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The Lower Triassic continental to transitional deposits of the Maritime Alps (NW Italy): stratigraphical and sedimentological features

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ABSTRACT - The summarized results are here presented of an investigation undertaken on the continental to transitional siliciclastic Lower Triassic deposits of the Maritime Alps. Stratigraphic sections of the involved units has been described, analyzed and correlated A) to refer correctly the outcrops to the proper formational unit; B) to infer the stratigraphic relationships of the different lithofacies; C) to assess the depositional environments and their lateral variability through times, in order to relate them to the general transgressive trend of the Early Triassic.

Keywords: Continental environment; Lower Triassic; Maritime Alps; Sedimentology; Stratigraphy.

1. INTRODUCTION

Investigations on the basal deposits of the Mesozoic transgression are currently undertaken in some areas of the Southwestern Alps. Although very similar each other, in detail the studied successions show diverse features accordingly with the location. In fact, the Maritime Alps succession (Ormea-Upega sector) presents some significant variations of thicknesses and features in respect to that one outcropping in the northward Cottian Alps area (Demonte-Acceglio sector: Costamagna, 2013) (Fig. 1). A certain lateral variability has been evidenced even in the single analyzed sectors. Here the Maritime Alps sector will be presented.

2. GEOLOGICAL FRAMEWORK

In Maritime Alps the Triassic deposits start unconformably over Permian volcanosedimentary deposits (rhyolites, pyroclastics and rare embedded pelitic beds of the Porfiroidi del Melogno Fm: Cabella et al., 1988; Dallagiovanna and Gaggero, 2006). First are the coarse mainly quartzose siliciclastics of the Verrucano Brianzonese *sensu* Cassinis and Perotti, 2006). They are covered by the finer Ponte di Nava Quarzites Fm (Boni et al., 1971). Upwards follow thin greenish pelites (Case Valmarenca Pelites Fm, Vanossi, 1974, 1991) that represent the transition to the upper Middle Triassic carbonate ramp units (Costa Losera Fm, Lualdi and Bianchi, 1990). The age of the previously mentioned siliciclastic Early Triassic units is inferred basing on their relative position, posed unconformably over the Permian units and below the paleontologically well-dated Middle Triassic carbonates. All the successions are significantly deformed by the Alpine tectonics.

3. STRATIGRAPHICAL AND SEDIMENTOLOGICAL DATA

In the investigated area from E to W five stratigraphic successions (Aimoni, Quarzina E, Quarzina W, Passo Laiardo, Upega: Figs. 1, 2) have been characterized and sampled.

In the easternmost Aimoni stratigraphic section, located along the road cuts of a secondary road leading to the Quarzina village, over the Early Permian Porfiroidi del Melogno Auct. volcanosedimentary complex rest:

1) 3 m of massive to poorly bedded FU alternations built of polygenic conglomeratic (pebbles of red porphyritic bodies, greenish cineritic pyroclastics and quartz), to arenaceous (quartz and feldspars) sequences with subangular to subrounded elements from well-sorted to moderately well sorted. The basal unconformable contact is not clearly visible.

2) The unit 1 pass upwards to 60 to 70 m of poorly stratified, locally massive greenish well-sorted quartzose litharenites with minor polygenic microconglomerates mainly built of small pebbles of greenish cineritic pyroclastics and subordinated quartz. This interval is possibly organized in metric depositional FU couplets featured by a lower and thinner massive, coarse base and an upper thicker, locally bedded finer top. Locally cross-

