Ofioliti, 2001, 26 (2a), 165-168

STRUCTURAL CONSTRAINTS FOR A GEODYNAMIC MODEL IN THE NORTH TYRRHENIAN-NORTHERN APENNINES POST-COLLISIONAL SYSTEM

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Keywords: *seismic data, deep extension. North Tyrrhenian Sea, Northern Apennines.*

EXTENDED ABSTRACT

The North Tyrrhenian-Northern Apennines post-collisional system (NTAS) developed its extensional setting since the Middle-Late Miocene, dismembering the Cretaceous-Miocene Northern Apennines fold and thrust belt with a remarkable eastward migration of the extensional events (Fig. 1). In this work the NTAS has been analysed with the following principal aims:

– to provide an up-to-date structural pattern of the extensional frame;
– to furnish the geometric relationships between the shallow and the deep extensional features of the crust; and
– to suggest a structural interpretation that better fits the geometric elements obtained both from marine seismic data and recent field studies.

E and NE-dipping extensional faults are the new post-collisional geometric elements of the North Tyrrhenian Sea and of the inner part of the Northern Apennines chain, recently outlined in works dealing with offshore and onshore areas (e.g. Bartole, 1995; Barchi et al., 1997; Bertini et al., 1991; Carmignani and Kligfield, 1990; Keller and Pialli, 1990; Lavecchia et al., 1997; Pascucci et al., 2001). These faults, along with those which dip toward W and SW, belong to a rift system composed of rotated blocks, half grabens, listric master faults striking N and NW, and of anti-Apennine E and NE oriented transversal faults (Fig. 2). As a consequence, two opposite and centrifugal extension polarities are recognized in the NTAS: while some extensional basins are bound by W or SW facing master faults (Tyrrhenian extension polarity), others are bound by E or NE facing master faults (anti-Tyrrhenian polarity) (Fig. 2).

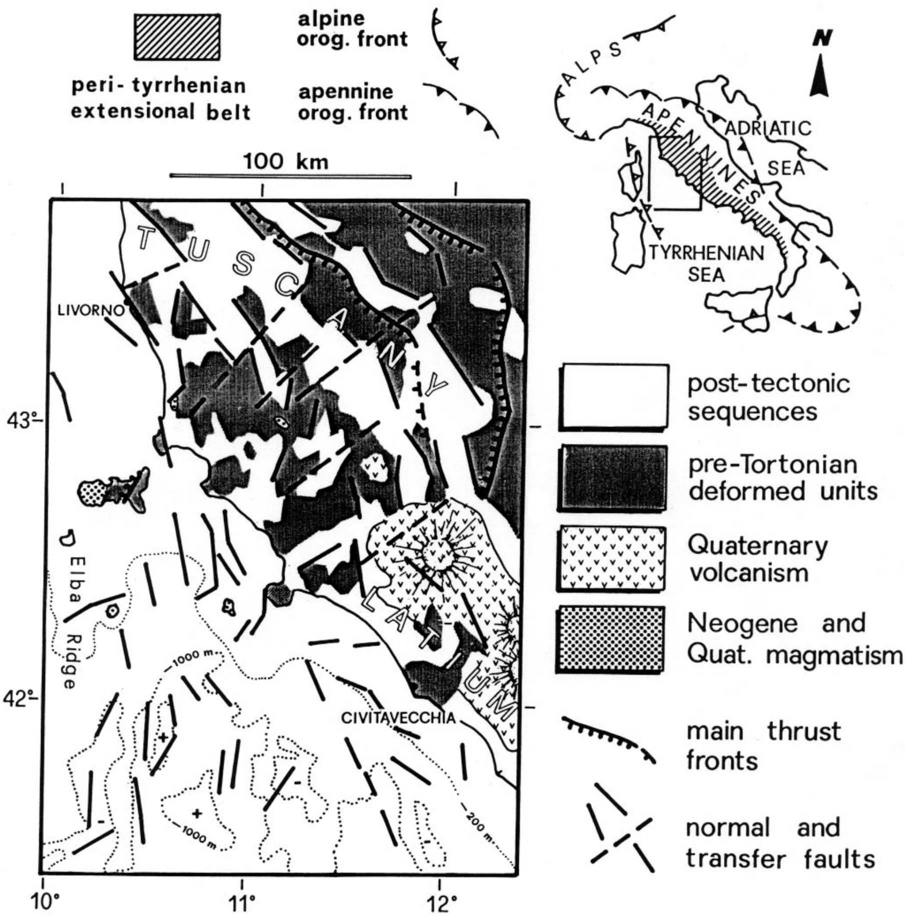

Fig. 1 - Simplified structural scheme of the North Tyrrhenian-Northern Apennines post-collisional system (NTAS).

