomerates. The olistolith embedding conglomerates are structureless. No bedding plane or clasts preferential orientation is visible in the 2.5 m thick rudites underlying the limestone block.

The size variety of the pebbles is obvious. The dimension of the conglomerate clasts varies from less than 1 cm to more than 10 cm. The largest noticed cobble is around 20 cm in diameter (Fig. 7). Most of the conglomerate elements, especially the larger ones, are fairly well rounded.

The conglomerate matrix is sandy or very fine conglomeratic. The rudites are clast-dominated sediments (Fig. 7 c, d).

Close to the limestone boundary the conglomerate includes several large limestone clasts (up to 1 m diameter), much bigger than the largest cobbles (Fig. 7b).

4. DISCUSSION

Ciucaș conglomerates in the context of the Carpathian Bend Albian rudites. The Albian conglomerates in the Carpathian Bend display a wide occurrence area. Four mountain massifs are dominantly conglomeratic (Bucegi, Ciucaș, Postăvaru -Piatra Mare and Persani Mountains; Fig. 8). Albian conglomerates also occur in the Baraolt and Codlea areas (Fig. 8). The extensively cropping out Carpathian Bend Albian conglomerates were interpreted by Murgeanu *et al*. (1963) as a large submarine fan. This concept is supported by the fan-like spreading of the Albian conglomerates paleocurrent system (Mihăilescu *et al*., 1967; Patrulius *et al*., 1967) (Fig. 8). Stanley and Hall (1978) revealed the deep water submarine slope environment of the Albian ruditic fan (Olariu *et al*., 2014). This character is shared by all the Albian rudites equivalent to the Bucegi Lower Member from the Carpathian Bend area (1 to 6 in Fig. 8). They also show common facies (texture and sedimentary structures) features. The Ciucaș conglomerates are the easternmost occurrence of the Albian deep sea fan sediment accumulation (Fig. 8).

The Bucegi middle and upper members conglomerates, representing a different sedimentation episode in the framework of the Bucegi Formation, are shallow-water shelf sediments (Olariu *et al*., 2014). Almost all the about 100 olistoliths embedded in Albian Bucegi conglomerates belong to the shelf sediment accumulation and are concentrated close to the main source area (Fig. 8). In the deep sea fan Albian conglomerates only several olistoliths occur, all of them in the immediate proximity of the source-area.

