MICROFACIES AND MICROFOSSILS IN UPPER JURASSIC LIMESTONES FROM CHEILE TURENILOR

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ABSTRACT. In the Cheile Turenilor (Tureni Gorges) area, a carbonate succession about 150 m thick developed on top of island arc magmatites. It mainly consist of gravity - induced deposits (debris flows, mass flows and grain flows). Coral, sponges and stromatoporoid bioconstructions are associated. Microbolites play an important role, as binders of the intraclastic rudstones/ grainstones facies, as well as of the incorporated corals, sponges, stromatoporoids, bryozoans, molluscs.

KEY WORDS: limestone, facies, microfacies, microfossils, Late Jurassic, Trascău, Apuseni Mountains.

1. INTRODUCTION

Cheile Turenilor is located in the north-eastern part of Trascău Mountains, between Tureni and Copăceni (Fig. 1). The succession of Mesozoic deposits in the area belongs to the northern end of Bedeleu Nappe, which is included within the Austrian Transilvanides (Balintoni & Iancu, 1986; Balintoni, 1997). The original area from where Bedeleu Nappe originated was an island arc (Nicolea et al., 1992; Gandrabura, 1981; Cioflică & Nicolae, 1981; Nicolae, 1994; Cioflică et al., 1981; Balintoni, 1997, etc.), below which subduction took place. These island arc deposits occur as a north-south elongated strip below Tertiary formations in the the Săndulești-Buru-Poiana Aiudului areas, as well as in Cheile Turenilor. On the top of the arc magmatites, Stramberk-type limestone formed. Hauer & Stache (1863) described coral fragments and *Sphaerodus* teeth in these deposits for the first time, and attributed them to the Late Jurassic (Tithonian) based on the similarities with other Stramberk-type limestones. The carbonate deposits in the region are part of the Săndulești Formation (Dragastan et al., 1987).

2. FACIES, MICROFACIES AND MICROFOSSILS

In the area studied, on the top of the island arc-type magmatites (breccias, agglomerates, rhyolitic tuffs interlayered with lava flows) the carbonate succession is about 150 m thick. It is mainly represented by deposits of gravity - induced processes. Intraclastic-bioclastic rudstones are the facies that dominate the whole succession cropping out in Cheile Turenilor.

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Figure 1 - Location of the study area

2.1 Debrites and conglomeratic deposits

Description: On the top of the island arc complex, the succession commences with layers of breccia and conglomerates containing blocks of “reef” limestone surrounded by a red matrix (Pl. I). They show a lens-type geometry, a reduced lateral continuity – meters or tens of meters, and decimetric-centimetric thickness. The blocks are arranged chaotically, no sorting is evident, while the clasts of various size are rounded to angular. The matrix is a mixture of fine-grained carbonate (including silt- and sand sized particles), lithoclasts of island arc magmatic rocks, quartz, and fresh feldspar, as well as terrigenous mud, rich in iron and manganese oxides. The matrix of the conglomeratic deposits is represented by extraclastic-oidic grainstones (Pl I, fig. 3; Pl III, fig. 1). The nuclei of the ooids are generally large, and consist of fragments of volcanic rocks and quartz. The cortices are very thin.

Szentpétery (1904) attributed a Triassic age to these deposits. Study of the carbonate pebbles reveals the following microfacies:

- coral boundstones with sponges, stromatoporoids (Pl. IV, fig. 2,3), and halimedaceans (*Nipponophycus ramosus* YABE & TOYAMA) (Pl. VIII, fig.1, 3). The internal sediment is represented by bioclastic grainstones/packstones, with *Terquemella* sp., (Pl. VIII, fig.2), *Thaumatoporella parvovesiculifera* RAINIERI, *Lithocodium aggregatum* ELLIOTT, *Mohlerina basiliensis* (MOHLER) (Pl.X, fig. 5), *Andersenolina* sp., “*Tubiphytes*” *morronei* CRESCENTI, fragments of echinoderms, molluscs, miliolids, and bryozoans.

- bioclastic peloidal grainstones/packstones with *Salpingoporella enayi* BERNIER (Pl. VII, fig. 5), *Clypeina sulcata* (ALTH) (Pl. VII, fig. 6), *Diversocalis* sp. (Pl. VIII, fig. 6), *Radiomura cautica* SENOWBARI – DARYAN & SCHAEFFER, *Protopeneroplis striata* WEYNSCHENK (Pl. IX, fig. 5), *Trocholina* sp., “*Tubiphytes*” *morronei* CRESCENTI, *Mercierella dacica* DRAGASTAN (Pl. X, fig 1), fragments of corals, echinoderms, and miliolids.

