THE ROLE OF WRENCH TECTONICS
IN THE NEOGENE-QUATERNARY EVOLUTION
OF THE WESTERN HYBLEAN PLATEAU (SICILY)

This study focuses on the kinematics and temporal variations of neotectonic-to-active structures on the margin of the Southern Apennines thrust front. The border between the thrustbelt contractional terrenes and continental plateau hosts a number of strike-slip and, normal and inverse structures of still disputed geometry. Based on newly-acquired data, this research opened new issues with respect to present-day kinematics of these fault systems, suggesting a new interpretation for the tectonic mechanisms underpinning the Hyblean Plateau. In this paper the neotectonic structures which characterise the western margin of the Hyblean Platform are analysed, in order to study the dynamics of the foreland margin in the context of a convergent scenario such as that observed in Southern Sicily. For the purpose of this study all the data available inland area have been taken into account, including field mapping, structural observations, photogrammetry and satellite images.

The foreland of the southern Afro-European zone of convergence in Sicily is characterized by distinct crustal segments which exhibit different structural styles and patterns. The structural framework of the Hyblean Plateau highlights a tectonic history influenced by intraplate extension (Sicily Channel) and plate margin deformation (thrustbelt), so convergent and divergent domains are closely juxtaposed.

The neotectonic fault pattern of the western Hyblean margin implies right-lateral movements along a broad NE, NNE oriented fault system, which consists of the Scicli-Ragusa, Comiso-Chiaramonte faults. These faults transect the southern Sicilian foreland oblique to the Maghrebian Arc.

Structural analyses unveiled fault systems caused by (a) extensional tectonics, (b) strike-slip stages, and (c) contractional regime, thus allowing the reconstruction of tectonic processes that involved the outcropping terrenes.

Objectives is:
- to define kinematics and geometry of main systems;
- to analyze the development of fault systems pertaining to the main shear zone striking NNE-SSW (Scicli-Ragusa and Comiso-Chiaramonte systems);
- to highlight interplay among strike-slip deformation, reactivated pre-existing extensional structures and fold/reverse fault systems that dominate the western Hyblean sector.

The structural analysis was developed adopting the following methodologies:
- Interpretation of: Air photos, Satellite imagery (Spot), Digital topography (DEM)
- Structural fieldwork:
  - reconstruction of geometries of synthetic and antithetic faults and of minor brittle systems;
  - analysis of kinematics indicators on fault planes;
  - spatial distribution of bedding planes;
  - analysis of fold systems.

The Hyblean Plateau is characterized by a continental crust overlain by thick
Mesozoic to Quaternary carbonate sequences and it is located on the northern margin of the African Plate within the Central Mediterranean region. It represents the emerged foreland of the Upper Cenozoic Maghrebian thrust belt, that formed as a result of collision between the North African continental margin and the Calabrian arc and represents the leading edges of the African foreland, which in the surroundings of Sicily, is largely submerged. It is bounded to the south by the stable Saharan Platform, and to the north by the frontal part of the Sicilian segment of the Maghrebian thrust belt. In the east it is confined by the Malta Escarpment, to the west it terminates abruptly onshore in central Tunisia against the North-South Axis. Given its geodynamic environs, the present-day structural configuration of the Hyblean Plateau reflects a long tectonic history involving both intraplate extension and plate margin deformation. As a consequence, the platform area has been dominated by a complex interplay between extensional tectonic together with compressional and strike-slip tectonic phases, expressed by sub vertical faults that can be broken-down into the principal trends: NE-SW, NNE-SSW and NNW-SSE. The neotectonic fault pattern and the crustal segmentation of this sector of the African foreland is partly influenced by older structural trends and units, which originated during the Mesozoic evolution of this plate margin.

Fieldwork, integrated by interpretation of aerial photos and SPOT images, contributed to constrain and enhance a structural model of the region. A detailed structural study in a sample area located around the Ragusa platform area, allowed to evaluate the deformation style of these upper Miocene deposits.

The main NNE-SSW faults system, Scicli–Ragusa and Comiso-Monterosso, is well exposed in the western part of the Hyblean plateau, called Ragusa Platform. About 30 km wide, this belt of crustal failure develops with a N-S to NE-SW direction and trends oblique to the frontal thrusts of the Maghrebian Arc. The Scicli-Ragusa Line is an important structural feature which affects all domains present here, and marks the eastern boundary of the fault zone. Its segment is formed by a discrete fault plane exhibiting dextral strike-slip mechanisms. This research revealed that a wrench mechanism along the main analysed system was active until Lower-Middle Pleistocene time.