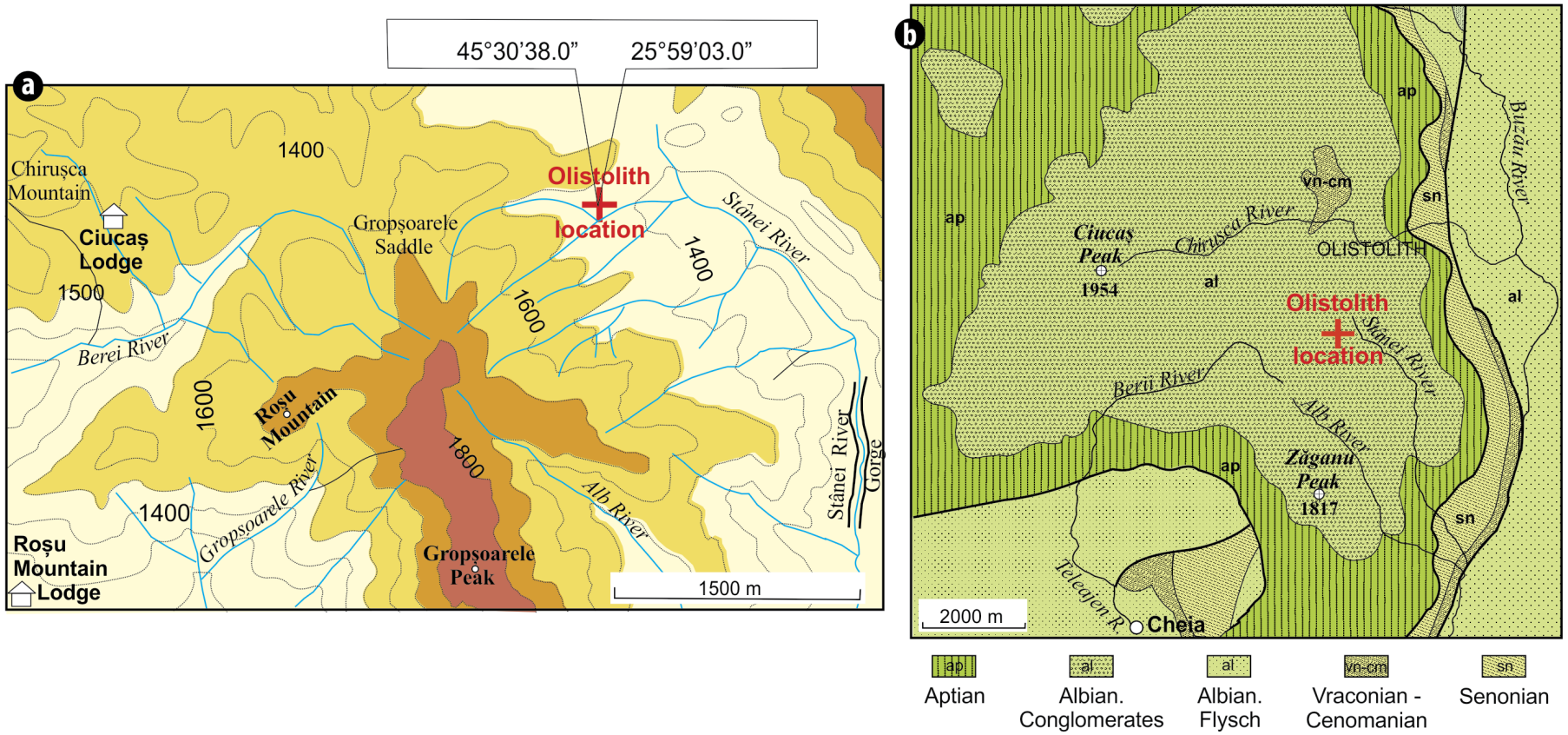

Fig. 4. Limestone olistolith location in the Ciucaș Mountains area. **a**. Topographic map, modified after Niculescu (1986). **b**. Geological map, simplified after Patrulius *et al*. (1966).

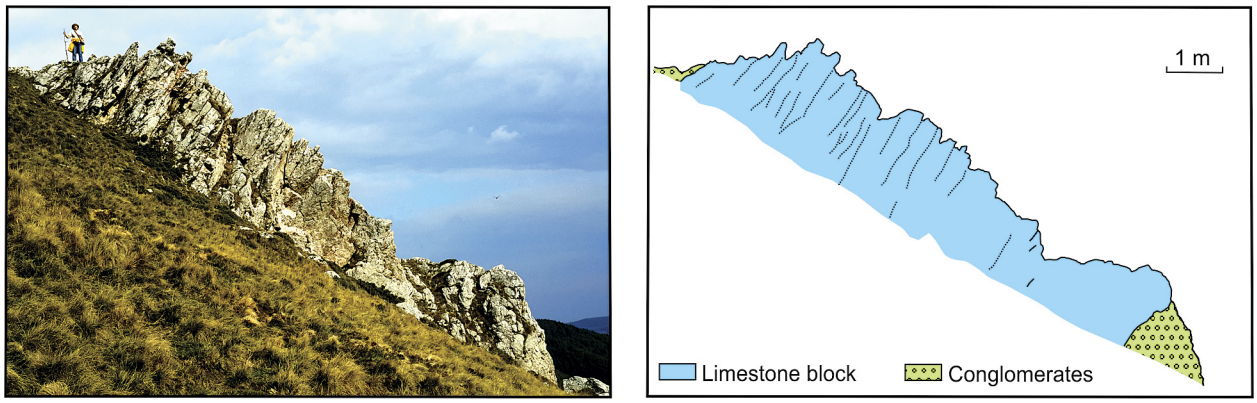

Fig. 5. The limestone olistolith from Ciucaș Mountains.

Fig. 6. Ciucaș olistolith structofacies. **Left**: stratified limestone. **Right**: massive limestone.

