Oligocene-Neogene kinematic constraints in the retroforeland basin of the Northwestern Alps

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Oligocene-Neogene kinematic constraints in the retroforeland basin of the Northwestern Alps

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The contractional tectonic evolution of the Alpine retroforeland in NW Italy has been recorded at surface in the Late Eocene to Pliocene marine succession of the Torino Hill and Monferrato units (fig. 1) whose sedimentary evolution has been strongly controlled by the tectonic mobility of their basements. These units are placed at the join between the Western Alps belt, the buried SE-vergent fronts of the south Alpine thrust system and the NW-vergent external front of the Apennine chain.

Dating and description of geometry and kinematics of faulting stages recorded in Torino Hill and Monferrato has been recently allowed by detailed geologic mapping (1:50.000 scale «Torino Est» and «Trino» sheets of the Geological Map of Italy).

The Torino Hill succession rests unconformably on methamorphic basement, buried at a depth of 2-3 km (BONSIGNORE *et alii*, 1969; POLINO *et alii*, 1991; MILETTO & POLINO, 1992), interpreted as the South-Alpine basement (MOSCA *et alii*, this volume). The structural setting of Torino Hill consists of a NE-SW transpressive flower structure mainly formed before Late Burdigalian, that evolved in Langhian to Tortonian times as an asymmetric open anticline. Late Cretaceous to Lower Eocene Ligurian sediments have been observed at the base of the succession, and they are locally involved at the core of the flower structure. The Monferrato succession rests on Cretaceous to Lower Eocene non-methamorphic Ligurian units (BONSIGNORE *et alii*, 1969; DELA PIERRE *et alii*, 2003). The magnetic basement is buried at a depth of 8-10 km (CASSANO *et alii*, 1986; POLINO *et alii*, 1991; MILETTO & POLINO, 1992). The structural setting consists of a mosaic of NW striking rock slices, bounded by transpressive faults and mainly made up of pre-Langhian sediments, alternated with open synclines and/or monoclines made up of Langhian to Tortonian sediments. Messinian to Pliocene sediments unconformably rest on the south flank of the Torino Hill and Monferrato.

These units, bounded at the base by the buried Late Neogene to Quaternary Padane Thrust Front (PTF), are separated by the Rio Freddo Deformation Zone (RDFZ, *sensu* POLINO & PIANA, 1995; FESTA & PIANA, 2003), a regional, long-lived, NW striking, fault zone. The latter has been understood as the surface expression of a deep-seated steep shear zone (PIANA & POLINO, 1995) active mainly since Rupelian to Burdigalian (FESTA & PIANA, 2003).

The tectonic evolution of both Torino Hill and Monferrato is due to five main stages that show different style of deformation into the two units:

– *Faulting stage A (Rupelian)*: in this stage, NW striking left lateral transtensive faults were dominant, although minor NE striking extensional faults also developed. These mutually crosscutting fault systems, mainly observed in Monferrato and RFDZ, defined localized NW striking pull-apart basins, in which the drowning of the Early Oligocene shelf sediments occurred (DELA PIERRE *et alii*, 2003). At a regional scale, this faulting stage is coeval to the extension due to the Balearic rifting, that affect the Ligurian realm, and roughly coeval to the ther-