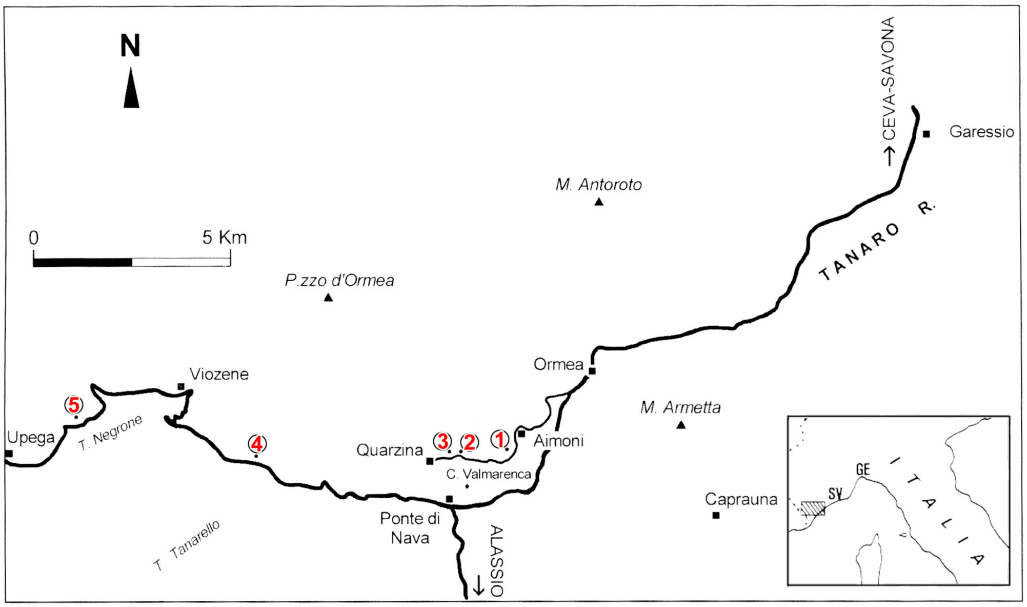

Fig. 1 - Localization of the Maritime Alps stratigraphic sections: 1) Aimoni; 2) Quarzina E; 3) Quarzina W; 4) Passo Laiardo; 5) Upega.

bedding structures has been noticed. In the top of the interval a resumption of polygenic conglomerates takes place.

3) 15 metres of bedded alternations of coarse litharenites to quartzarenites, moderately well-sorted monogenic quartzose conglomerates, rare greenish middle grain-sized sandstones. They locally form FU sequences.

4) 20 m of irregular alternations of well-sorted fine to middle grain-sized quartzarenites: perhaps they form cyclical alternations.

5) 20 m thick transitional zone follows: irregular alternations of light quartzarenites and greenish, locally laminated quartzarenites-quartzsiltites-litharenites.

Scattered beds of greenish-brownish pelites showing localized ripple mark structures are present.

6) The section ends with nearly 10 metres of tightly bedded quartzsiltites and greenish-brownish pelites showing sedimentary structures (cross bedding, flaser bedding) and containing rare beds of whitish quartzarenites.

This stratigraphic section dips southward but with highly variable inclination: thus, since the presence of folds and doublings are suspected, the inferred thickness of 130-140 m is conjectural. The interval 1 is referable to the Verrucano Brianzonese Fm. The intervals 2 to 4 pertain to the Ponte di Nava Quarzites Fm. The interval 5 represents the gradual transition to the Case Valmarenca Pelites Fm, while the interval 6 pertains to the Case Valmarenca Pelites Fm.

Westward, still along the secondary road to the Quarzina village is the Quarzina E stratigraphic section. Over the Early Permian volcanic breccias of the Porfiroidi del Melogno complex rest:

1) 15 m of well-bedded polygenic, quartz-dominated conglomerates with subangular to rounded elements and rare lens of quartzarenites. Rare pebbles of red porphyritic bodies and greenish cineritic pyroclastics occur. Cross-bedding is present. The basal contact is not clearly visible.

2) 8 m of monogenic quartzose, finer cross-bedded conglomerates containing lenses of coarse quartzarenites. A possible NW-ward paleoflow has been measured.

3) 20 m of cross-bedded quartzose conglomerates and microconglomerates embedding lenses of exceptionally well-exposed coarse cross-bedded pebbly quartzarenites (Fig. 3). Local recirculations of hematite and dm-sized pebbles of red porphyritic bodies are scattered.

4) 10 m of cross-bedded pebbly quartzose micro-conglomerates and coarse pebbly quartzarenites. Local beds of quartzose conglomerates are still present. Again, a NW-ward paleoflow has been measured.

5) 20 m of well-bedded pebbly quartzarenites with rare intercalations of greenish fine quartzarenites. Rare beds and lenses of cross-bedded quartzarenites are present.

6) The section end with some tens of metres of fine whitish quartzarenites alternated with greenish quartzsiltites.

This stratigraphic section dips SE with an average inclination of 30°. A thickness of less than 100 m is supposed. The intervals 1 is referable to the Verrucano Brianzonese Fm. The intervals 2 to 5 form the Ponte di Nava Quarzites Fm. The interval 6 represents the transition to the Case Valmarenca Pelites Fm.

And still westward along the road cuts of a secondary road to the Quarzina village is the Quarzina W stratigraphic section. Again over Early Permian volcanic breccias belonging to the Porfiroidi del Melogno volcano-sedimentary complex rest:

1) 1 m of chaotic, poorly sorted and heterogeneous polygenic conglomerates with angular elements probably representing the eluvium resting directly over the metavolcanics.