This principal system reactivated previous normal fault planes which have determined an uplift of the area in the Mesozoic time. Structural analysis was primarily concentrated in this zone.

Notably, north of Ragusa, the Comiso-Monterosso fault splays up into a fault system formed by en echelon inverse and oblique faults. A large set of structural elements, associated with the principal right-lateral NNE-SSW and NE-SW fault zone, was documented in the area and local transpressive elements, associated with these faults, are shown on the basis of their morphological evidence.

A large bending and elevated area characterises the northern edge of the Ragusa platform and unveils the presence of several NNW-SSE and NE-SW striking reverse faults, and anticlinal folds. The presence of rare thrust and reverse faults is interpreted as flower structures and push-up system which developed in a transpressive stress regime.

The structural elements gathered in the Ragusa Plateau revealed that the main families of the mesoscopic structures, inscribed within a propagation and evolution system, are:

- Strike-slip dextral, striking N20°E and N30°-40°E;
- Strike-slip sinistral, striking N110°-120°E;
- Reverse, striking N150°-170°E, N30°E;
Normal, striking N60°-70°E;
Two main fold systems, striking N140°E and N30°E.

These structures are visualized in the diagram besides, which shows the deformation ellipse associated to the strike-slip shear zone and geological structures geometrically compatible with dextral shear zone.

The detailed meso-structural analysis conducted on the Ragusa platform area revealed the presence of non-coaxial compressive deformations, that generated folds, reverse faults and rare thrusts, involving the Upper Miocene-Lower Pleistocene deposits. The structural analysis was conducted at a scale of 1:25,000, using the dispersion of bedding data to define the orientation of the main structures. These data display a certain scattering, but allow to recognise a common trend, and the main fold system is characterised by structures about N-S. Subordinately, another set of folds is present; these are less developed and continuous than the previous set, forming fold with an average trend of about N 140°E. The scattering of these structures is summarized in the structural scheme developed, which shows diagrams of some meso-folds recognized in the field.

The occurrence of NNE-SSW striking fold systems highlights the development of remarkable flower structures along the main shear zones. These geometries, already suggested by thrust system stranding NNE-SSW, entail a synchronous interplay between fold growth and the main strike-slip system. Folding in the Pleistocene terrennes indicates the activity of the Comiso-Monterosso system at least up to Lower-Middle Pleistocene time. In order to devise a tectonic model of the Hyblean plateau, the structural dataset was supplemented with a comparative morphological analysis, as revealed by fieldwork, satellite images, aerial photos and topographic data. Drainage network has been thoroughly ascertained.

In the case that the preferential directions of rivers were statistically significant and different from those expected from non-structural controls (e.g. topographic and geographic trend), they were deemed to be a diagnostic tool to identify the deformation system. This is based on the assumption of a strict structural control of the local hydrographic network and its evolution.

The Scicli-Ragusa and Comiso-Chiaramonte systems indicate a lateral dextral shear mechanism which reactivated pre-existing normal fault planes. This study indicates that widespread occurrence of folds and reverse faulting can be ascribed to the transpressive regime, as a consequence of regional wrenching capable of generating push-up and positive flower structures. Consequently, transform systems and brittle/ductile deformation is herewith envisaged to pertain to a single major deformation event connected to a simple shear mechanism. This research revealed that a wrench mechanism along the main analyzed system was active until Lower-Middle Pleistocene time.

The structures of the studied area are a good example to derive the dynamics of a foreland zone in a neotectonically active convergent scenario. Within the central Mediterranean framework, the Scicli shear zone represents the on-shore strand of a major dextral transform system, documented off-shore to be the triggering mechanism connected to the opening of the Sicily Strait, connecting the Pantelleria Rift break-up with the external front of the thrustbelt. Such system also splits the western and eastern sectors of the Hyblean Plateau, as indicated by differing kinematics evolutions. The onset of the neotectonic dextral activity of the foreland faults system coincide with the evolution of the Pantelleria Rift, representing NE-SW oriented crustal stretching in the Strait of Sicily and with the latest SE directed thrusts along the Maghrebian Chain.