Interpretation: Unsorted blocks of “reef” carbonate rocks in a chaotic arrangement, and clasts of various size in a finer-grained matrix are all arguments for considering these deposits as debris flows, or mass flows (Coniglio & Dix, 1992; Stow, 1995; Einsele, 1991; Enos & Moore, 1983). The microfossils identified within the limestone pebbles do not allow exact estimation of their age, but indicate the Late Jurassic.

2.2 Grain flow deposits

Description: On the top of the debrites and conglomeratic deposits, well-sorted banks of carbonate sand bodies develop, showing normal and inverse grading (Pl III, fig.3), interlayered with hemipelagic limestones with small-sized belemnites and ammonites. The carbonate sands have sheet-type geometries, with erosive basal contact (Pl. II, Pl. III, fig. 3) and are intraclastic bioclastic rudstones/grainstones. The latter contain *Salpingoporella johnsoni* (DRAGASTAN) (Pl. VII, fig. 2), *Salpingoporella annulata* CAROZZI (Pl. VII, fig. 3-4), *Clypeina sulcata* (ALTH), *Neotrocholina* sp. (Pl. IX, fig. 4), *Andersenolina* sp., *Lenticulina* sp., *Nautiloculina* sp. (Pl. IX, fig. 6), *Neokilianina rahonensis* (FONRY & VINCENT) (Pl. IX, fig. 2), *Charentia* sp. (Pl. IX, fig. 3), *Mercierella dacica* DRAGASTAN, “*Tubiphytes*” *morronei* CRESCENTI, fragments of corals, bryozoans, sponges, and echinoderms. Towards the top of these banks ooids occur, while the frequency of carbonate sand bodies increases while the hemipelagic limestones decrease.

The hemipelagic limestones are represented by bioclastic wackestone/packstone with sponge spicules, frequent echinoderms plates, small belemnites, ammonites and hemipelagic foraminifers (*Lenticulina* sp.).

Interpretation: The well-sorted, normal and inversely graded sheet-type carbonate sand bodies with erosive basal contacts, interlayered with hemipelagic limestones, indicate grain flow deposits (Lowe, 1982; Einsele, 1991; Stow et al., 1996).

Figure 2 – Sedimentological log through the limestones in Cheile Turenilor area.

2.3 Coarse „reef“ detritus deposits and bioconstructions

Description: A succession of carbonate breccia about 120 m thick occurs above the grain flow deposits. It consists of sheets containing cobbles of “reef” limestone in a fine-grained carbonate matrix (including silt- and sand sized particles) (Pl. IV, fig.1). These deposits are poorly sorted, they lack stratification, and the clasts are chaotically displayed. (Pl. IV, fig.1). The clasts are angular to subrounded, and vary in size from pebbles-to cobbles. They mainly consist of boundstones with corals and sponges, coralligenous-thrombolitic boundstones, and bioclastic grainstones/packstones. Both in the matrix, and in the clasts, the following microfossils were identified: *Salpingoporella pygmaea* (GÜMBEL) (Pl. VII, fig. 1), *Salpingoporella annulata* CAROZZI, *Clypeina sulcata* (ALTH), *Trocholina* sp., *Andersenolina* sp., *Protopeneroplis* sp., *Nautiloculina oolitica* MOHLER, “*Tubiphytes*” *morroneensis* CRESCENTI, *Mohlerina basiliensis* (MOHLER), *Radiomura cautica* SENOWBARI – DARYAN & SCHAEFFER, *Mercierella dacica* DRAGASTAN, sponges, coral fragments, mollusks, echinoderms, bryozoans, and rare small belemnites, and ammonites. The corals and the sponges are intensely encrusted. The most frequent identifiable encrusting microfossils are *Lithocodium aggregatum* ELLIOTT (Pl. III, fig. 5; Pl. VI, fig. 1-3,6), *Thaumatoporella parvovesiculifera* RAINERI (Pl. VI, fig.4-5), *Koskinobullina socialis* CHERCHI & SCHROEDER (Pl. VI, fig. 2-3), *Radiomura cautica* SENOWBARI – DARYAN & SCHAEFFER (Pl. VIII, fig. 5), *Trogrotella incrustans* WERNLI & FOOKES (Pl. VI, fig. 6), *Bacinella irregularis* RADOIČIĆ, and encrusting foraminifers (Pl. VI, fig. 1).