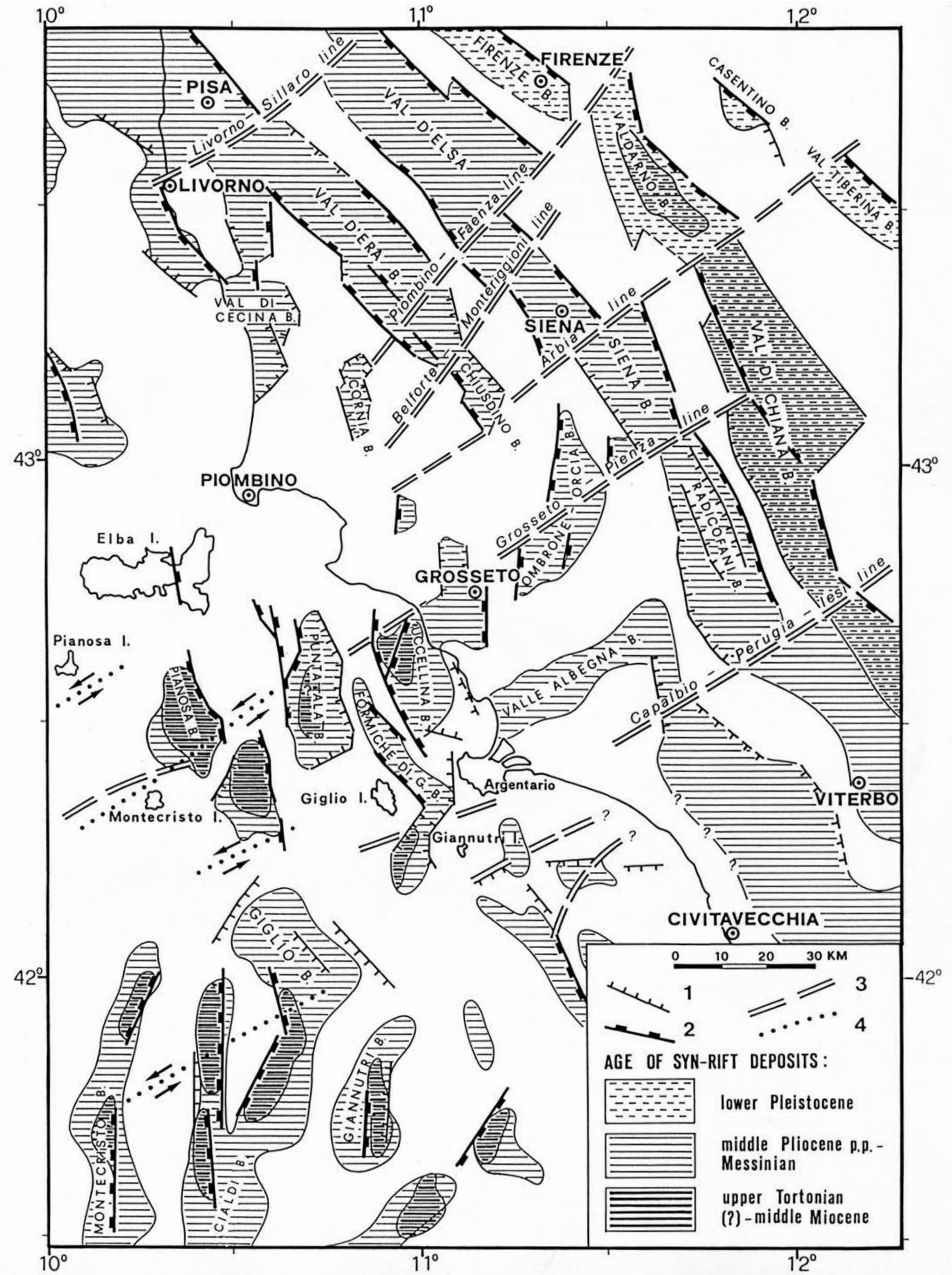

Fig. 2 - Structural map of the NTAS and basin evolution. Marine seismic surveys and recent field data show that master faults do not only occur at the northeastern flanks of the extensional basins; they are also present at their southwestern flanks or on both sides. Notice the basin rejuvenation towards NE. 1- minor normal faults; 2- basin master faults; 3- main transversal faults; 4- strike-slip faults of the magnetic basement, after Cassano et al. (1986).

