Mem. Descr. Carta Geol. d'It.
LXII (2003), pp. 166-170
3 figg.

The CROP profiles across the Western Mediterranean basins
I profili CROP attraverso i bacini del Mediterraneo Occidentale

FANUCCI F. ([1]), MORELLI D.([1])

ABSTRACT - In this paper, a short description of the main aims and achievements of the CROP-MARE I profile, which was part of the French-Italian "ECORS-CROP" Project, is presented. This line was acquired in the Western Mediterranean Sea crossing the Gulf of Lyons Margin, the Sardinian-Balearic-Provençal Basin, and the Western Sardinian Margin. The results of the "ECORS-CROP" Project indicate the complete absence of a typical spreading center or ridge in the oceanic sector; moreover the structural pattern of the opposite margins was shown to be asymmetrical. Therefore, the proposed new opening model for the basin is based on a crustal detachment process.

KEY-WORDS: Provençal Basin, Western Sardinian Margin, reflection seismic, deep crust.

RIASSUNTO - In questo lavoro viene presentata una breve descrizione dei principali obiettivi e risultati del profilo CROP-MARE I, che è stato acquisito nell'ambito del progetto italo-francese "ECORS-CROP". Questa linea sismica è stata acquisita nel Mar Mediterraneo occidentale attraversando il Golfo di Lione, il bacino balearico-provenzale e il margine occidentale della Sardegna. I risultati del Progetto "ECORS-CROP" indicano la completa assenza di una dorsale nel settore oceanico; inoltre, è stato dimostrato che l'assetto strutturale dei due opposti margini è asimmetrico. Di conseguenza, il modello proposto per l'apertura del bacino è basato su un processo di detachment crostale.

PAROLE CHIAVE: Bacino Provenzale, margine occidentale sardo, sismica a riflessione, crosta profonda.

INTRODUCTION

The first crustal profile made in the Western Mediterranean Sea was the CROP-MARE I profile, which was part of the French-Italian "ECORS-CROP" Project. It represents the Italian transect of a discontinuous line linking the continental inner shelf of the Gulf of Lyon and the northwestern sardinian slope (see fig. 1).

The 570 km of ECORS seismic reflection data were acquired by CGG and the 210 km of CROP line by OGS, in October 1988, using standard industrial equipment.

The Gulf of Lyon Margin, the area of highest development of the saline diapirs, the deepest part of the Sardinian-Balearic-Provençal Basin, and the Western Sardinian Margin were completely covered. In the Gulf of Lyon, beneath the shelf and the slope, some reflections are observed until ten seconds near the Moho.

As concerns the main structures and crustal characters, the main aims of this project were:
- to investigate the existence of a spreading ridge in the axial part of the Basin;

([1]) Dipartimento di Scienze Geologiche, Ambientali e Marine (DISGAM), Università di Trieste, Via Weiss, 2 - 34127 Trieste.

