R.C.M.N.S. Interim Colloquium

MARCH 2011 - SCONTRONE (L'AQUILA), ITALY

Field Guide to the Post-Conference Excursions (Scontrone, Palena and Montagna della Majella)

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Edited by

Giorgio CARNEVALE*, Etta PATACCA** & Paolo SCANDONE**

**Dipartimento di Scienze della Terra, Università degli Studi di Torino*

***Dipartimento di Scienze della Terra, Università di Pisa*

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THE MAJELLA MIOCENE DEPOSITS

Etta PATACCA & Paolo SCANDONE

Dipartimento di Scienze della Terra, Università di Pisa

The *Lithothamnium* Limestone, characterized by a rich rhodalgal association, constitutes a deepening-upward sequence, conformably overlain by hemipelagic deposits (*Turborotalia multiloba* Marl), which occupies the upper portion of the Bolognano Group. The latter, usually quoted in the geological literature as the Bolognano Formation (e.g. Crescenti et al., 1969; Centamore et al., 2003) or Calcari a Briozoi e Litotamni Formation (e.g. Brandano & Corda, 2002; Pomar et al., 2004), is actually a higher-rank lithostratigraphic unit composed, in the most complete sections, of six formations (see foldout 3 in the guidebook):

- The *Lepidocyclina* Limestone and the overlying Cerratina Cherty Limestone;
- The Bryozoan Limestone and the overlying *Orbulina* Limestone;
- The *Lithothamnium* Limestone and the overlying T. multiloba Marl.

The Bolognano Group as a whole ranges in age from the late Oligocene to the late Miocene. The disconformities at the base of the *Lepidocyclina* Limestone, Bryozoan Limestone and *Lithothamnium* Limestone represent sequence boundaries controlled by global sea-level changes.

The chronostratigraphic scheme in foldout 3 shows that the most complete succession is exposed in Northern Majella where gaps separating the different sequences are relatively short. The

succession becomes more and more incomplete moving towards the south; at the southern margin of Majella (Guado di Coccia) the Messinian portion of the *Lithothamnium* Limestone lies directly above the Maastrichtian limestones of the Orfento Formation with a gap of about sixty million years. Such a wide stratigraphic hiatus is comparable with the one recorded in the Capo di Fiume section. The only differences between these two sections are represented by the "terra rossa" soil, present in the Capo di Fiume section and missing in the Guado di Coccia section, and by the facies of the *Lithothamnium* Limestone at Guado di Coccia and of the *Lithothamnium* Limestone equivalent at Capo di Fiume indicating respectively a marine environment with proliferation of red algae and corals (see Danese, 1999), and a coastal-transitional marine environment with an evolution from wetland to estuarine conditions.

The excursion has been planned in a way that participants can observe, along easily accessible sections, the progressive appearance of the different terms constituting the Bolognano Group and the concomitant decrease in the duration of the stratigraphic hiatuses separating the different depositional sequences. In the northernmost sections, where the hiatus between the *Orbulina* Limestone and the *Lithothamnium* Limestone is minimum or absent, the Tortonian-Messinian age of the *Lithothamnium* Limestone is well constrained by the first occurrence of *Neogloboquadrina acostaensis* in the upper portion of the *Orbulina* Limestone about 15 m. below the base of the *Lithothamnium* Limestone (Merola 2007 and by the first occurrence of *Bulimina echinata* near the top of the *Lithothamnium* Limestone.

Stop 1. Palena Cemetery

Along the Frentana Road near the Palena Cemetery (see fig. 1), the upper (Messinian) part of the *Lithothamnium* Limestone disconformably overlies Eocene nummulitid-bearing calcarenites referable to the Colle Remacinelli Formation (upper portion of the Santo Spirito Group). In the same section the *Lithothamnium* limestones, just a few metres thick, grade upward into spicule-rich hemipelagic marls (*Turborotalia multiloba* Marl).

