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The interation of compressional and extensional tectonics during the Sicily Chain building

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INTRODUCTION

During mountain belts evolution commonly exist very closely relationships between in sequence thrusting, out-of-sequence faulting and extension. The simple foreland-breaking sequence of deformation characterizing the accretion of a sedimentary wedge during the subduction stage can be interrupted either by backward vergent deformation, syn-orogenic extension or backthrusting/thickening near the orogenic backstop (e.g., PLATT & VISSERS, 1989).

The evolution of chain-foredeep-foreland systems is characterised by contractional structures coupled by extensional deformations, both at the chain-foredeep and at the foredeep-foreland transition zone. As a consequence, the architecture of most foredeep depressions is generally envisioned as controlled by active regional thrusts and coeval subsidiary normal faults in their inner and outer edges. These structures may contribute to accommodate flexure of foreland plates induced by the load of advancing thrust sheets.

In Sicily lack a kinematic model relative to the chain building, including in sequence/out-of-sequence folding-and-thrusting and extension. The aim of this paper is to provide constraints to help unravel the structural evolution of the Sicily chain using stratigraphic data and relationships between map-scale structures.

GEOLOGICAL SETTING

The Sicilian Thrust System (STS) is a south-verging fold-and-thrust belt and represents the South eastern arcuate portion of the Apennine-Maghrebides thin-skinned fold-and-thrust belt.

The STS is made of a lot of thrust sheets, including Mesozoic-Lower Tertiary pre-orogenic multilayered sedimentary sequence and occupies the larger part of the island. (Fig. 1).

The thrust stack owes its origin to the deformation of pre-orogenic strata deposited in different palaeogeographic domains belonging to the Northern Africa passive margin.

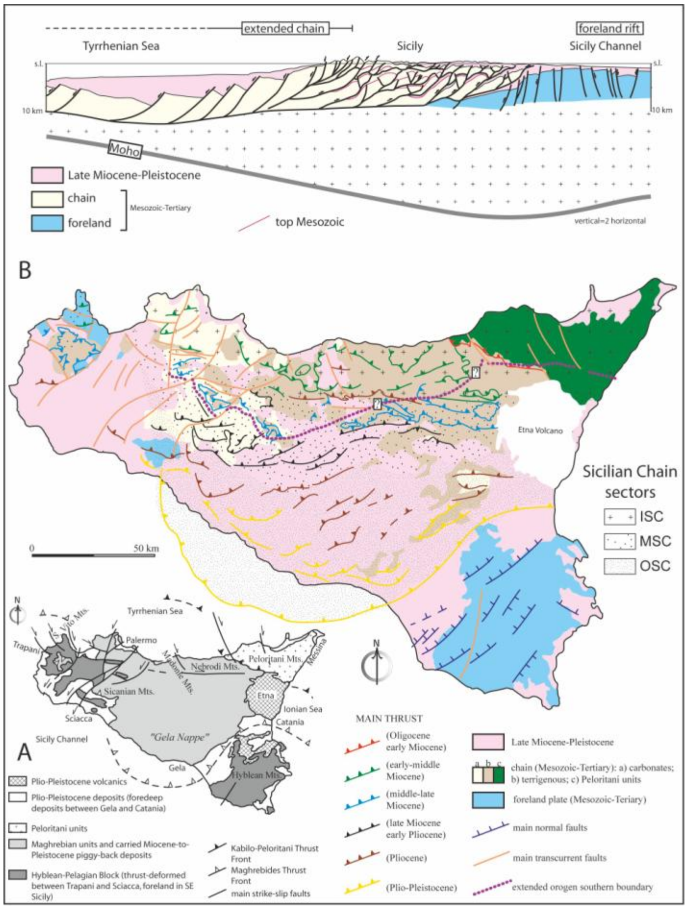

Fig.1 - (A) Main structural elements in Sicily. (B) Structural sketch of Sicily and schematic cross section. The thrust system has been divided into three zones: Inner Sicilian Chain (ISC), Middle Sicilian Chain (MSC) and Outer Sicilian Chain (OSC) on the basis of the timing of thrust activity.

The belt developed during the Neogene, following the closure of the Tethys Ocean and the continental collision between the Sardo-Corso Block and the Africa margin.

The thrust pile was detached from the underlying basement during Miocene-Pleistocene time interval and experienced both faulting, folding and stretching. A general hinterland-to-foreland thrust propagation is recorded in the syn-orogenic deposits (Fig. 2).

