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THE BEGINNING OF THE PIEDMONT TERTIARY BASIN HISTORY: SOME OBSERVATIONS ON THE "ALTO MONFERRATO" AREA

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Riassunto. In questa nota vengono brevemente esaminate le principali caratteristiche della Formazione di Molare (Oligocene) affiorante nell'Alto Monferrato, tra il Rio Morsone, Mornese e Bosio. Vengono quindi delineate le fasi iniziali della storia geologica del Bacino Terziario ligure-piemontese, con particolare riguardo all'area presa in esame.

Abstract. The main features of the Oligocene Molare Fm. cropping out in the "Alto Monferrato" area (Piedmont Tertiary Basin, Northern Italy) are briefly summarized. Lithofacies associations and sandstone composition allow to outline the initial stage of the PTB history in the examined area.

Introduction.

The Piedmont Tertiary Basin (PTB) is bordered southwards and westwards by the Western Alps, while northwards by the north-western end of Apennines. It represents an episutural basin developed on a substrate consisting of allochthonous Alpine and Apenninic units. Its history began at the Eocene-Oligocene boundary and has continued through the Oligocene in a scenario mainly dominated by extensional tectonics, and then through the Miocene under compressional tectonic conditions. A succession of siliciclastic deposits more than 4,000 m thick filled up the basin during its development (Gelati et al., 1993).

In this paper a small, but key-area is considered, in which a very thick Early Oligocene succession crops out: the "Alto Monferrato", in the eastern part of the PTB.

The Early Oligocene succession of the Rio Morsone-Bosio transect (Alto Monferrato).

In the area between Stura River and Lemme River valleys (eastern part of the PTB), a thick, mainly conglomeratic succession marks the beginning of the PTB history. These deposits (Molare Fm. in the Sheet No. 82 Genova of the Italian Geological Map 1:100,000), have been inferred to represent fan delta depositional systems of Oligocene age.

Along the Rio Morsone-Bosio transect (Fig. 1) it is possible to observe the following members, from bottom to top:

1) The first member consists of a succession made of pebble to cobble conglomerates, with local intercalations of sandstones or pebbly sandstones, up to 350 m thick (Fig. 2A). Referring to the facies code proposed by Postma (1990) the observed deposits can be ascribed mainly to lithofacies Gm, Gms, (Gh), (Gp), St, Sp, Sh; conglomerates with a rough inverse grading are also present.

In the lower part of member 1, a large tree in living position (Fig. 2B) was observed. Now unfor-

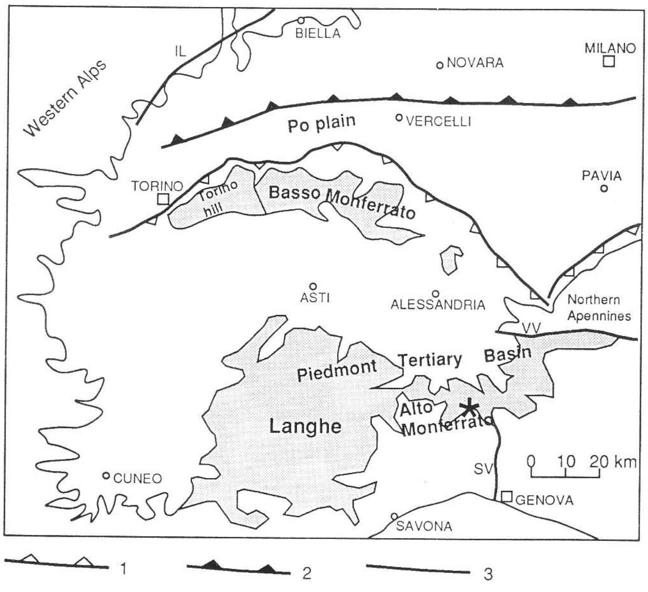

Fig. 1 - The Piedmont Tertiary Basin, northern Italy (modified after Falletti et al., in press). The asterisk indicates the studied area. 1) Thrust front of the Northern Apennines; 2) thrust front of the Western and Southern Alps; 3) tectonic lines (SV, Sestri-Voltaggio; VV, Villalvernia-Varzi; IL, Insubric Line).