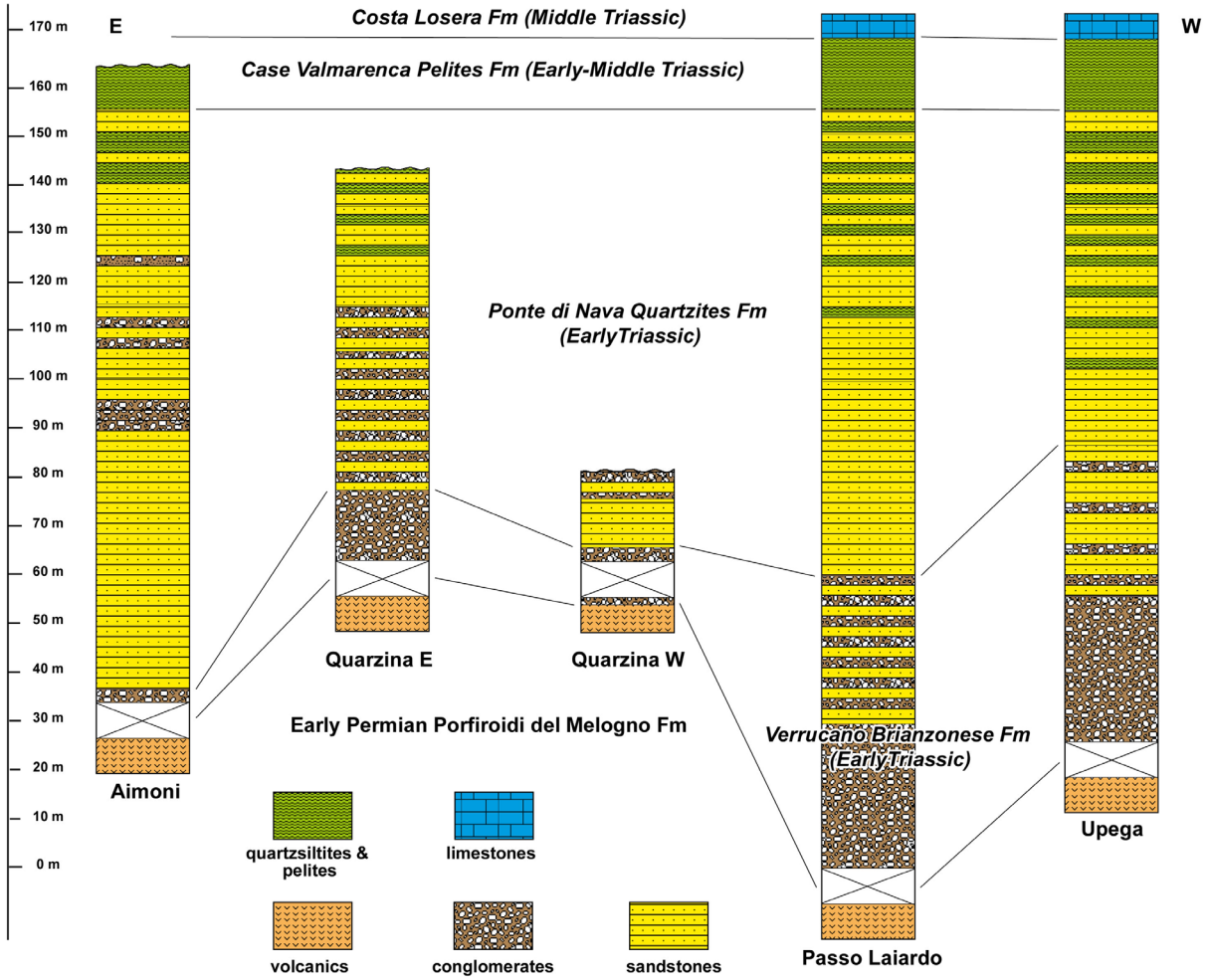

Fig. 2 - Lower Triassic stratigraphic sections of the Maritime Alps area.

Fig. 3 - Quarzina E section, interval 3: cross-bedded quartzarenites in the Ponte di Nava Quartzites Fm.

2) 1 to 2 m of polygenic conglomerates with dominant quartz pebbles with minor pebbles of red porphyritic bodies;

3) 10 m of alternations of whitish quartzarenites.

4) 5 m of alternations of conglomeratic breccias and whitish quartzarenites.

The upwards prosecution of the section is covered by alluvial debris. Its whole thickness is not more than 20 m. The interval1 belongs to the Verrucano Brianzonese Fm while the intervals 2 and 3 pertain to the Ponte di Nava Quartzites Fm.

Along the road running the Tanaro Valley towards Viozene and Upega, the road cuts expose two others stratigraphic sections in Lower Triassic deposits. At the Km 5.1 the Passo Laiardo section has been characterized.

Here, over the greenish pyroclastics of the Porfiroidi del Melogno complex, rest with contact hidden by debris:

1) 60 m of well-bedded alternations of coarse monogenic quartzose conglomerates: in the upper half conglomeratic sandstones with minor laminated quartzarenites appear: they possibly form FU sequences.