Figure 1. *Palena Cemetery stratigraphic section. The Lithothamnium Limestone disconformably overlies the Eocene carbonates of the Santo Spirito Group and grade upwards to the Turborotalia multiloba Marl.* ***1.a****.*

General view on the section. ***1.b****. Detail of the disconformity. The duration of the stratigraphic gap approximates 26 million years.*

Figure 1b is a detail of the disconformity in which it is possible to see that the contact between the two formations follows the bedding planes with just a feeble evidence of erosion in spite of the very important stratigraphic gap of the duration of approximately 26 million years.

Stop 2. Vallone di Taranta

In the Vallone di Taranta section, exposed along the Frentana Road about 5 kilometres north of the Palena Cemetery, the gap between the *Lithothamnium* Limestone and the Eocene Calcarenites of the Santo Spirito Group is partly filled by two new formations represented by the Langhian Bryozoan Limestone and the Serravallian *Orbulina* Limestone (Fig.2).

Figure 2*. Vallone di Taranta stratigraphic section. The stratigraphic gap between the Lithothamnium Limestone and the Eocene carbonates of the Santo Spirito Formation is partly filled by a depositional sequence, lacking in the southernmost Majella area, made up of the Langhian Bryozoan*

Limestone and the Serravallian portion of the Orbulina Limestone Formation.

In addition, the column of the *Lithothamnium* Limestone is more complete as it includes a Tortonian portion that is lacking in the Palena Cemetery section. In this stop the Bryozoan Limestone is represented by 2-3 metres of cross-bedded bioclastic calcarenites strongly bioturbated and rich in glauconite grains in the upper portion where the rock assumes a characteristic greenish colour. *Praeorbulina transitoria* and *P. glomerosa* s.l., present at the base of the unit, indicate the N8 Zone. Near the top, *Orbulina suturalis* immediately followed by *Orbulina universa* indicates the latest N9/earliest N10 Zones. The glauconitic calcarenites are conformably overlain by 6-8 metres of thin-bedded pelagic limestones and marly limestones belonging to the *Orbulina* Limestone Formation. The planktonic foraminifer assemblage ranges from the N9 Zone after the FCO of *Orbulina universa* to the N13 Zone after the FO of *Paragloborotalia partimlabiata*. The overlying *Lithothamnium* Limestone Formation, disconformably overlying *Orbulina* Limestone, is represented by a deepening-up succession about 15 metres thick made up of detrital limestones rich in *Ammonia* and *Elphidium* grading upward into massive rhodolith-rich limestones. Near the top of the formation, where beds are separated by thin marly layers, benthonic foraminifers of the *Bulimina echinata* Zone are present. Finally, the *Lithothamnium* Limestone is conformably overlain by hemipelagic marls rich in sponge spicules containing *Turborotalia multiloba* (*T. multiloba* Marl).

Stop 3. Colle di Votta quarry near Abbateggio

In this stop the Messinian evaporites of the Gessoso-Solfifera Formation are exposed in the artificial section of an abandoned quarry. The section is constituted by some metres of massive selenite

overlain by a thinning-upward sequence 25-30 metres thick made up of gypsum (selenites, gypsrudites, gypsarenites, and laminated gypsum) alternating with sapropelic black shales more frequent and thicker in the upper part (Fig. 3).

***Figure 3**. Artificial section in the evaporites of the Messinian Gessoso-Solfifera Formation near Abbateggio.*

Stop 4. Roccamorice

In the northern Majella area all lithostratigraphic units forming the Bolognano Group are present, with the three almost complete depositional sequences each of them represented by inner or shallow middle-ramp transgressive calcarenites grading upwards into outer-ramp hemipelagic carbonate deposits:

Sequence 1, represented by the *Lepidocyclina* Limestone, conformably followed by the Cerratina Cherty Limestone (Chattian-Aquitanian);

Sequence 2, represented by the Bryozoan Limestone conformably followed by the *Orbulina* Limestone (Burdigalian-Tortonian p.p.);

Sequence 3 represented by the *Lithothamnium* Limestone conformably followed by the *T. multiloba* Marl (Tortonian p.p.-Messinian).

The three sequences are separated by very short gaps, as indicated in the chronostratigraphic scheme of foldout 3.