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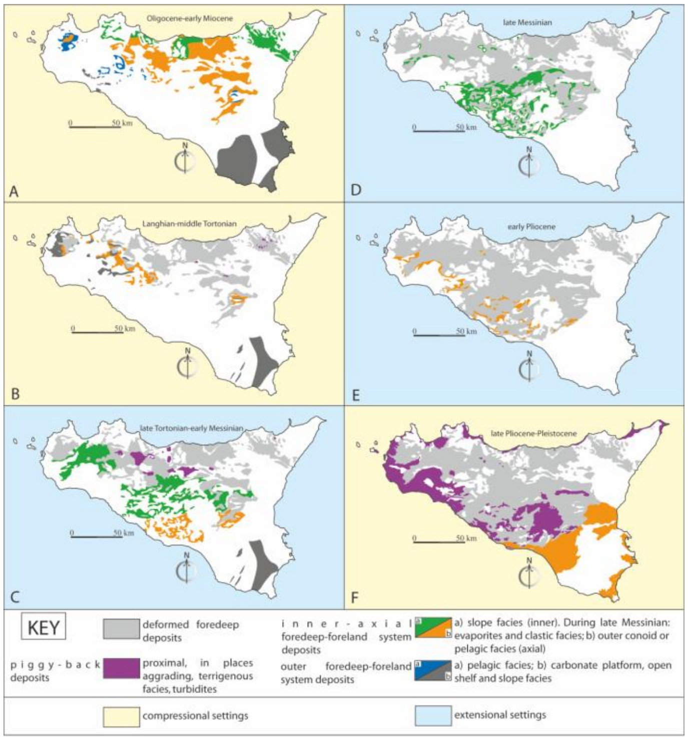

Fig.2 - Distribution, in the Sicilian Thrust System, of the facies of the foredeep-foreland and piggy-back deposits from Oligocene to Pleistocene that underwent contractional and extensional events.

During chain building, the Sicilian wedge experienced both extension and further out-of-sequence renewed thrusting in the inner stack, coheval with the growth in the toe region.

The progression of deformation is represented by different regionally-significant structural stages (layer-parallel shortening, folding-and-thrusting, extension and renewed thrusting, strike and normal/oblique normal deformations).

The STS can be separated into three main sectors (Figure 1B): the Inner Sicilian Chain (ISC), the Middle Sicilian Chain (MSC) and the Outer Sicilian chain (OSC).

The ISC extends W-E in northern Sicily and is a result of the Late Oligocene-Early Miocene thrust tectonics which dominated the Africa-Europe collision (OGNIBEN, 1960; GIUNTA, 1991; ROURE *et alii*, 1990a; CATALANO *et alii*, 2000).

The MSC and OSC mostly consist of Late Oligocene-Pleistocene foredeep deposits cropping out in central and southern Sicily, which were progressively involved in the compressional deformation (Broquet *et alii*, 1966; Giunta, 1991; NIGRO & RENDA, 2000) since the Middle-Late Miocene. The growth of the orogenic wedge since the Pliocene, generated by the accretion of syn-tectonic sediments, is represented by a stack of tectonic slices known as "Gela Nappe" (Beneo, 1958).

The recognised regional-scale structural setting allow us to reconstruct tectonic evolution (Fig.3):

I) piggy-back thrusting from the Late Oligocene to the Langhian, inducing the building of the Inner Sicilian Chain (ISC) that migrated progressively forelandwards. Extensional deformations were active in the foredeep-foreland system;

II) piggy-back thrusting from the Langhian to the Tortonian, inducing the building of the Middle Sicilian Chain (MSC) that migrated progressively forelandwards. Extensional deformations were active both in the foredeep-foreland system and in the ISC;

III) generalised extensional deformations in the chain-foredeep-foreland system from the Tortonian to the earliermost Pliocene;

IV) new onset of piggy-back thrusting since the Early Pliocene, allowed the building of the Outer Sicilian Chain (OSC) and out-of-sequence thrusting in the previous emplaced ISC and MSC. Extensional deformations were active in the foredeep-foreland system;

V) starting from the Late Pliocene, strike and normal/oblique normal deformations affected the ISC and MSC as the effects of the Southern Tyrrhenian Basin dynamics.