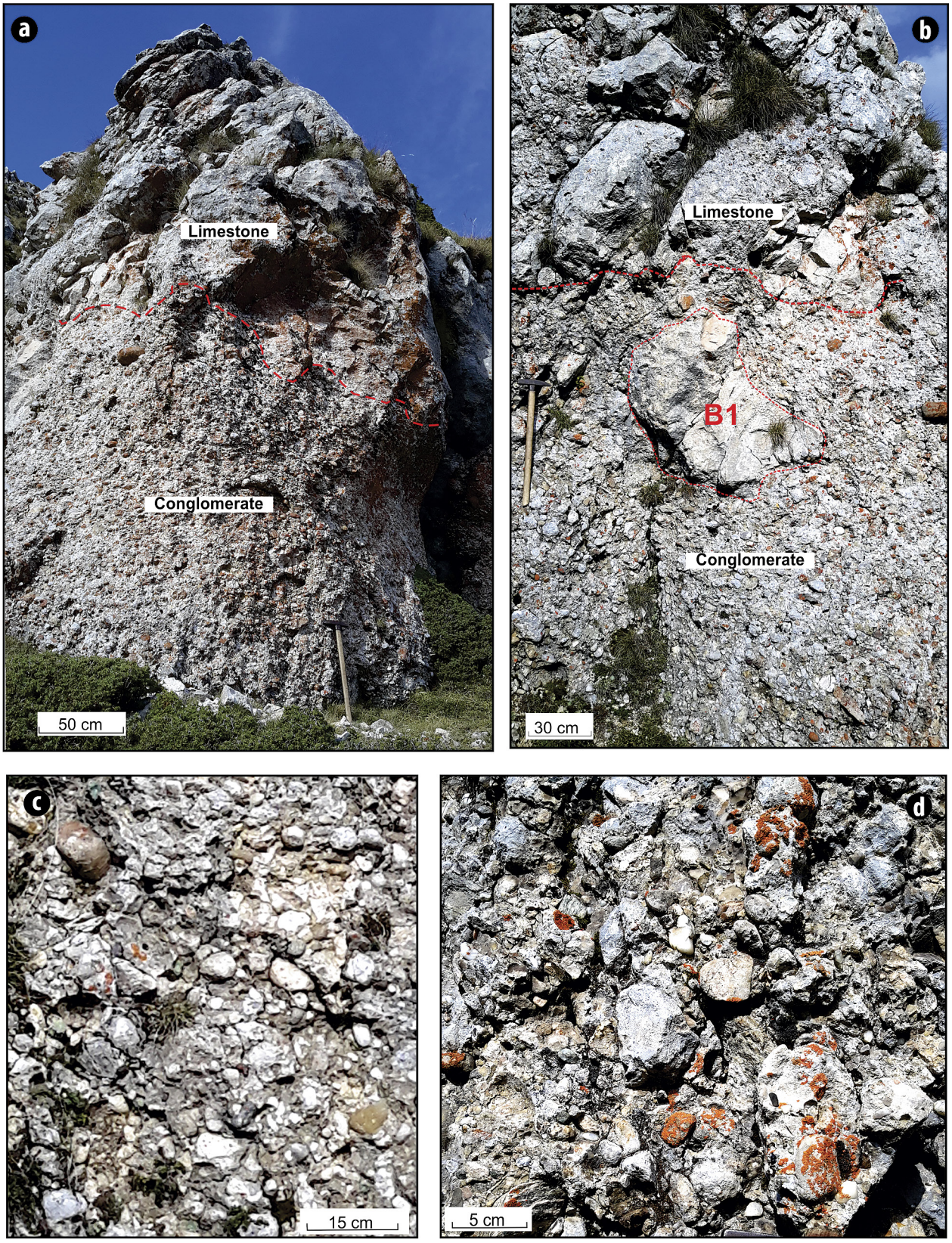

Fig. 7. Conglomerates underlying the Ciucaș limestone olistoliths. See explanations in the text.

