THE CALABRIAN ARC SUBDUCTION SYSTEM: ACTIVE FAULTS, MUD DIAPIRISM AND THE GEOLOGICAL RECORD OF CATASTROPHYC EVENTS

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Abstract

The Calabrian Arc (CA) is part of the most active seismic belt in the Central Mediterranean region and it has been struck repeatedly by very strong historical earthquakes often associated with destructive tsunami. We addressed CA tectonics through an integrated geological/geophysical approach which has the potential to reveal if subduction is active, to map location and geometry of major faults absorbing plate motion, and to unravel relationships between tectonics, sedimentation and fluid flow in the accretionary wedge.

Keywords: Ionian Sea, Active Margins, Tectonics, Sedimentation, Seismics

The Calabrian Arc (CA) subduction complex connects the E-W trending Sicilian Maghrebian belt with the NW-SE trending Southern Apennines (Fig. 1) and develops along the African-Eurasian plate boundary in the Ionian Sea.

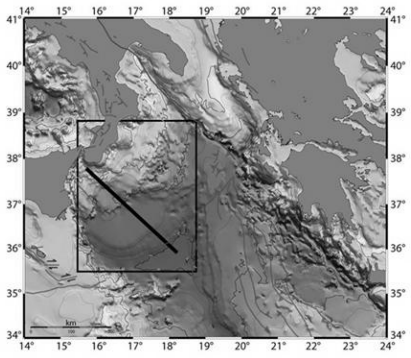

Fig. 1. Tectonic map of the study area with location of profile CROP M2B. Tectonic model from [1]. Seafloor bathymetry: GEBCO One Minute Grid.

At the toe of the CA, the thick sedimentary section of the African plate has been scraped off and piled up along thrust faults. This contributed to emplace a thick and about 300 Km wide subduction complex represented by a well developed accretionary wedge, multiple slope sedimentary basins and a seaward dipping continental backstop (Fig. 2). Although the regional architecture of the margin geometry has been described through the analysis of high penetration seismic data [2,3,4], some major questions are still debated: where is located the outer deformation front marking the Africa/Eurasia plate boundary? What is the location, nature and geometry of active faults absorbing plate motion? Are there evidences of the geological record of past catastrophic events in the subsurface?

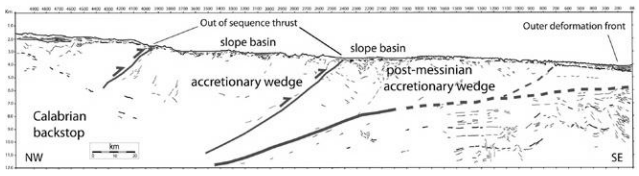

Fig. 2. Line drawing of pre-satck depth migrated MCS line CROP M-2B across the CA subduction system.

In order to address these issues we analysed in detail the structure and the evolution of the external CA through an integrated multi-scale geophysical approach that involves the combined analysis of multi-channel and single channel reflection profiles together with morpho-bathymetric data [5]. The interpretation of this multi-scale data-set represented the basis for a geophysical/geological cruise (CALAMARE cruise - Calabrian Arc Marine Geophysical Experiment) carried out in April-May 2008 with R/V CNR Urania [6]. We acquired geophysical (high resolution MCS reflection profiles and sub-bottom CHIRP) and geological data (gravity cores) in three key-areas selected through the interpretation of available data (outer and inner deformation fronts and the western lateral boundary of the subduction complex at the foot of the Malta escarpment). Sediment cores have been collected above morphological swells related to argilo-kinetic processes and within sedimentary basins in order to apply submarine earthquake geology in the CA and analyze the geological record of past catastrophic events in the subsurface. We collected well targeted sediment samples in tectonically controlled sedimentary basins to study the indirect effects of fault activity (i.e. mass wasting events, sand injections, turbidites, etc). Sediment cores from the Ionian abyssal plain and slope basins on the accretionary wedge have sampled turbidite sequences which likely contain a record of the great earthquakes or catastrophic events in the region. Radiocarbon ages will be obtained from monospecific planktonic foraminiferal samples above and beneath suspected seismic related deposits, while Pb210 and Cs137 radiocarbon dating will be applied to selected cores to resolve sedimentary structures associated with some recent events. If we will be able to make correlations between the sedimentary record (of earthquake-triggered submarine landslides or turbidites) and the earthquake catalogue in Southern Italy, we will try to extend the paleoseismic catalog further back in time. This approach has the potential to determine which portions of the arc have recorded catastrophic events in the past and which is the recurrence time of major events in the different regions of the subduction system. The lack of seismicity along the CA subduction fault plane (with a characteristic shallow dipping thrust-type focal mechanism) can mean either that subduction has ceased or that subduction is active but aseismic or locked. Diverse earthquake scenarios can be envisioned depending on which of these hypotheses is taken into account and the implication of each scenario for the hazard facing this region vary widely. The integrated analysis of the multi-scale geological/geophysical data-set acquired in the frame of the CALAMARE project has the potential to reconstruct CA active deformation and improve seismic risk assessment in the Central Mediterranean region.

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