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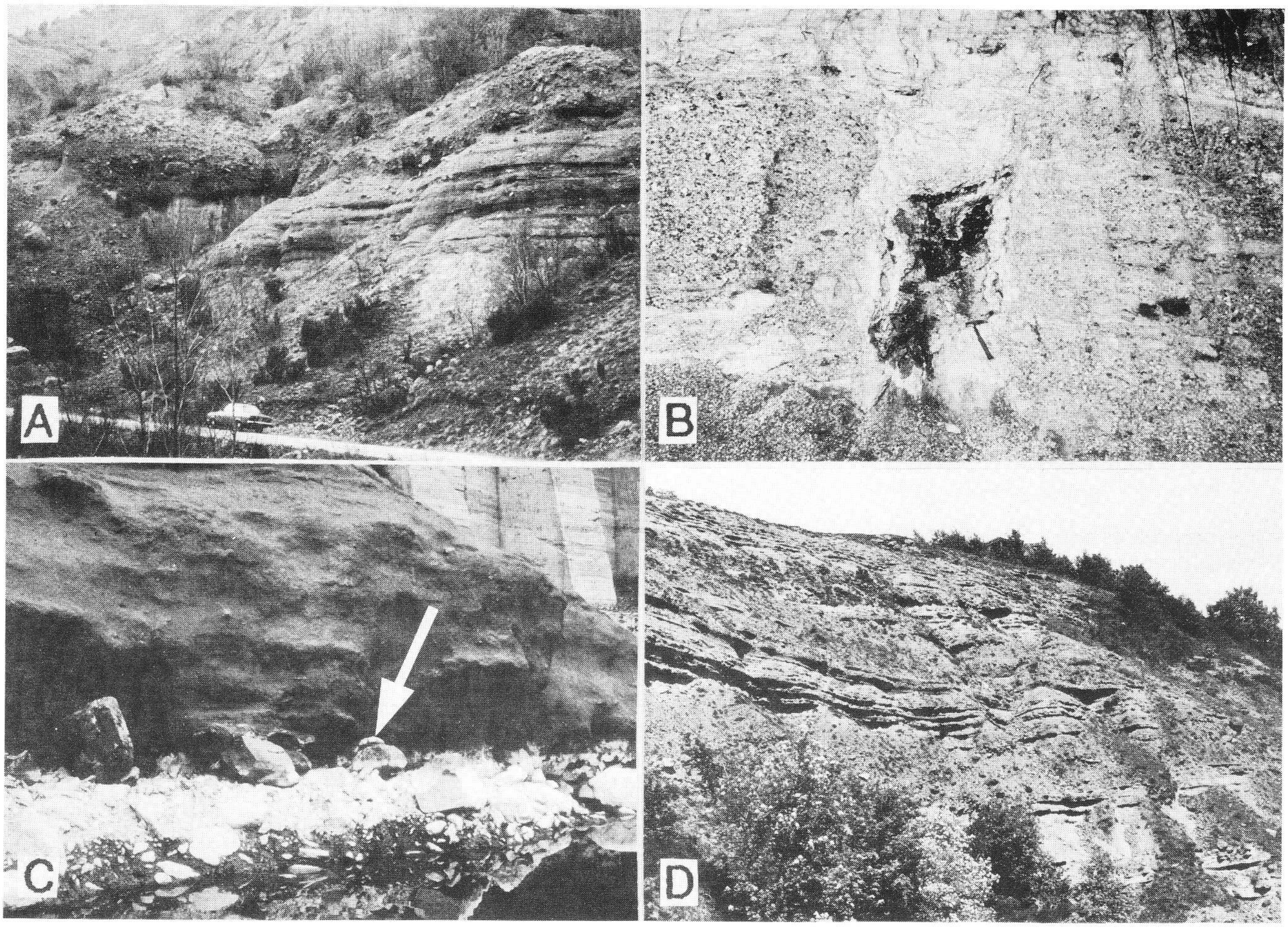

Fig. 2 - A) Massive conglomerates of member 1 in the Rio Morsone valley. B) A fossil tree in living position in the lower part of member 1, Rio Morsone valley. C) Ravinement surface at the boundary between members 1 and 2; a small coral colony is indicated by the arrow. D) Conglomerates and sandstones of member 3 near Bosio.

tunately it is lost owing to the widening of the small road of the Rio Morsone valley.