The bases part of the breccia beds are usually erosional, while the upper parts are finely graded. The tops of these breccia beds are intensely encrusted by microbolites, sometimes accompanied by coral bioconstructions with sponges and stromatoporoids. These bioconstructions are not proper reef-builders, but sometimes they show a constrictal growth fabric (sensu Insalaco, 1998). The bioconstructions are intensely encrusted by microbial structures, algae, and foraminifera. The microbolites incorporated corals, sponges, and stromatoporoids, and at the same time they stabilized (bound) the intraclastic rudstones/grainstones. According to the classification of Riding (1991,2000), and Schmid (1996), the most frequent microbolite type identified in Cheile Turenilor is clotted mesostructure (thrombolite) (Pl. V, fig. 1-2) represented by mesoclots with shapes varying from simple spheroids to polilobate masses. The mesoclots consist of diverse microstructures including peloids, grumelous fabric, and cement. The microbolites are frequently associated with encrusting algae and foraminifera. The internal sediment between the bioconstructions is in general represented by bioclastic packstone/ wackestone with *Terebella* sp. (Pl. V, fig. 2), annelid tubes, *Lenticulina* sp., “*Tubiphytes*” *morroneensis* CRESCENTI, sponge spicules, and echinoderm plates.

Interpretation: Poorly sorted deposits lacking stratification, containing angular to subrounded pebble-to cobble sized, chaotically arranged clasts in a fine-grained matrix allow us to regard these deposits as gravity flows (Coniglio & Dix, 1992; Stow, 1995; Einsele, 1991; Enos & Moore, 1983).

The coral - microbial bioconstructions associated with gravity flow deposits contain sponge spicules, echinoderm plates, “*Tubiphytes*” *morroneensis*, *Terebella* sp., annelid tubes, hemipelagic foraminifera (*Lenticulina* sp) indicating an open marine environment, below normal wave basis. The *Terebella* - “*Tubiphytes*” *morroneensis*

association is tolerant of disaerobic conditions and occupied a deep environment (Schmid, 1996).

3. CONCLUSIONS

In Cheile Turenilor area the carbonate succession is mainly represented by gravity-induced deposits (debris flows, grain flows, mass flows). In addition, hemipelagic limestones are present in the basal part of the succession, while in the middle and upper part coral bioconstructions with sponges and stromatoporoids are present, indicating an open marine environment below normal wave basis. The association of gravity flow deposits with hemipelagic limestones and bioconstructions are indicative of fore-“reef” slope environment.

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PLATES

Plate I – Debris and conglomeratic deposits from the basal part of the succession in Cheile Turenilor.

- Fig. 1 - Breccia
Fig. 2,4 – Detail of the fig. 1.
Fig. 3 – Conglomerates

Plate II – Grain flow deposits

- Fig. 1,2 - Carbonate sand bodies interlayered with hemipelagic limestones.
Fig. 3,4 – Well - sorted banks of carbonate sand bodies with angular to rounded clasts at their bases, grading upward into medium sand and fine – grained limestones.

Plate III – Microfacies and microfossils from Sănduleşti Limestone Formation in Cheile Turenilor.

- Fig. 1 – Extraclastic oolitic rudstone/grainstone. Scale bar is 2 mm.
Fig. 2 – Bioclastic packstone (bottom) grading into a intraclastic-bioclastic grainstone/ rudstone (grain flow deposits with inverse grading). Scale bar is 5 mm.
Fig. 3 – Small channel with erosive basal contact. Bioclastic wackestone (bottom) and bioclastic grainstone towards top. Scale bar is 5 mm.
Fig. 4 – Ooid sands (bottom) stabilized by microbolites. Scale bar is 2 mm.
Fig. 5 - Coralligenous-thrombotic boundstone. A – grumelous microstructure; B – coral; C - *Lithocodium aggregatum* ELLIOTT; D – sponge; E – microbial pseudostalactite structures. Scale bar is 1 mm.

