MORPHOLOGY, STRUCTURE AND EVOLUTION OF THE SARDINIAN CHANNEL

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Abstract

The Sardinian Channel is located in a 400 km-long submerged section of the maghrebian branch of the Alpine chain. This 2000m deep trough connects the Algerian-Ligurian and Tyrrhenian Oceanic Basins. Sixteen dives were conducted on the channel scarps using CYANA submersible during two cruises in 1994 and 1995. A structural and morphological study involving film, seismic profile, relief map and sample analyses allowed recognition of the basement and its sedimentary cover. The oligo-miocene crustal thickening is followed by an early oligo-miocene extension and a latter tortonian rifting. A quaternary compressive event eventually inverts inherited extensive structures.

Keywords : Geomorphology, Basin formation, Tyrrhenian basin, Algerian Basin

SARCYA and SARTUCYA dives

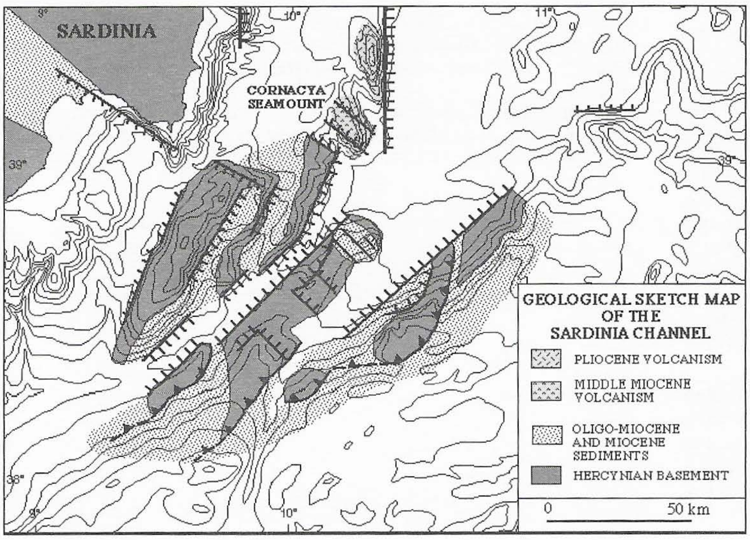
Early stages of the European margin outer blocks break-off that led to separation of Calabria and Peloritan terranes from Sardinia achieved elsewhere in the Tyrrhenian Sea. Slope steepness and deep sea water currents prevented burial of the channel margins under pelagic sediments thus allowing visual investigations. Dives data include 112 rock samples and a 78 hours film record.

Basement and sedimentary cover oligo-miocene evolution

Sardinian channel basement is made of metamorphic panafrican to hercynian rocks weakly metamorphised during alpine orogenesis. Like the on-shore Calabrian-Peloritan-Kabylian (CPK) basement, it records a oligo-miocene crustal thickening and erosion, here increasing toward the CPK front (as suggested by $^{40}Ar/^{39}Ar$ and apatite fission track datings).

The channel basement is overlain by the oligo-miocene detrital cover of peloritan or kabylian type. The dives led to the discovery of shoshonitic tortonian volcanism on both the sardinian and tunisian margins.

The South Cornaglia Scarp is characterized by lower slopes developed on the basement. They display a succession of scree-covered triangular facets and deep narrow canyons fringed with high cliffs. Above the lower slopes, the tertiary sedimentary cover is buried under more than 100m plio-pleistocene pelagic sediments deposited on a subdued relief in large valleys. Thus the tertiary sediments only outcrop in the canyon heads. A wide span of CPK sedimentary formations were sampled, however, as loose blocks on the lower slopes. The morphologic signature of the tertiary cover was used to draw a geological scheme of the channel (see figure). The south scarp exhibits several aprons, oblique to the main scarp direction. They could result from differential erosion around basement rocks or mezosoic limestones. As the Teulada Apron stands above a shallow dipping crustal reflector, they could be basement units thrusted over the sedimentary cover, or alternatively they could result from the intersection of the Late Miocene channel fault scarps with older rifted structures. Tertiary sediments were also found as pebbles along the sardinian slopes. They could lie on top of the tilted blocks along the Sardinian Margin and on the Median Ridge.



Indices of an early inversion

In some places, differential erosion has stripped off the basement topography drawned under the first oligo-miocene sediments. The interface is quite flat, broken by numerous fault scarps like in the Peloritan Mountains. This surface could account for the flat topped Teulada Apron and Median Ridge.

This buried faulted topography documents a regionally known early stage of extension during the ligurian-algerian rifting. This first tectonic inversion directly follows the stage of crustal thickening.

Tortonian evolution: the second period of faulting

Incipient tyrrhenian rifting propagated into the channel area during tortonian times and created the present trough. Whereas opening of neighbouring Tyrrhenian Sea is still an active process, it stopped abruptly before Messinian in the channel, and did not reached oceanization. Fractures orientations show that almost all the older structures were reactivated and that tyrrhenian strike-slip and normal faults directions prevail.

The Sardinian Margin exhibits a classical structure with 3 main steps of tilted crustal blocks and faulted relief at all scales. The Sicilian-Tunisian Margin formation could involve larger strike-slip components. It has been argued that the present slopes are detachment surfaces inverting older oligo-miocene thrusts. They would connect in the crust to shallow-dipping reflectors detected on deep seismic records. The slopes investigated here did not show evidence of the strong deformations that could be expected on pristine denudation slopes. However, those are not representative of the south margin as a whole.

Messinian evolution

The channel bottom is filled with several hundred meters of messinian evaporites. They grade into detrital formations at the foot of surrounding canyons. This suggest a continental evolution of the scarps consistent with a sea level drop.

Some conglomerates were found scattered on the Median Ridge and the Sicilian Margin slopes . They stand for possible remnants of continental or fluvial erosion. However, the other features observed on dive sites can be explained by post-miocene submarine gravitational processes: rock slide, rock fall, rock avalanches.

Quaternary evolution

Scree deposits several tens of meter thick blanket the lower slopes of the South Cornaglia Scarp. They are filled with a quaternary pelagic micrite and breached in some places by recent faults bringing the basement to the surface. Those dislocations are located on topographic flexures well visible on bathymetric maps. The flexures are linked to recent reverse activity on former normal faults, as it can be noticed at the foot of the Cornaglia Scarp where a ridge is growing into the sediments and dams the canyon outlets. This strain regime is also responsible for a wide bulge drawning canyons of the Sentinelle Apron. Other fold-like structures postdating erosion features surround the Median Ridge and the Sentinelle Apron. The influence of gravity driven instabilities cannot be excluded in their growth.