STRUCTURE AND TECTONIC EVOLUTION OF THE EASTERN CANTABRIAN MARGIN: RESULTS FROM MARCONI MULTICHANNEL SEISMIC DATA

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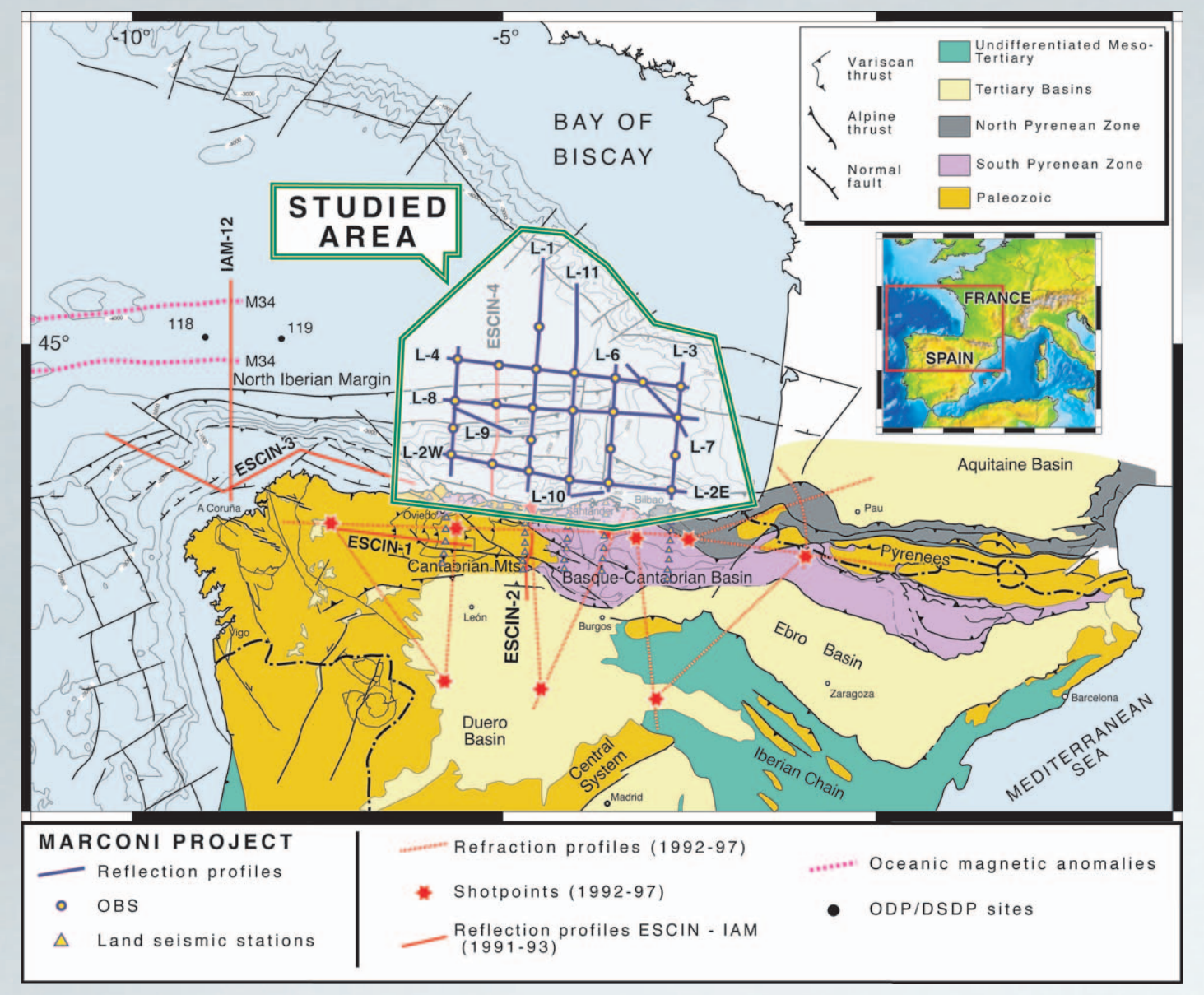
Abstract