Plate IV - Microfacies and microfossils from Sănduleşti Limestone Formation in Cheile Turenilor.

- Fig. 1 – Intraclastic bioclastic rudstones (coarse “reef” detritus deposits). Scale bar is 2 cm.
Fig. 2 - Boundstones with corals and sponges. Scale bar is 1 cm.
Fig. 3 – Sclerosponge. Scale bar is 5 mm.

Plate V – Thrombolitic facies from Săndulești Formation in Cheile Turenilor.

Fig. 1 – Mesoclots composed of grumelous microstructures. Scale bar is 5 mm.

Fig. 2 - Coralligenous-thrombolitic boundstone. A – *Terebella* sp.; B – sponge; C – peloidal microstructure; D – grumelous microstructure. Scale bar is 1 mm.

Plate VI – Encrusting microfossils.

Fig. 1 - Encrusting foraminifers. Scale bar is 0.4 mm

Fig. 2 –3 *Lithocodium aggregatum* ELLIOTT and *Koskinobullina socialis* CHERCHI & SCHROEDER. Scale bars are 0.8 mm and 0.4 mm, respectively.

Fig. 4 –5 *Thaumatoporella parvovesiculifera* RAINERI. Scale bars are 0.8 mm and 0.4 mm, respectively.

Fig. 6 - *Lithocodium aggregatum* ELLIOTT and *Trogrotella incrustans* WERNLI & FOOKES. Scale bar is 0.4 mm.

Plate VII – Dasycladaleans from Săndulești Limestone Formation in Cheile Turenilor.

Fig. 1 – *Salpingoporella pygmaea* (GÜMBEL). Scale bar is 0.4 mm.

Fig. 2 - *Salpingoporella johnsoni* (DRAGASTAN). Scale bar is 0.2 mm.

Fig. 3,4 - *Salpingoporella annulata* CAROZZI. Scale bar is 0.4 mm.

Fig. 5 - *Salpingoporella enayi* BERNIER. Scale bar is 0.4 mm.

Fig. 6 - *Clypeina sulcata* (ALTH). Scale bar is 0.4 mm.

Plate VIII – Dasycladaleans, halimedaceans, rivulariaceans from the Săndulești Limestone Formation in Cheile Turenilor.

Fig. 1, 3 - *Nipponophycus ramosus* YABE & TOYAMA. Scale bars are 0.8 mm and 0.2 mm, respectively.

Fig. 2 - *Terquemella* sp.. Scale bar is 0.2 mm.

Fig. 4 - *Lithocodium aggregatum* ELLIOTT. Scale bar is 0.4 mm.

Fig. 5 - *Radiomura cautica* SENOWBARI – DARYAN & SCHAEFFER. Scale bar is 0.8 mm.

Fig. 6 - *Diversocalis* sp.. Scale bar is 0.4 mm.

Plate IX – Foraminifera from the Săndulești Limestone Formation in Cheile Turenilor.

Fig. 1 - *Lenticulina* sp.. Scale bar is 0.4 mm.

Fig. 2 - *Neokilianina rahonensis* FONRY & VINCENT. Scale bar is 0.4 mm.

Fig. 3 - *Charentia* sp.. Scale bar is 0.2 mm.

Fig. 4 - *Neotrocholina* sp.. Scale bar is 0.2 mm.

Fig. 5 - *Protopeneroplis striata* WEYNSCHENK. Scale bar is 0.2 mm.

Fig.6 - *Nautiloculina* sp.. Scale bar is 0.2 mm.

Plate X – Foraminifers and other microfossils from the Săndulești Limestone Formation in Cheile Turenilor.

Fig. 1 - *Mercierella dacica* DRAGASTAN. Scale bar is 0.2 mm.

Fig. 2,3 – “*Trocholina*” sp. Scale bar is 0.4 mm.

Fig. 4 - “*Tubiphytes*” *morronensis* CRESCENTI. Scale bar is 0.8 mm.

Fig. 5 - *Mohlerina basiliensis* (MOHLER). Scale bar is 0.2 mm.

Fig. 6 - *Lithocodium aggregatum* ELLIOTT and *Trogrotella incrustans* WERNLI & FOOKES. Scale bar is 0.8 mm.

PLATE I

PLATE II

PLATE III

PLATE IV

PLATE V

PLATE VI

PLATE VII

PLATE VIII

PLATE IX

PLATE X