2) 40 m of whitish quartzarenites with rare intercalations of quartzose conglomerates. In the upper part rare hematitic recirculations have been found.

3) 50 m of quartzarenitic beds in which gradually appear intercalated greenish quartzarenitic-quartzsiltitic beds until they form tight alternations with the whitish quartzarenites.

4) 20 m in which the whitish quartzarenites gradually disappear and the greenish quartzarenites-quartzsiltites become dominant: their carbonate content grows up gradually to finally change them to finely stratified marly beds forming a transitional belt about 20 m thick that in their turn give sharply way to the Middle Triassic limestones of the Costa Losera Fm.

This stratigraphic section dips strongly S. The thickness of the section is estimated to be nearly 160 m. The interval 1 are referred to the Verrucano Brianzonese Fm, while the 2 and 3 pertain to the Ponte di Nava Quartzites Fm that in their upper part pass transitionally to the interval 4 belonging to the Case Valmarenca Pelites Fm.

Passed the Viozene village, at the km 13.5 of the road to the Upega village, there is the Upega section. Here, over the greenish pyroclastics and the reddish porphyritic bodies of the

Porfiroidi del Melogno complex Fm, rest with contact hidden by debris:

1) 60 m of well-bedded alternations of quartzose conglomerates (with rare pebbles of reddish porphyritic bodies and greenish pyroclastics) and pebbly quartzarenites with faint cross bedding.

2) 50 m of quartzarenites in which gradually intercalate fine whitish quartzarenites and greenish quartzarenitic-quartzsiltitic beds until they form tight alternations with the whitish quartzarenites. In the upper part of the interval, cross bedding is highly diffuse in the whitish quartzarenites.

3) 20 m in which the cross-bedded whitish quartzarenites disappear and are replaced by marly pelites.

4) 15 m of finely bedded marly pelites with cross-bedding, flaser bedding, ripple marks, and interference ripple marks on the strata surfaces. They pass suddenly upwards to the Middle Triassic limestones of the Costa Losera Fm.

This stratigraphic section dips strongly SW. Its thickness is about 150 m. The interval 1 belongs to the Verrucano Brianzonese Fm, while the 2 and 3 pertain to the Ponte di Nava Quartzites Fm. The interval 4 can be referred to the Case Valmarenca Pelites Fm.

4. DISCUSSION AND CONCLUSIONS

One of the main problems to address has been the separation between the Verrucano Brianzonese Fm and the Ponte di Nava Quartzites Fm, since the two units have always a gradational passage and the separation has not been clearly performed before. The separation has been done using as criteria A) grain-size; B) composition; C) sedimentary structure content. The reasonable use of together all the three criteria gave satisfying results. So, while the Verrucano Brianzonese Fm is a generally coarser unit containing also pebbles of the Porfiroidi del Melogno complex and poor of sedimentary structures, conversely the Ponte di Nava Quartzites Fm is a finer unit composed usually only by quartz pebbles and grains, and rich of sedimentary structures. Locally this latter unit may be rich of lithoclasts and so bearing thick litharenitic beds.

The exposed sedimentary features allow to correlate the different intervals of the surveyed stratigraphic sections (Fig. 2) and to infer their depositional environment. The Verrucano Brianzonese Fm pertains to middle to high-energy alluvial (fan?) environments levelling the older articulated Variscan and Permian volcanic morphology: it is featured by frequent chaotic depositional events. It gradually interdigitates and passes upwards to the Ponte di Nava Quartzites Fm, this representing a middle energy fluvial braided environment characterized by possibly transverse bars which directions appear to be steady (NW-ward) in the studied area. The local resumption of conglomerates in the upper Ponte di Nava Quartzites Fm may be referred to late extensional tectonic movements of a fall in the LMR. The Ponte di Nava Quartzites Fm gradually passes through alternations with finer, greenish deposits to the transitional Case Valmarenca Pelites Fm, characterized by tidal features, and foretelling the passage to the marine Middle Triassic carbonate units. The comparison of the several stratigraphic sections evidences a certain degree of lateral variability of the stratigraphic units even at short distance, perhaps related to the articulated morphology they cover. The same lateral variability of the stratigraphic sections enforces a not-marine environment for all the quartzose lithotypes.

The basal Verrucano Brianzonese Fm has been previously referred to the Permian (e.g. Cassinis and Perotti, 2006), but based on its stratigraphic continuity

with the following quartzarenitic unit, their passage featured by an interfingering of the two units, and its analogies with other close well-dated Early Triassic successions (Provence, Sardinia: Cassinis et al., 2000, and references therein) it is possible to refer it instead to the Early Triassic times together with the quartzarenites and the pelites as a whole sedimentary sequence leading to marine environments.

Petrographic investigations currently underway will allow to enlighten the provenance of the feeding debris of the unit.

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