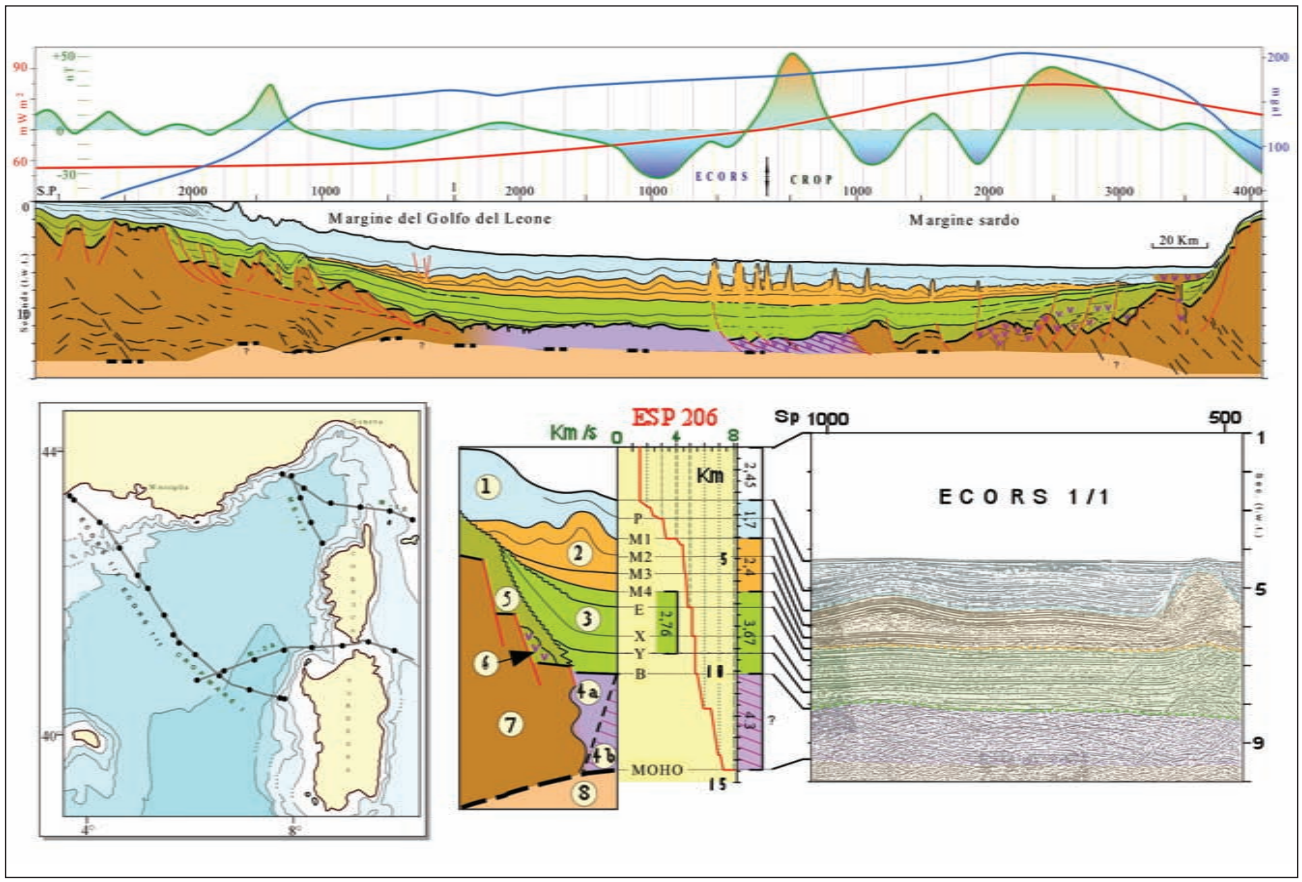

Fig. 1. - Crustal section ECORS-CROP. At the top, magnetic and gravimetric anomalies and heat flow represented by green, blue and red lines respectively. On the left, positional map of the seismic lines (bathimetry in meters). Above seismostratigraphic scheme of the section with thickness of the main depositional and crustal unit, obtained from the ESP data (PASCAL *et alii*, 1993). 1) Plio-Quaternary; 2) Evaporites; 3) Deep sedimentary sequence (Pre-evaporitic); 4) Oceanic Crust of the first (a) and second (b) opening phase; 5) sedimentary sequence pre-sin-drifting; 6) Volcanites; 7) Continental Crust; 8) lithospheric mantle.

- Sezione crostale CROP-ECORS. Nella parte alta della figura sono riportate le anomalie magnetiche e gravimetriche e il flusso di calore rappresentate rispettivamente da linee verdi, blu e rosse. In basso a sinistra, mappa di posizione delle linee sismiche (batimetria in metri). In basso a destra, schema sismostratigrafico della sezione con gli spessori delle principali unità, ottenuti da i dati ESP (PASCAL et alii, 1993). 1) Plio-Quaternario; 2) Evaporiti; 3) Sequenze sedimentarie profonde (pre-evaporitiche); 4) Crosta oceanica relativa alla prima (a) e alla seconda (b) fase di apertura; 5) sequenze sedimentarie pre-sin-drifting; 6) Vulcaniti; 7) Crosta continentale; 8) Mantello litosferico.

- to improve knowledge of the thickness and the process of formation of the oceanic crust;
- to determine the actual thickness and the structure of the Sardinian margin;
- to determine the structure of the continental basement in the Lion Gulf and compare the structural styles of the two opposite margins;
- to investigate the post-opening evolution of the basin and margins.

Main stratigraphical objectives involved:
- the thickness and the acoustic features of the sedimentary pre-evaporitic formations in the Basin and their transgression on the margins;
- the characteristics of the evaporitic sequence and its relations with lower levels;
- the origin of "salt walls".

RESULTS

The objectives were all achieved. In particular, the profile indicates the complete absence of a spreading center or ridge in the oceanic sector, which leads to a refutation of geodynamical models that define the Basin as a small ocean or a back-arc basin similar to those of the Western Pacific.

The structural pattern of the opposite margins was shown to be asymmetrical; the proposed new opening model for the Basin is based on a crustal detachment process (fig. 2, a, b).