A complete section of the *Lithothamnium* Limestone Formation around 15 m thick can be observed near Roccamorice along the road connecting this village with San Valentino in Abruzzo Citeriore. The stratigraphic contact between the *Lithothamnium* Limestone and the underlying *Orbulina* Limestone is well exposed in the wall of a gorge delimiting Roccamorice in the west (Fig. 4.1). In the same valley the middle-upper portion of the *Orbulina* Limestone are also very well exposed (Fig. 4.2). The lowest terms are constituted of a few metres of nodular calcilutites, marly calcilutites and subordinate marls appearing in thin section as planktonic-foram wackestones. This portion is characterized by a pervasive bioturbation represented by burrowing parallel to the bedding and by frequent casts of *Zoophycus*. The nodular calcilutites are followed by about 15 metres of grey calcisiltites and very fine-grained calcarenites. In this interval burrowing parallel to the bedding is still frequent, but vertical traces are also developed and become prevalent in the upper part of the interval. In thin section the calcisiltites/calcarenites appear as bioclastic packstones to wackestones rich in planktonic foraminifers, echinoid spines, subordinate benthic foraminifers and unidentified biodetritus. In terms of sequence stratigraphy, the coarser-grained sediments of the second interval have been interpreted as the high-stand systems tract subsequent the maximum flooding.

Figure 5 shows a columnar section of the *Lithothamnium* Limestone in the Roccamorice area which has been correlated with a columnar section of the *Lithothamnium* Limestone cropping out at Scontrone Cemetery. The two sections are basically identical, apart from the high-energy bars at the base of the *Lithothamnium* Limestone of Scontrone Cemetery which were deposited on an inner ramp during the marine transgression and did not develop in the more distal depositional domain of the northern Majella area. The **a-**

e intervals in the left side of the Scontrone Cemetery column indicate the major deepening steps of the sedimentary sequence.

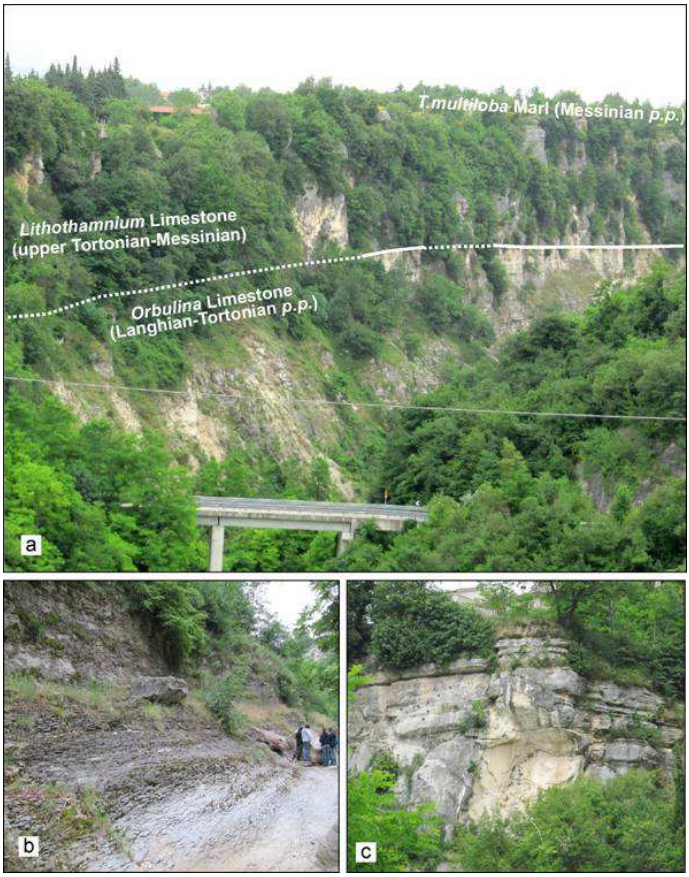

***Figure 4**. Roccamorice stratigraphic section in the Tortonian-Messinian Lithothamnium Limestone. **4.a**. General view of the contact between the Orbulina Limestone and the Lithothamnium Limestone formations in the gorge west of Roccamorice. **4.b**. Detail of the Orbulina Limestone in the same gorge of figure 4.a. **4.c**. Upper portion of the Lithothamnium Limestone. The Messinian benthic foraminifer Bulimina echinata has been found at the top of this interval.*