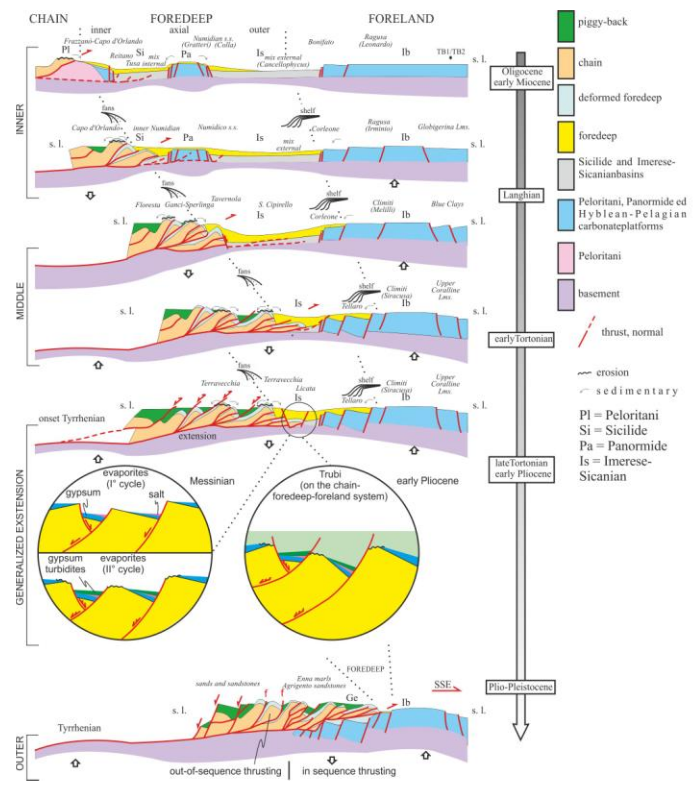

Fig.3 - Model of the tectono-sedimentary evolution of the Sicilian chain-foredeep-foreland system since the Oligocene, depicting the deformation of the pre- and syn-orogenic strata deposited in the different palaeogeographic domains and in the foredeep-foreland system. The ISC (Peloritani, Sicilide, Panormide and Imerese-Sicanian p. p.) and MSC (Imerese-Sicanian p. p.) were emplaced from Oligocene to the Late Miocene. Extension occurred during Late Miocene-Early Pliocene and extensional setting developed, allowing the deposition of evaporites and deep-water marls (Trubi Fm.). These conditions allowed renewed deformations of the Imerese-Sicanian and previous foredeep deposits (Gela Nappe emplacement).

The interplay between compression and extension during the STS emplacement has been developed in a continuous kinematics, as revealed by the analysis of minor structures.

Starting from the northern Sicilian coast, a process of crustal attenuation and subsidence has affected the chain since late Tortonian time (Kezirian *et alii*, 1994; Giunta *et alii*, 2000). Repeated failure of the orogenic wedge also occurred during the Pliocene-Pleistocene time interval (Nigro & Renda, 2001).

During the Pliocene-Pleistocene time interval, dextral transcurrent tectonics affected northern Sicily and its Tyrrhenian offshore domains (Boccaletti *et alii*, 1982; Finetti & Del Ben, 1986). Strike-slip deformations inland were mainly accommodated by a W-E narrow shear zone with right-lateral kinematics (Ghisetti & Vezzani, 1984; Renda *et alii*., 2000).

Extensional structures was displaced along Plio-Pleistocene strike-slip faults, leading also to tectonic depressions in the off-shore areas north of Sicily (Giunta *et alii*, 2000). This neotectonic system may be connected to a W-E trending right-lateral simple shear system, which controls the recent development of the Southern Tyrrhenian margin (Fig. 4).

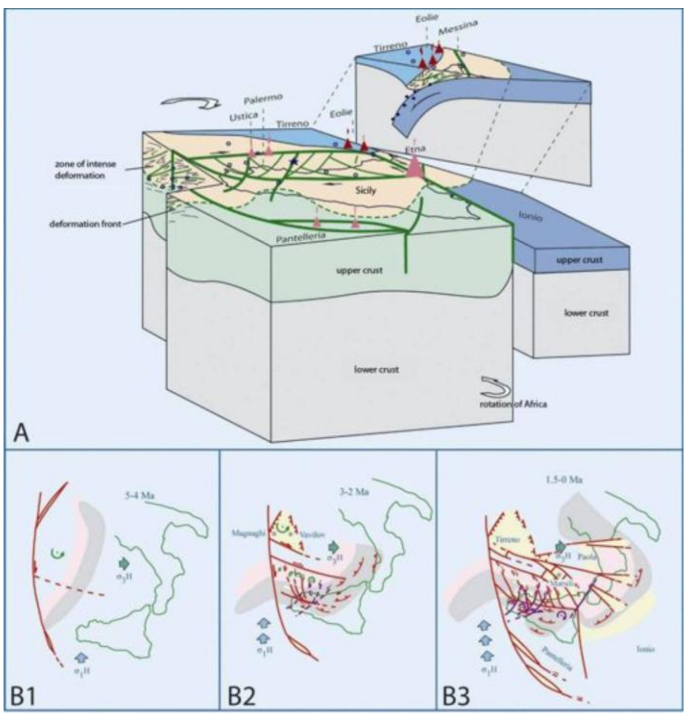

Fig. 4 – A) 3D of the Sicilian area and neighboring areas showing major neotectonic fault systems (in green), areas of the chain (beige) and non-deformed areas (light green). In the split is also visible the Ionian subduction zone in the Aeolian sector. B) evolution of the central Mediterranean neotectonic in the last 5 Ma connected with the gradual rotation of the African Plate. The dynamics of openings of the Tyrrhenian Basin appears controlled by the activity of crustal shear systems that in the nothern submerged Sicilian sector determine the formation of strongly subsidence basins which extend until in the emerged areas of the island.

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