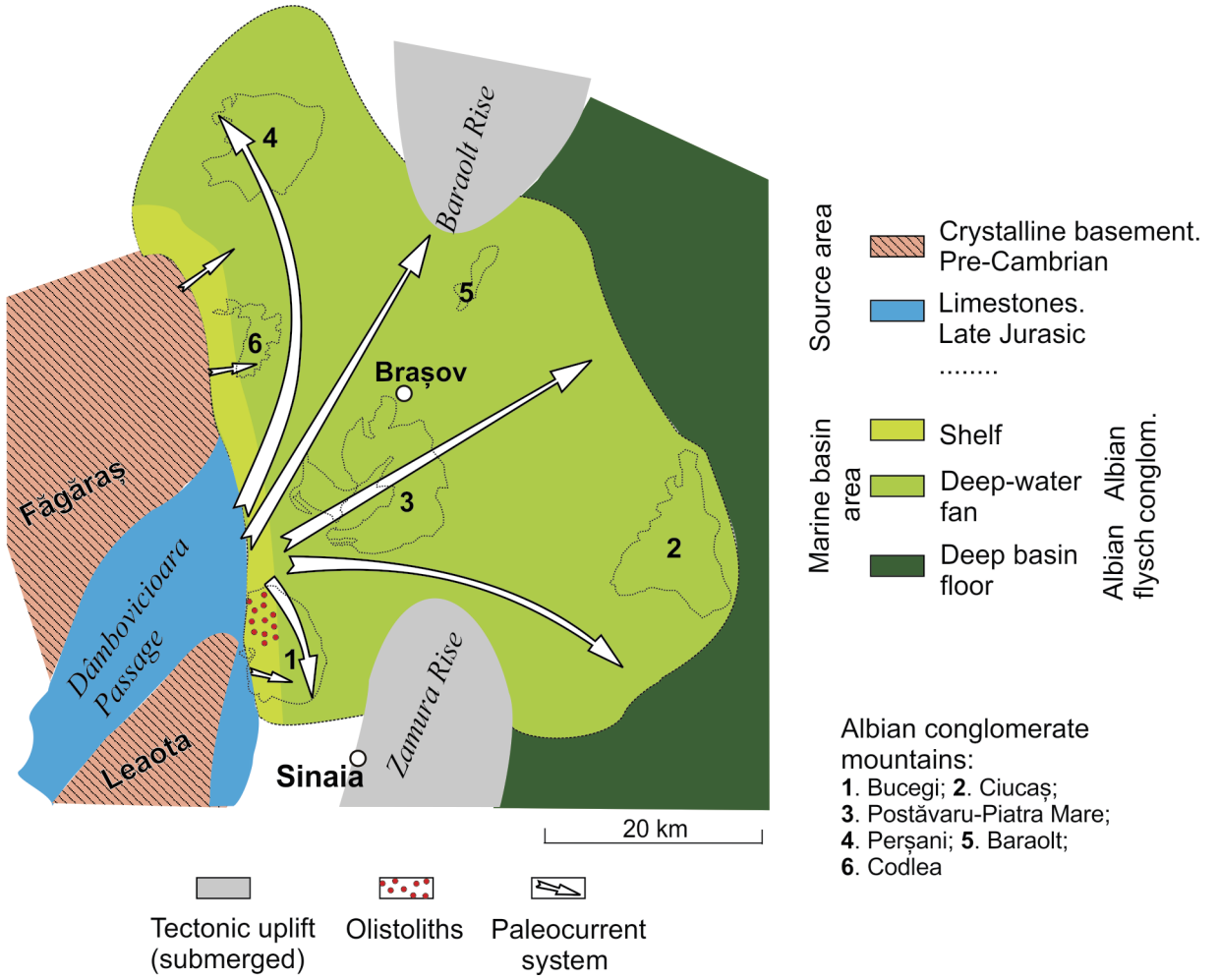

Fig 8. Geological setting of the Carpathian Bend Albian conglomerates. See explanations in the text.

On the whole the olistoliths embodied in the Bucegi conglomerates are very proximal, located in the zone where the detrital flux derived from the source area is entering into the sediment accumulating space. From the Carpathian Bend deep sea fan Albian deposits (areas 1 to 6 in Fig. 8) no olistoliths have been reported so far.

Ciucaș limestone blocks olistolithitic character. The limestone block incorporation within the Ciucaș conglomerates represents an important genetic feature. No matter if it is of Barremian – Aptian or Late Jurassic age, the limestone body is an exotic block in Albian deposits and can be considered an olistolith.

Ciucaș olistolith sedimentary dynamics The structureless facies and poor sorting displayed by the olistolith-bearing Ciucaș conglomerates are sedimentary features suggesting transport by gravity flow processes. This process influenced both the rudites and the olistoliths.

The conglomerates in contact with the limestone block show no texture or fabric changes. Consequently we can conclude the olistolith did not move independently, but was transported together with the ruditic sediments.