The above-mentioned "oceanic crust" is composed of two sectors respectively, developed in two different phases of movement of the Sardinian Block. Both phases cause denudation of the subcontinental LID, but the second also determines brittle deformation and intrusion of this layer (fig. 2, c).

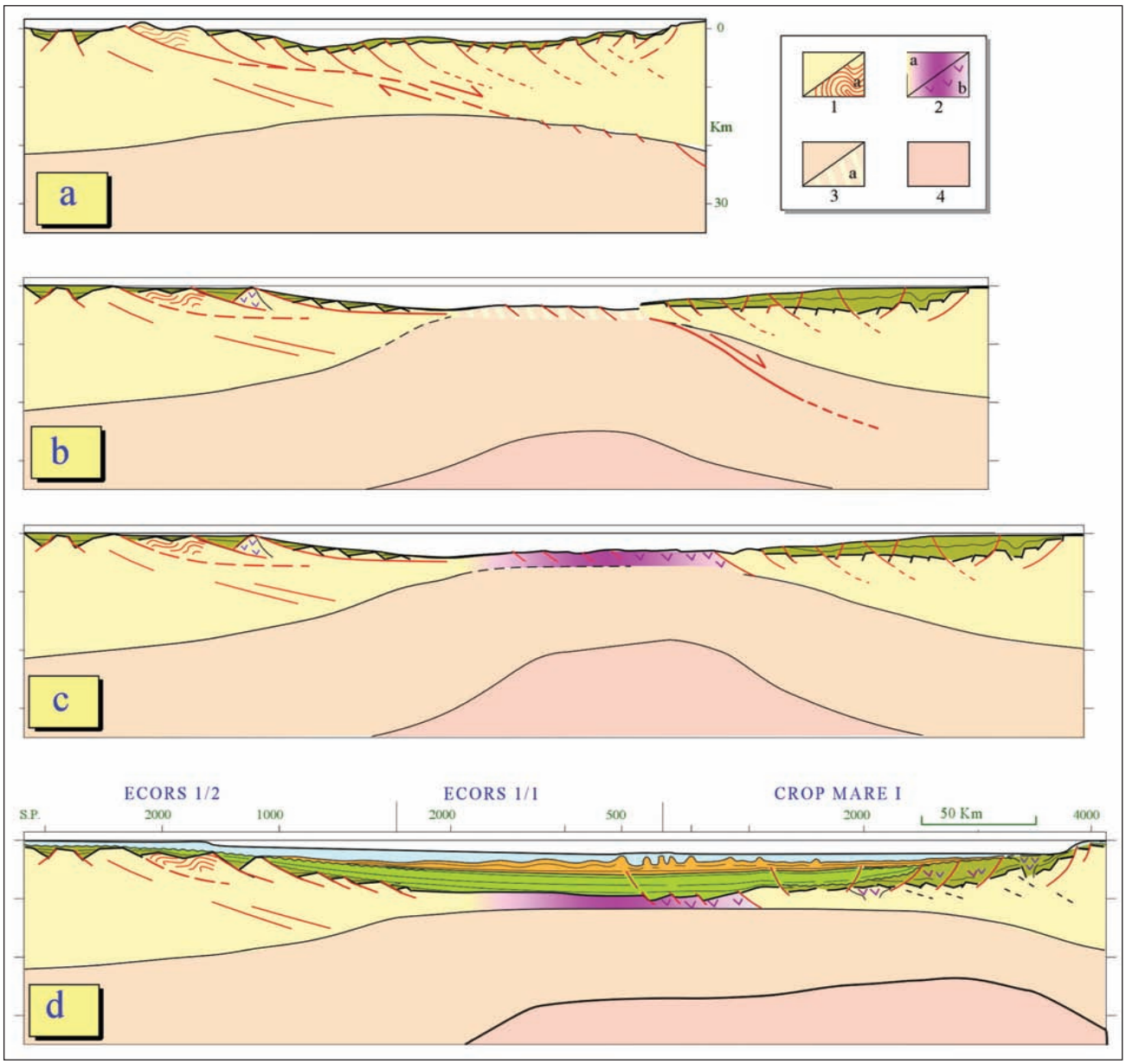

Fig. 2. - Kinematic sketch of the lithospheric section crossed by CROP and ECORS profiles: a) rifting (up to Aquitanian); b) first drifting phase of the Sardinian Block, (up to Mid-late Burdigalian), c) second drifting phase (up to Langhian), d) effects of the Plio-Pleistocene rifting extention on the western margin of Sardinia (present time structure of the basin). 1) Continental crust and part of the Pyrenean Orogene (a), 2) oceanic crust of the first (a) and second (b) drifting phase; 3) Lithospheric mantle and its denuded part (a); 4) Astenosphere. For the other symbols see keys on figure 1.