These sediments were apparently deposited in a subaerial setting (Gnaccolini, 1978b), as an alluvial fan or as the subaerial part of a coarse-grained fan delta (*sensu* Nemec & Steel, 1987, 1988).

About 130 m from the base of this interval, a local intercalation of intensively bioturbated sandstones, associated with laminated sandstones and some well-rounded pebble to cobble conglomerates, has been observed, testifying an aborted transgressive event.

Modal analysis of seven sandstone samples from member 1 (250 grains counted; Gazzi-Dickinson method, Zuffa 1980) gave the following QFL mean composition (Fig. 4):

Q = 7.6% (standard deviation 7.7);
F = 1.9% (s.d. 2.0);
L = 90.2% (s.d. 9.2).

Serpentinite fragments are the most abundant among L components (Fig. 3).

2) The second member (10-30 m thick) consists of bioturbated sandstones, with pelecypod, echinoid and coral fragments and macroforaminifers. These sandstones, interpretable as shoreface deposits (Gnaccolini, 1978a), generally overlie a cobble to boulder alignment, locally encrusted by small coral colonies or oysters (Fig. 2 C), and grade upwards to shelf fossiliferous siltstones (mainly benthic foraminifers; planktonic foraminifers are rare).

Member 2 is observable in the whole examined area and testifies to a well-defined transgressive event.

Modal analysis of six sandstone samples gave the following QFL mean composition (Fig. 4):

Q = 36.1% (standard deviation 15.9);
F = 4.1% (s.d. 1.7);
L = 59.5% (s.d. 17.0).

It is worth noting the difference in composition between these samples and the sandstones of member 1. Fig. 3 shows the apparent increase of quartz grains and the decrease of serpentinite fragments passing from member 1 to member 2.

3) Member 3 (120 m thick) is made of a succession of pebble to cobble conglomerates, sandy conglomerates and sandstones (Fig. 2 D), locally fossiliferous (pelecypods, gastropods, echinoids). Considering the facies code proposed by Postma (1990), these deposits can

SAMPLE N.	310	311	306	307	308	314	315	316	301	302	303	304	305	332	321	322	323	324	325	326	327	328	329	330	331
Monocrystalline quartz	-	0.8	1.6	4.4	1.6	12.4	12.4	14.4	30.0	26.0	30.0	18.8	8.8	4.0	12.0	14.0	20.8	16.0	12.8	19.8	2.4	17.6	15.6	12.8	18.8
Policrystalline quartz	0.4	0.8	0.8	0.4	-	1.6	1.6	5.6	1.6	2.4	2.4	-	-	0.4	1.2	1.6	2.8	2.8	3.2	2.0	0.4	1.6	1.2	1.2	1.6
Feldspar	2.0	0.4	2.0	0.4	-	4.4	1.6	1.2	3.6	4.4	2.4	2.8	2.0	0.8	3.2	5.6	1.2	3.2	2.0	2.0	0.4	2.0	3.6	5.2	4.8
Quartz+mica lithics	0.4	-	-	-	0.4	3.2	1.6	2.8	4.8	1.2	0.4	1.2	-	0.8	2.8	6.0	7.2	10.4	2.4	5.6	0.4	4.0	2.0	3.2	3.2
Acidic metavolcanites	-	-	-	-	-	-	-	2.4	0.4	0.4	-	-	-	-	-	0.4	-	-	-	-	-	-	-	-	-
Metabasites	5.2	0.4	5.6	4.4	0.4	4.0	2.8	8.8	3.6	4.4	2.0	0.8	4.4	2.0	2.8	3.2	2.4	2.4	3.6	2.0	1.2	1.6	3.6	4.8	3.2
Serpentinites	88.4	72.0	71.2	76.8	32.4	46.8	56.4	40.0	26.0	31.2	18.4	30.0	59.6	80.4	66.0	53.2	41.2	36.0	47.6	44.4	80.8	47.2	52.4	52.0	53.2
Extrabasinal carbonates	-	5.6	6.0	2.4	62.0	-	-	14.8	-	0.4	-	0.8	-	-	0.4	0.8	-	10.4	1.6	-	-	-	-	0.4	0.4
Micas, chlorites	1.2	8.4	7.2	6.4	1.2	20.8	18.8	8.4	23.6	20.8	36.4	35.2	12.4	6.4	10.0	13.2	21.6	15.6	24.0	17.6	6.4	14.8	18.8	14.8	9.6
Heavy minerals	0.8	10.0	2.8	2.0	1.2	4.0	3.2	0.8	2.0	7.6	2.0	6.8	9.6	2.8	-	2.0	2.4	1.2	1.6	1.2	7.2	1.6	1.6	3.6	0.8
Bioclasts	-	-	-	-	-	-	-	-	2.0	0.4	4.4	0.4	0.4	-	0.4	-	-	-	-	4.8	-	7.2	-	0.8	2.8
Undeterminate grains	1.6	1.6	2.8	2.8	0.8	2.8	1.6	0.8	2.4	0.8	1.6	3.2	2.8	2.4	0.4	-	0.4	2.0	1.2	0.8	0.8	2.4	1.2	1.2	1.6