Examples of microfacies characterizing the different intervals are provided in the a-e pictures. The first interval**,** present only in the Scontrone area, is represented by 3 metres of lithobioclastic calcarenites displaying large-scale and low-angle cross stratification. The microfacies (picture a in Fig. 5) is represented by fine to medium-grained bioclastic packstones/grainstones with large-sized *Ammonia* (lower and upper left side of the picture) and *Elphidium crispum* (upper right side). The characteristic *Ammonia*-and-*Elphidium* association and the evident winnowing of the sediment suggest a nearshore environment with reduced salinity.

Interval **b**, displaying identical characteristics both in the Scontrone and Roccamorice areas, consists of 2 metres of bioclastic calcarenites rich in *Heterostegina*, deposited on a shallow middle ramp. In thin section (picture b in Fig. 5) these calcarenites appear as coarse-grained litho-bioclastic packstones rich in abraded skeletal particles, fragmented red-algal rhodoids (lower left side of the microphotograph) and *Heterostegina* (upper right side) associated with *Elphidium crispum* (centre). The *Heterostegina*-bearing calcarenites are overlain by about 10 metres of massively-bedded limestones and subordinate marly limestones rich in *Lithothamnium* thallii that form well-developed rhodoliths (interval **c**). The depositional environment was a deeper middle ramp. Thin sections from this portion of the unit show a rhodolith floatstone with very large composite red algal-bryozoan rhodoids set in a silty bioclastic matrix (picture c in Fig. 5). The litho-biofacies of this relatively muddier interval points to a low-energy mid-ramp setting with temperate water. Interval **c** is overlain by about 3 metres of bedded marly limestones with thin marly interlayers (interval **d** in Fig. 5; see also Fig. 4.3) deposited over an outer ramp. The marly limestones still contain dispersed *Lithothamnium* thallii together with bivalves, mostly pectinids. Occasional beds of *Heterostegina*-bearing calcarenites (packstones rich in *Heterostegina* associated with

fragmented echinoid spines and scattered planktonic forams, see picture e in Fig. 5) represent sporadic storm accumulations on an open, warm/temperate outer-ramp setting below fair weather wave base.

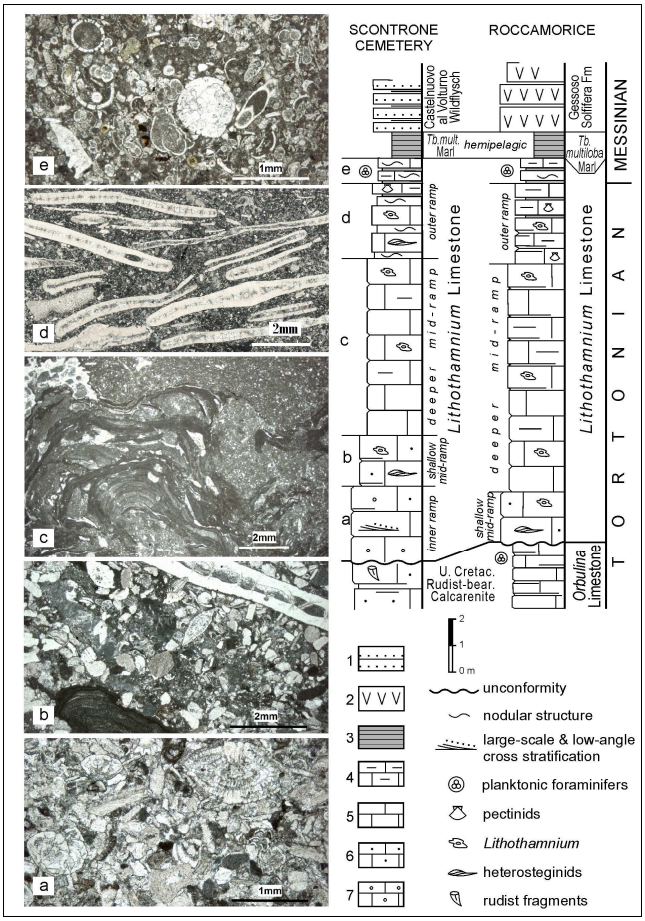

Figure 5. *Columnar section of the Lithothamnium Limestone Formation in the Roccamorice area and correlation with the Lithothamnium Limestone*