- Schema cinematico della sezione litosferica attraversata dai profile CROP ed ECORS: a) rifting (sino all'Aquitaniano); b) prima fase di drifting del blocco sardo (sino al Burdigaliano medio-superiore); c) seconda fase di drifting (sino al Langhiano); d) effetti dei processi estensionali plio-pleistocenici sul margine occidentale della Sardegna (struttura attuale del bacino). 1) Crosta continentale e parte dell'orogene pirenaico; 2) Crosta oceanica relativa alla prima (a) e alla seconda (b) fase di drifting; 3) Mantello litosferico e sua parte denudata; 4) Astenosfera. Per tutti gli altri simboli si può fare riferimento alla figura 1.

Another process of lithospheric thinning involved the Sardinian margin in the Plio-Pleistocene, determining subsidence, basaltic volcanism and the recent setting of the area (fig. 2, d). During this phase some structures of "oceanic crust" were reactivated.

The Western part of the M-2A profile crosses the above-mentioned profile (fig. 1), the Bocche di Bonifacio Straits and the Asinara Gulf (Asinara sphenochasm) in order to better define the structure and genesis of the latter, by investigating the relations between the two parts of the Sardinian-Corsican Block during its migration.

Further objectives are related to the investigation of the Hercynian basement structures of the Block.

The M-10 profile partly follows the route of the old OGS-MS47 line (fig. 1, 3) in order to explain the origin of the Ligurian Basin, defined by recent models as a developed pull-apart basin, limited by

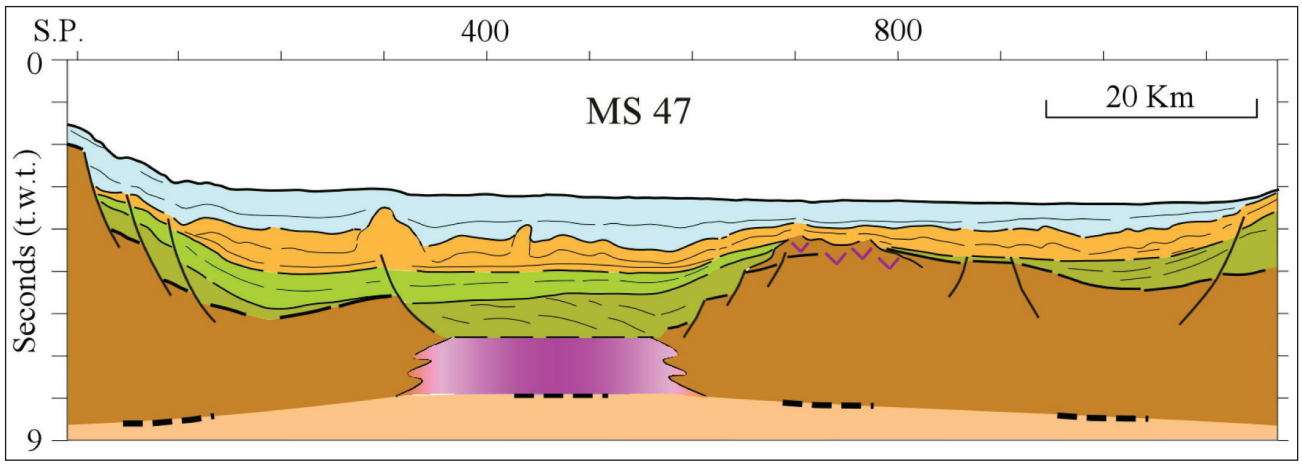

Fig. 3. - Seismic profile MS 47. For the location and symbols see figure 1.
- Profilo sismico MS 47. Per ubicazione e simbologie vedere figura 1.

important trasform faults, which affected the Northern part of the Sardinian-Corsican Block.

REFERENCES

Alvarez W. (1972) - *Rotation of Corsica Sardinia microplate*. Nat. Phys. Sc., **235:** 103-105.

Auzende J. M., Bonnin J. & Olivet J.L. (1973) - *The origin of the Western Mediterranean basin*. Jour. Geol. Soc. London, **129**: 607-620.

Bayer R., Le Mouel J. L., & Le Pichon X. (1973) - *Magnetic anomaly pattern in the Western Mediterranean*. Earth and Planet. Sc. Lett.: **19**: 168-176.

Boillot G. & Coulon C. (1998) - *La dechirure continentale et l'ouverture oceanique*. Gordon and Breach Science Publishers.