Tab. 1 - Sandstone composition (250 grains counted, Gazzi-Dickinson method, Zuffa 1980). Samples 310 to 315, member 1; samples 316 to 305, member 2; samples 332 to 331, member 3.

be described as Gms, Shl, Shc; conglomerates with a rough normal grading are also present. Thin, bioturbated siltstones, with benthic and planktonic foraminifers, are locally intercalated in the upper portion of member 3.

This succession is inferred to be deposited in a subaqueous setting, probably as the subaqueous part of a fan delta body (Gnaccolini, 1978b).

The mean QFL composition (twelve samples) is the following (Fig. 4):

Q = 19.9% (standard deviation 8.7);
F = 3.5% (s.d. 2.0);
L = 76.4% (s.d. 9.5).

The composition of these sandstones is clearly different from that of member 2, but more similar to that of member 1 sandstones.

As far as the quartz and serpentinite fragments percentage is concerned, it is worth of note the sudden increase of serpentinite and the decrease of quartz grains passing from member 2 to member 3 (Fig. 3).

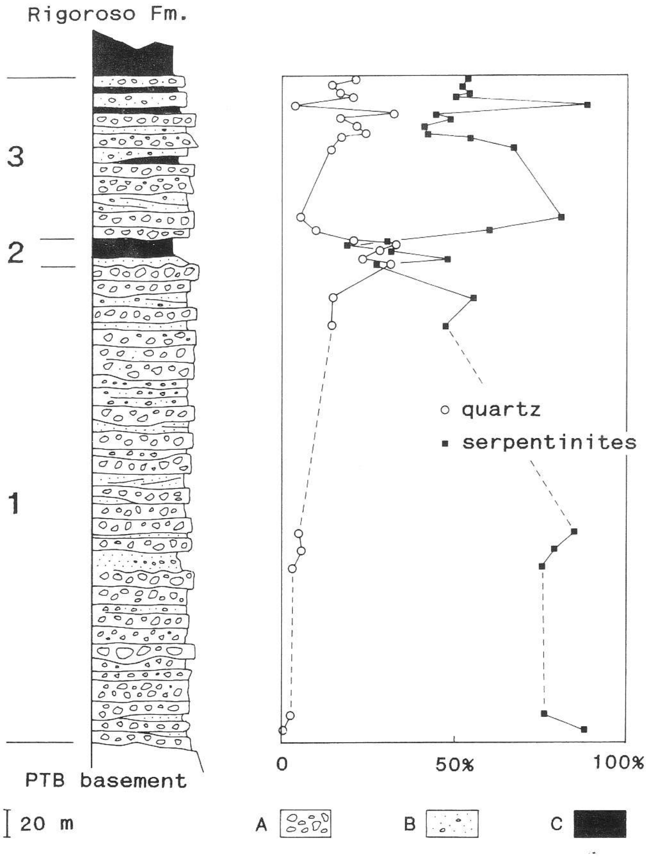

Fig. 3 - Schematic columnar section of the Rio Morsone-Bosio transect. A) Conglomerates; B) sandstones and pebbly sandstones; C) mudstones. On the right, quartz and serpentinite percentage on the total NCE content (25 sandstone samples).