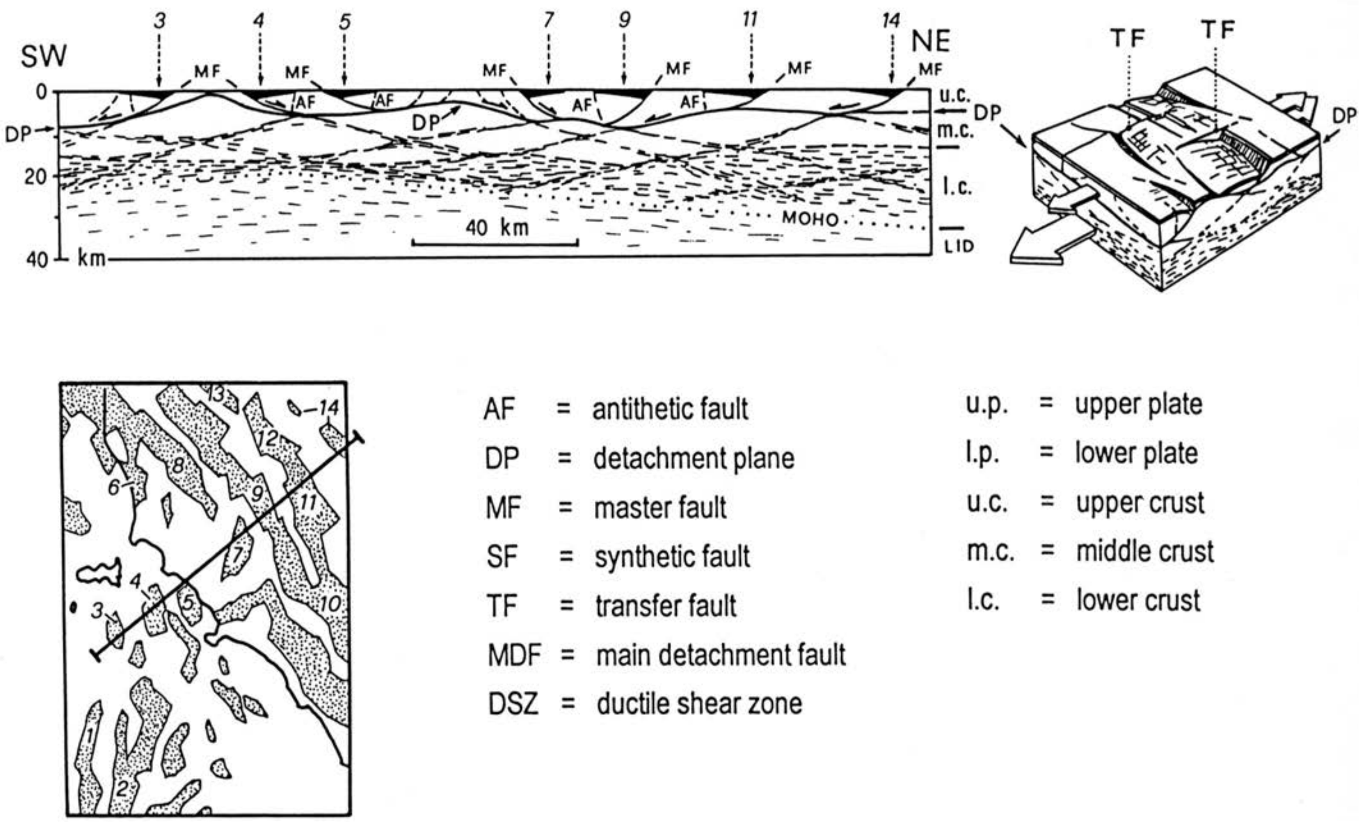

Fig. 3 - Schematic cross-section from near Elba Island to Val Tiberina according to the anastomosing shear model of extension. Upper crustal rifted blocks tilt and slide apart along both Tyrrhenian and anti-Tyrrhenian facing master faults which all connect to a shallow, regionally extended "wavy" detachment plane (DP). The underlying middle and lower crust undergoes a much higher extension rate, as shown in Fig. 4. Basins of the NTAS: 1- Montecristo B.; 2- Cialdi B.; 3- Gioglio B., Giannutri B., Pianosa B.; 4- Punta Ala B.; 5- Uccellina B.; 6- Val di Cecina B.; 7- Ombrone-Orcia B.; 8- Volterra-Val d'Era B.; 9- Val d'Elsa-Siena B.; 10- Tiber Valley B.; 11- Val di Chiana B.; 12- Upper Valdarno B.; 13- Firenze B.; 14- Casentino and Upper Val Tiberina B.