Brun J. P. & Beslier M. O. (1996) - *Mantle exhumation at passive margin*. Earth Planet. Sci. Letters. **142:** 161-173.

Burrus J. (1984) - *Contribution to a geodynamical synthesis of the Provençal Basin (North Western Mediterranean)*. Marine Geology, **55** (3/4): 247-259.

Burrus J. (1989) - *Review of geodinamic models for extensional basin; The paradox of stretching in the Gulf of Lions (Northwest Mediterranean)*. Bull. Soc. Géol. Fr., **2** (8): 377-393.

De Voogd B., Nicolich R., Olivet J.L., Fanucci F., Burrus J., Mauffret A., Pascal G., Argnani A., Auzende J.M., Bernabini M., Bois C., Carmignani L., Fabbri A., Finetti I., Galdeano A., Gorini C.Y., Labaume P., Lajat D., Patriat P., Pinet B., Ravat J., Ricci Lucchi F., & Vernassa S. (1991) - *First deep seismic reflection transect from the Gulf of Lions to Sardinia (ECORS-CROP profiles in Western Mediterranean)*. Geodynamics, **22**: 265-274.

Della Vedova B., Lucazeau F., Pasquale V., Pellis G. & Verdoya M. (1992) - *Heat flow in the tectonic provinces crossed by the southern segment of the European Geotraverse*. Tectonophysics, **244**: 57-74.

Fanucci F. & Nicolich R. (1984) - *Il Mar Ligure: nuove acquisizioni sulla natura, genesi ed evoluzione di un "bacino marginale"*. Mem. Soc. Geol. It., **27**: 97-110.

Fanucci F. (1986) - *Evolution stratigraphique de la région du Golfe de Genes depuis l'Eocène supérieur*. Mem. Soc. Geol. It., **36:** 19-30.

Fanucci F., Firpo M., Morelli D. & Piccazzo M. (1994) - *Il Mar Ligure: origine e storia di un bacino mediterraneo*. In: "Studi geografici in onore di Domenico Ruocco", Loffredo Editore: 117-130.

Fanucci F. & Morelli D. (1994) - *Principali lineamenti strutturali ed evoluzione del Mar Ligure (Mediterraneo occidentale)*. Atti del XI Congresso Nazionale dell' A.I.O.L.: 793-806.

Fanucci F. and Morelli D. (2000) - *Caratteri e cronologia della deriva del Blocco Sardo-Corso*. Atti del XIII Congresso Nazionale dell' A.I.O.L.: 167-181.

Gorini C., Le Marrec A. & Mauffret A. (1993). *Contribution to the structural and sedimentary history of the Gulf of Lions (Western Mediterranean), from the ECORS profiles, industrial seismic profiles and well data*. Bull. Soc. Géol. France, **164**: 353-363.

Le Douaran S., Burrus J. & Avedik F. (1984) - *Deep structure of the North Western Mediterranean basin: results of a two ships seismic survey*. Marine Geology, **55** (3/4): 325-346.

Morelli C. , Giese P., Carozzo M. T., Reichert C., Colombi B., Guerra I., Hirn A., Letz A., Nicolich R., Prodehl C., Rower C., Sapin M., Sciarascia S. & Wigger P. (1977) - *Crustal structure of the northern Apennines, the Ligurian Sea and Corsica, derived from seismic and gravimetric data*. Boll. Geof. Teor. Appl., **75-76**: 199-260.

Morelli D., Fanucci F. & Santini S. (1993) - *Struttura ed evoluzione del Mediterraneo occidentale: alcuni risultati del progetto ECORS-CROP*. Atti del XII Convegno Nazionale del GNGTS: 31-42. CNR.

Pascal G.P., Mauffret A. & Patriat P. (1993) - *The ocean-continent boundary in the Gulf of Lion from analysis of expanding spread profiles and gravity modelling*. Geophys. J. Int., **113**: 701-726.

Rehault J.P. (1981) - *Evolution tectonique et sedimentaire du Bassin Ligure (Mediterranèe Occidentale)*.Thèse d'Etat Univ. de Paris VI: **138.**

Rehault J.P., Boillot G. & Mauffret A. (1984) - *The Western Mediterranean Basin: geological evolution*. Mar. Geol., **55**: 447-478.

Speranza F. , Cosentino D. & Villa I.M. (1999) - *Età della rotazione sardo-corsa: nuovi dati paleomagnetici e geocronologici*. Riassunti del Convegno Geoitalia 1999, **1:** 299-301.

Vigliotti L. & Langenheim V.E. (1995) - *When did Sardinia stop rotating? New paleomagnetic results*. Terra Nova, **7**: 424-435.