Geologic evolution of the region during the individualisation of the PTB.

Even if the studied area represents only a small part of the PTB, it is one of the region where the Molare Fm., which marks the beginning of the PTB history, shows very good exposures and can be better analysed. The examined region, therefore, can be con-

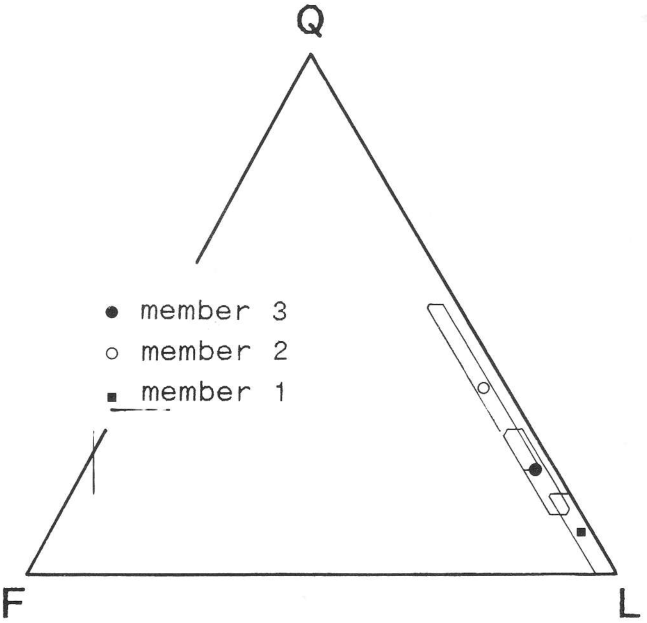

Fig. 4 - QFL diagram of sandstones from members 1, 2 and 3. Mean values and standard deviation polygons are shown.

sidered as a reference area, where key informations on the major events which characterized the beginning of the history of the PTB can be obtained.

On the basis of the previously exposed data, the following steps have been envisaged.

The first step was the sudden onset of a highly subsiding area, bordered by steep reliefs. The active erosional processes provided an abundant supply of coarse sediment to the basin, forming large alluvial fan bodies (member 1) probably facing the sea (with a first, aborted attempt of marine ingression in the middle portion).

The sandstone composition of member 1 points to a completely local feeding, mainly from the serpentinite rocks of the adjacent uplands.

Above the subaerial deposits of member 1, member 2 records a well-established marine transgression, marked by a ravinement surface traceable from the Stura River to the Lemme River valleys.

In this interval, the sandstone composition is characterized by a remarkable increase of quartz grains and by a contemporaneous strong decrease of serpentinite fragments, pointing to some reworking by waves and new "lateral" inputs, connected with longshore drifting processes.

The transgression could be related to: a) an increase of the rate of subsidence in the whole region, accompanied by a relevant retrogradation of the shoreline; b) a decreased sediment supply from the deeply eroded source area, the rate of subsidence being invariate; c) a quick eustatic rise.

The sudden input of coarse-grained sediments that marks the beginning of member 3 points to a renewed uplift of the source area, and is related to the progradation of coarse-grained fan delta slope deposits on the previous inner to outer shelf siltstones.

As far as the sandstone composition is concerned, this phase is characterized by the sudden increase of serpentinite fragments and by the contemporaneous decrease of quartz.

Final remarks.

Taking into account the overall transgressive trend of the studied succession, which is capped by the hemipelagic mudstones of the Rigoroso Fm., the depositional architecture could be outlined as in Fig. 5. The evolution of the area seems to be essentially related to accretionary transgressive events, interrupted by progradational pulses, the region being generally characterized by a subtle balance between rate of sediment supply and rate of relative sea-level rise.