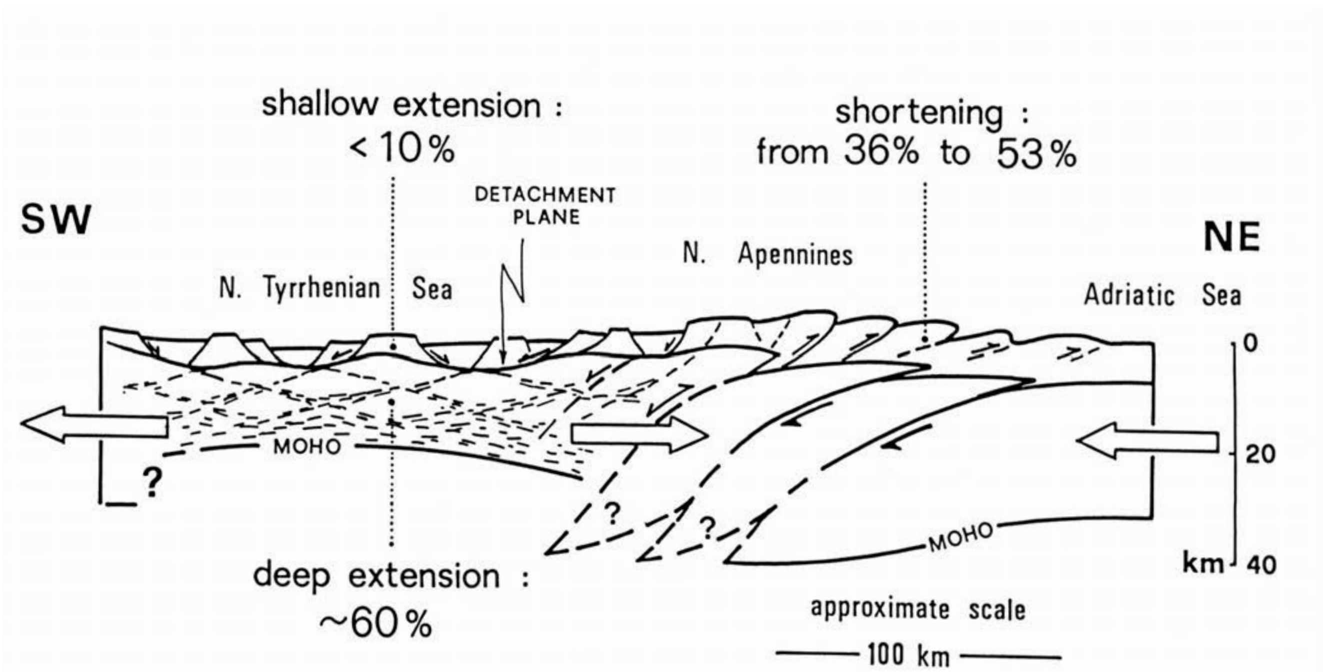

Fig. 4 - The anastomosing mode of extension allows the lower-middle crust of the Tuscany-Tyrrhenian area to extend at a higher rate (60%, according to Bertini et al., 1991) than observed in the upper brittle crust (less than 10%). This provides a better way to balance the synchronous extension and shortening respectively of the internal and external sectors of the Northern Apennines.

The occurrence of E and NE-dipping shallow detachment planes in the studied area constitutes a structural constraint that bears the following geodynamic implications:

1 - a greater emphasis is given to the role of the anti-Apennines lineations with respect to other ones because they separate rifted crustal blocks with Tyrrhenian extensional polarity (SW) from those having anti-Tyrrhenian polarity (NE);

2 - the concept of extensional re-utilization of crustal thrust planes (in this case with Adriatic vergence, i.e. with W or SW-dipping thrust surfaces) previously formed during contraction phases is partly contrasted because the E and NE facing master faults are new significant extensional features which originated during post-collisional times;

3 - the above described structural elements seem in better agreement with the extension mechanisms predicted by the anastomosing shear model (Kligfield et al., 1984; Carmignani and Kligfield, 1990; Reston, 1990) rather than by the simple shear (Wernicke, 1985) or by the delamination (Lister et al., 1986) models previously applied (Boccaletti et al., 1985; Lavecchia and Stoppa, 1989) to the NTAS.

According to this model (Fig. 3), brittle, ductile and pervasive pure-shear are the extension mechanisms respectively characterizing the upper, middle and lower crust. Both Tyrrhenian and anti-Tyrrhenian facing normal faults only affect the upper brittle crust and sole out into a regionally extended, waving detachment surface approximately located at the brittle-ductile transition. Extension in the metamorphosed middle crust originated low-strain, lozenge-shaped blocks, while in the remaining lower crust extension is supposed to be only of pure-shear type.

The major benefits of applying the anastomosing shear model to the post-collisional history of the NTAS are:

a- it has a better “flexibility” in explaining the great complexity of the structural frame with respect to other geometrically more “rigid” models;

b- it removes any hierarchy in the normal faults of the extensional system, since the terms synthetic and antithetic, utilized in the simple-shear and in the delamination models for the definition of the lithospheric detachment plane, now pertain to a local context rather than to a regional one; and

c- it allows a better balancing, with respect to the other models, between extension of the Tuscany-Tyrrhenian sector and the synchronous shortening of the Apennines-Adriatic one (Fig. 4).

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Received, May 5, 1999
Accepted, July, 15, 1999