exposed in the Scontrone Cemetery section. Explanations are in the text. 1, Fine-grained sandstones; 2, gypsum; 3, Marls and calcareous marls; 4, Marly limestones; 5, Calcilutites; 6, Bioclastic calcarenites; 7, Bioclastic calcarenites with oversized lithoclasts.

The uppermost portion of the *Lithothamnium* Limestone is everywhere represented by 1 metre of condensed marly limestones with clayey interlayers (interval **e** in Fig. 5). In thin section (picture e in Fig. 5) these marly limestones appear as foraminiferal packstones with large-sized *Orbulina universa* (e.g., in the centre and at the upper left side of the microphotograph), subordinate bolivinids and other benthic forams with hyaline calcareous well. The abundance of phosphatic coprolites and large, rounded glauconite grains together with the strong bioturbation suggest that these condensed marly limestones were deposited in a starved outer-ramp setting. The condensed interval has been attributed to the early Messinian because of the diffuse presence of *Rectuvigerina* characterizing the *Bulimina echinata* Zone of Colalongo & Sartoni (1979). This moment represents at the regional scale a moment of maximum flooding and of maximum landward encroachment of the shoreline in the innermost portions of the carbonate ramp which allow useful temporal correlations between shallow and deeper marine environments in the whole study area.

The *Lithothamnium* Limestone is everywhere conformably overlain by spicule-rich marls containing the marker *Turborotalia multiloba* (*T. multiloba* Marl). The first common occurrence of *Turborotalia multiloba* has been astronomically positioned at 6.415 Ma (see Hilgen & Krijgsman, 1999; Sierro et al., 2001).

In the Scontrone Cemetery section the *Lithothamnium* Limestone overlies the upper Albian-Turonian Rudist-bearing Calcarenite with a remarkable hiatus between the two lithostratigraphic units. In the Roccamorice section, on the contrary,

no significant temporal gap separates the *Lithothamnium* Limestone from the underlying Orbulina Limestone. Careful biostratigraphic investigations in the entire northern Majella area (Merola, 2007) allowed the recognition of important bioevents defining the age of the upper portion of the *Orbulina* Limestone: last occurrence of *Paragloborotalia siakensis* (about 15 metres below the top of the formation) immediately followed by the first occurrence of *Neogloboquadrina atlantica* and finally by the first occurrence of *Neogloboquadrina acostaensis*. The last occurrence of Pg. *siakensis* marks the top of the N14 Blow's Zone while *N. acostaensis* is a base marker of the N16Zone (Blow 1969). The first occurrence of the *Neogloboquadrina* group falls very close to the GSSP (Global boundary Stratotype Section and Point) of the Tortonian stage recently established in the Monte dei Corvi section near Ancona (Italy) which as been astronomically dated at 11.608 Ma (Hilgen et al., 2005).

In the Scontrone area it is impossible to date the base of the *Lithothamnium* Limestone, and therefore it is impossible to date by direct evidence the vertebrate-bearing deposits. In the Roccamorice section, on the contrary, the base of the *Lithothamnium* Limestone is chronologically well constrained by the Serravallian-Tortonian boundary recognized in the uppermost portion of the *Orbulina* Limestone. The boundary between the Tortonian portion of the *Lithothamnium* Limestone and the Messinian one is not well defined, but the recognition of the *Bulimina echinata* Zone at the top of the formation indicates, in any case, that the bulk of the limestones have a Tortonian age. Consequently, the terrestrial vertebrates of Scontrone, contained in deposits that occupy a basal position in the *Lithothamnium* Limestone Formation, cannot be younger than the Tortonian.

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