According to Helland-Hansen and Gjelberg (1994), an accretionary transgression can produce a complete preservation of facies with a fining and deepening upwards succession if the "shoreline trajectory" has a steeper gradient than the slope of shoreface, as it could be the case for member 3 (Fig. 5). If the "shoreline trajectory" has a lower gradient than the slope of shoreface, the succession may be less complete and may include a ravinement surface, as it could be the case for members 1+2 (Fig. 5). A depositional setting characterized by an accretionary transgression (rising relative sea-level, oversupply of sediments) could promote sediment gravity flow processes, transferring coarse-grained sediments from the fan-delta front to the slope and basin floor.

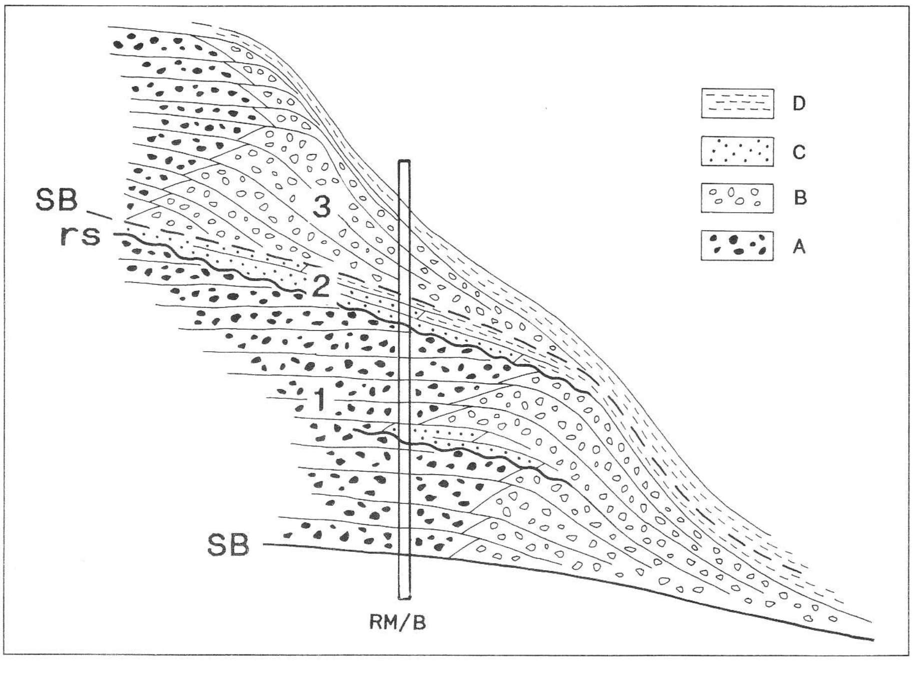

Fig. 5 - The Early Oligocene succession of the "Alto Monferrato": basin architecture. A) Alluvial fan/subaerial segment of a fan delta; B) subaqueous segment of a fan delta; C) shoreface transgressive deposits; D) offshore deposits; SB) sequence boundary; rs) ravinement surface; RM/B) Rio Morsone-Bosio transect; numbers 1, 2 and 3 refer to the members described in the text.

The achievement of a relatively deep depositional setting was the final step of the history, testified by the sedimentation of the hemipelagic mudstones of the Rigoroso Fm., which overlies the coarse-grained fan delta deposits of the Molare Fm.

As a final remark, two depositional sequences can be identified in the studied succession (Fig. 5):

a) the first one is represented by members 1+2 (alluvial conglomerates and sandstones, followed upwards by transgressive sandstones and siltstones);

b) the second one by member 3 (conglomerates and sandstones belonging to the subaqueous part of a fan delta system) and by the overlying hemipelagic mudstones (lower part of the Rigoroso Fm.).

These sequences can be correlated with the sequences of the Group A of the "Langhe" region (Gelati et al., 1993).

Keeping in mind the thick and very coarse clastic sedimentation which characterizes members 1 and 3, the beginning and the development of the lower part of sequences *a* and *b* could be mainly referred to a tectonic control. An increased rate of subsidence or the concurrence of an increased subsidence rate and a coeval eustatic rise could have influenced the development of the upper part of both the considered sequences.

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