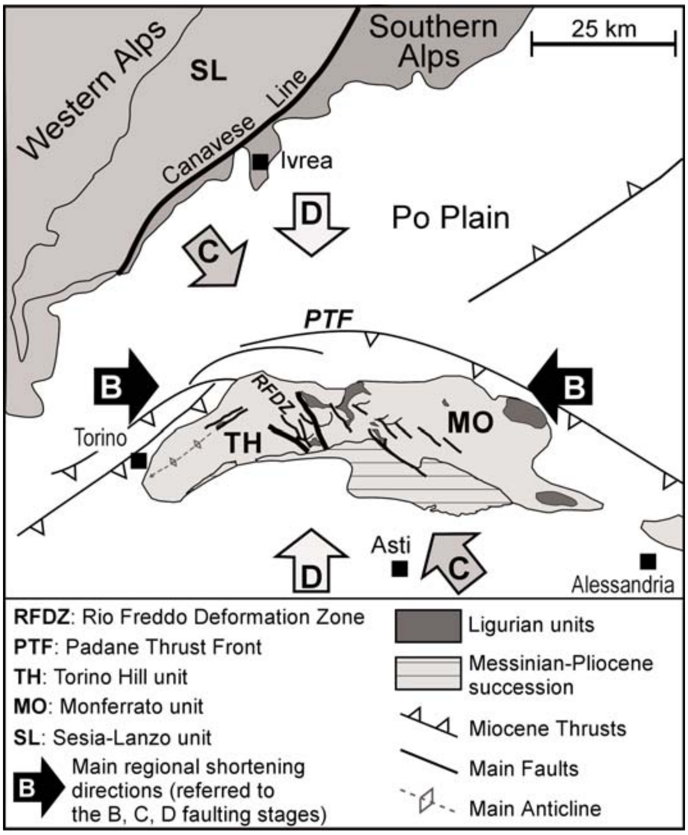

Fig. 1 - Structural sketch map of the NW Alps and its retroforeland basin.

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mal event responsible for the emplacement of the Biella and Traversella intrusives and others mafic dikes (c.f. MALUSÀ *et alii*, this volume) aligned on the Canavese Line.

– *Faulting stage B (Chattian-pre Late Burdigalian)*: the Rupelian extensional regime was inverted to a compressional one, mainly related to roughly E-W regional shortening. The Monferrato pull-apart basins were inverted, as indicated by deposition of shelf sediments onto slope deposits, and split into NW striking contractional strike-slip duplexes that show left-lateral and reverse movements. In the Torino Hill this faulting stage is mainly recorded by NE striking high angle transpressive and reverse faults that depict an asymmetric flower structure along wich slices of Ligurian sediments are tectonically involved. At regional scale, this faulting stage should be viewed as the result of the NW-ward propagation of Apennines thrust front in Monferrato and the Southeastern migration of the South Alpine thrust front within the Torino Hill subsurface units (c.f. MOSCA *et alii*, this volume); this kinematic was also coeval to the right-lateral movements of the Canavese Line (SCHMIDT *et alii*, 1989).

– *Faulting stage C (Late Serravallian)*: a regional NW-SE shortening occurred during this stage. This continous regional contractional evolution caused, in the Monferrato, the activation of SE-directed reverse shear zones, maybe due to a changing in the $\sigma 1$ orientation and/or to a mutual switching of the intemediate and minimum principal stresses in the horizontal plane (FESTA & PIANA, 2003). The Torino Hill is gently folded with NE-SW axis, subparallel to the strike of the main faults active during the stage B. The vergence of these folds is presently under debate.

– *Faulting stages D (Late Messinian, post-evaporitic) and E (Plio-Pleistocene)*: regional N-S shortening are prevalent during these stages and are consistent with the NW and N-ward movement of the PTF, that overthrust Torino Hill and Monferrato onto the Po plain foredeep. Large circulation of overpressured methane-rich fluids, maybe squeezed from the basal surface of the PTF, occurred along the Messinian faults (FESTA *et alii*, 2002 and in this volume; DELA PIERRE *et alii*, 2003). These faults are sealed by the Late Messinian «Lago Mare marls». The N-ward movement of the PTF continued during the Plio-Pleistocene times (*faulting stages E*) as suggested by the subsurface data (MOSCA *et alii*, this volume). This caused, at surface, only minor displacement of Torino Hill and Monferrato domains, that essentially suffered a gently S-ward tilting.

In conclusion, the kinematic constraints here described for Western Alps retroforeland tectonic evolution are comparable with those described by MALUSÀ *et alii* (this volume) in the Inner Western Alps.

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