The conglomerates below the limestone block include limestone megaclasts much larger than the conglomerate clasts (Fig. 7B). This feature suggests that during the gravity mass transport, friction existed between the olistolith and the embedding rudites which led to the separation of some limestone fragments.

Ciucaș olistolith hypothetic provenance. Presently we have no specific data on the origin of the limestone olistolith embedded in the Ciucaș conglomerates. Considering the regional geological settings, two hypotheses on the Ciucaș olistolith provenance can be examined.

More than one *in situ* Urgonian-type limestone bodies were reported from the basal part of the Ciucaș conglomerates or from the underlying Aptian deposits (Filipescu, 1953; Popescu, 1958). It is possible that the Ciucaș olistolith may represent an Upper Aptian reefal limestone resedimented in the Albian conglomerates. In this case the Ciucaș olistolith provenance is local.

The large majority of the olistoliths included in the Bucegi Aptian and Albian deposits consist of Upper Jurassic limestones (Patrulius, 1969). The Ciucaș olistolith limestone might

also be of Upper Jurassic age and might have the same Carpathian provenance (Leaota and Făgăraș Jurassic cover) as the Bucegi olistoliths.

The second hypothesis includes two challenging aspects. First of all the hypothetic Ciucaș olistolith transport distance is difficult to explain. The olistoliths from the Bucegi Albian deposits are proximal, and they did not move more than about 10 km from the source area border. According to the present geological regional setting, if the Ciucaș olistolith derived from the same source-area, it should have covered a submarine transport distance of at least 40 km (Fig. 8). Secondly, in the present interpretation (Olariu *et al.*, 2014) the Bucegi Albian olistoliths are embedded in shallow water shelf-type sediments, while the rest of the Carpathian Bend Albian conglomerates (including the Ciucaș conglomerates) belong to a deep-sea fan environment (Fig. 8). The acknowledgment of the presence of an Upper Jurassic limestone olistoliths in the Ciucaș conglomerates would require a reconsideration of the concepts regarding the sedimentogenetic history of the Carpathian Bend Albian rudites.

5. CONCLUSIONS

An 18 m long limestone block was located in the eastern part of the Ciucaș Mountains. This finding raises important sedimentogenesis problems.

The limestone block is embedded in structureless and poorly sorted Albian conglomerates. These sedimentary features suggest rudites transport by subaqueous debris flow. With the debris flow rudites as embedding matrix, the Ciucaș olistolith was also transported by a gravitational, mass movement process. Close to the Ciucaș limestone block or away from it, the embedding conglomerates show no texture or fabric changes. Consequently, we can conclude the olistolith did not move independently, but was transported collectively with the ruditic sediments.

The conglomerates below the limestone block incorporate limestone megaclasts much larger than the conglomerate clasts. This feature suggests that during the gravity mass transport, friction existed between the olistolith and the embedding rudites, which led to the separation of some limestone fragments.

The age of the olistolith limestone is uncertain. If the Ciucaș olistolith is an Upper Aptian reefal limestone resedimented in the Albian conglomerates, the Ciucaș olistolith provenance may be local. The Ciucaș olistolith limestone might also be of Upper Jurassic age and might have the same Carpathian provenance (Leaota and Făgăraș Jurassic cover) as the Bucegi olistoliths. As most of the Bucegi olistoliths, the Ciucaș olistolith limestone might be of Upper Jurassic age and deriving from the same Carpathian source area (Leaota and Făgăraș Jurassic cover).

The hypothetic Carpathian provenance of the Ciucaș olistolith implies two important impediments. The first problem refers to the olistolith transport. While the olistoliths from the Bucegi Albian deposits did not travel more than about 10 km from the source area edge, the Ciucaș olistolith should have covered a submarine transport distance of at least 40 km. Secondly, in the present interpretation (Olariu *et al*,, 2014) the Bucegi Albian olistoliths are embedded in shallow water, shelf-type sediments, while the rest of the Carpathian Bend Albian conglomerates (including the Ciucaș conglomerates) belong to a deep-sea fan environment. The acknowledgment of the presence of an Upper Jurassic limestone olistoliths in the Ciucaș conglomerates would require a reconsideration of the concepts regarding the sedimentogenetic history of the Carpathian Bend Albian rudites.

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