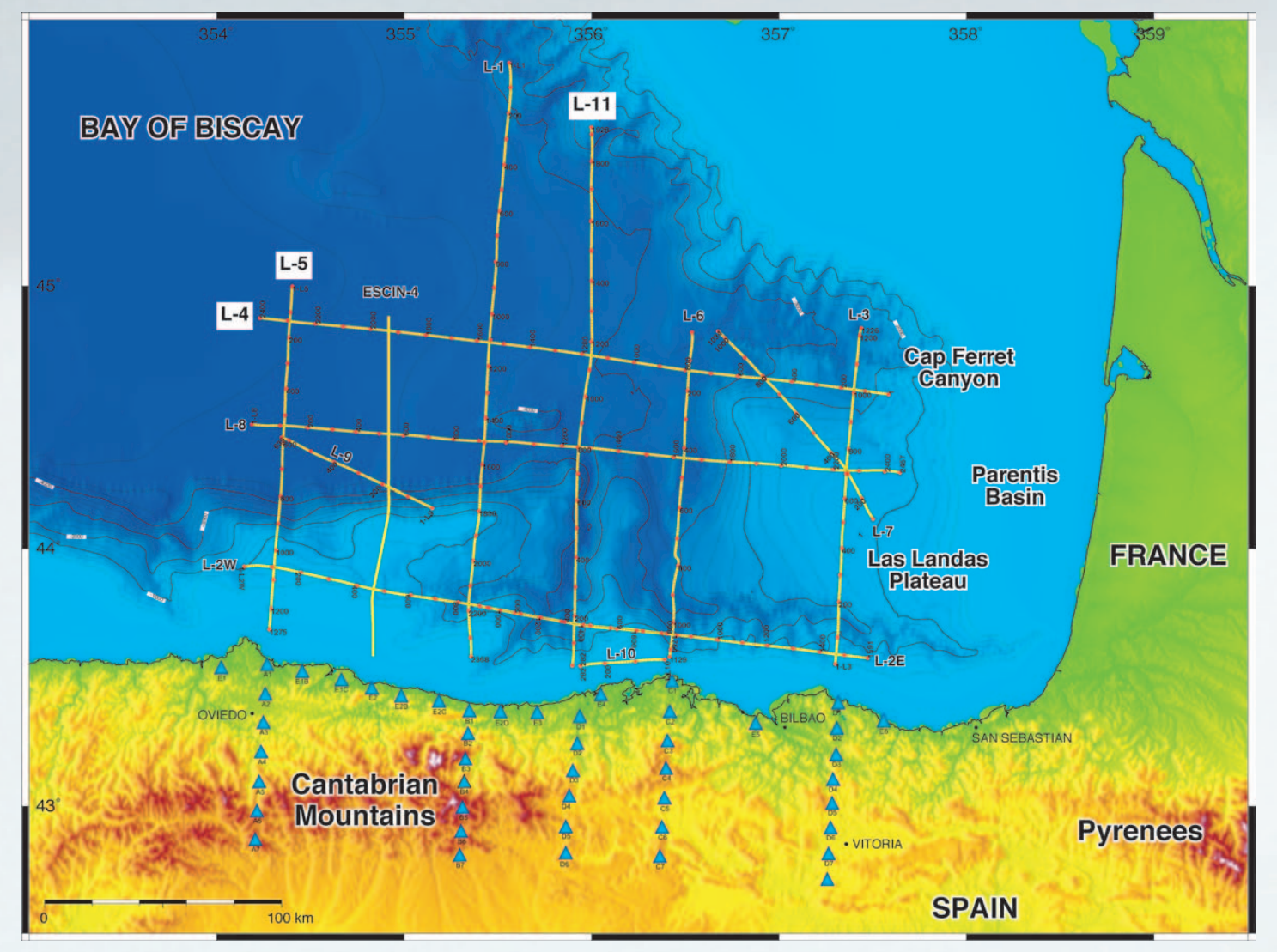
The Bay of Biscay formed during the Cretaceous as a consequence of the opening of the North Atlantic. The convergence between the Iberian and Eurasian plates during the Cenozoic resulted in its partial closure and the building of the Pyrenean-Cantabrian Mountains on land. Most of this deformation and shortening at the south easternmost part of the Bay of Biscay concentrated in the North Iberian Margin, making this area a unique place to study the initial stages of deformation in a passive margin.

In summer 2003, 11 deep seismic reflection profiles were acquired in the MARCONI seismic experiment, providing a new 3D image of the structure of the Bay. This new dataset shows that the structure of this margin is characterized by a thick sequence of Mesozoic-Cenozoic sediments (up to 4 s TWT, up to 6 km) partially deformed by northward vergent thrusts and related folds. The interpretation includes three sedimentary sequences separated by unconformities that correspond to the pre-, syn and post –tectonic units. A Mesozoic sedimentary basin imaged has indications of a Cenozoic tectonic inversion. Evidences of lateral and/or transfer structures coincide with two important North-South striking submarine canyons.

The overall crustal structure of the south-easternmost part of the Bay of Biscay has been interpreted as a thinned continental or transitional crust underthrusted to the S below the extremely steep North Iberian continental slope.

The MARCONI Experiment - Tectonic setting and Seismic Lines


-10°
-5°
BAY OF BISCAY
STUDIED AREA
IAM-12
M34
118
119
45°
North Iberian Margin
ESCIN-3
ESCIN-4
ESCIN-1
ESCIN-2
L-1
L-11
L-4
L-6
L-3
L-8
L-9
L-2W
L-7
L-10
L-2E
FRANCE
SPAIN
Aquitaine Basin
Pyrenees
Cantabrian Mts
Basque-Cantabrian Basin
Ebro Basin
Duero Basin
Central System
Iberian Chain
MEDITERRANEAN SEA
Variscan thrust
Alpine thrust
Normal fault
Undifferentiated Meso-Tertiary
Tertiary Basins
North Pyrenean Zone
South Pyrenean Zone
Paleozoic
MARCONI PROJECT
Reflection profiles
OBS
Land seismic stations
Refraction profiles (1992-97)
Shotpoints (1992-97)
Reflection profiles ESCIN - IAM (1991-93)
Oceanic magnetic anomalies
ODP/DSDP sites


BAY OF BISCAY
L-11
L-5
L-4
ESCIN-4
Cap Ferret Canyon
Parentis Basin
Las Landas Plateau
FRANCE
OVIEDO
BILBAO
SAN SEBASTIAN
VITORIA
Cantabrian Mountains
Pyrenees
SPAIN
100 km

a) Tectonic map of northern Iberia showing the location of the seismic reflection profiles acquired during the MARCONI Project (thick blue lines), the location of the Ocean Bottom Seismometers (OBS - blue circles) and the land seismic stations (blue triangles).

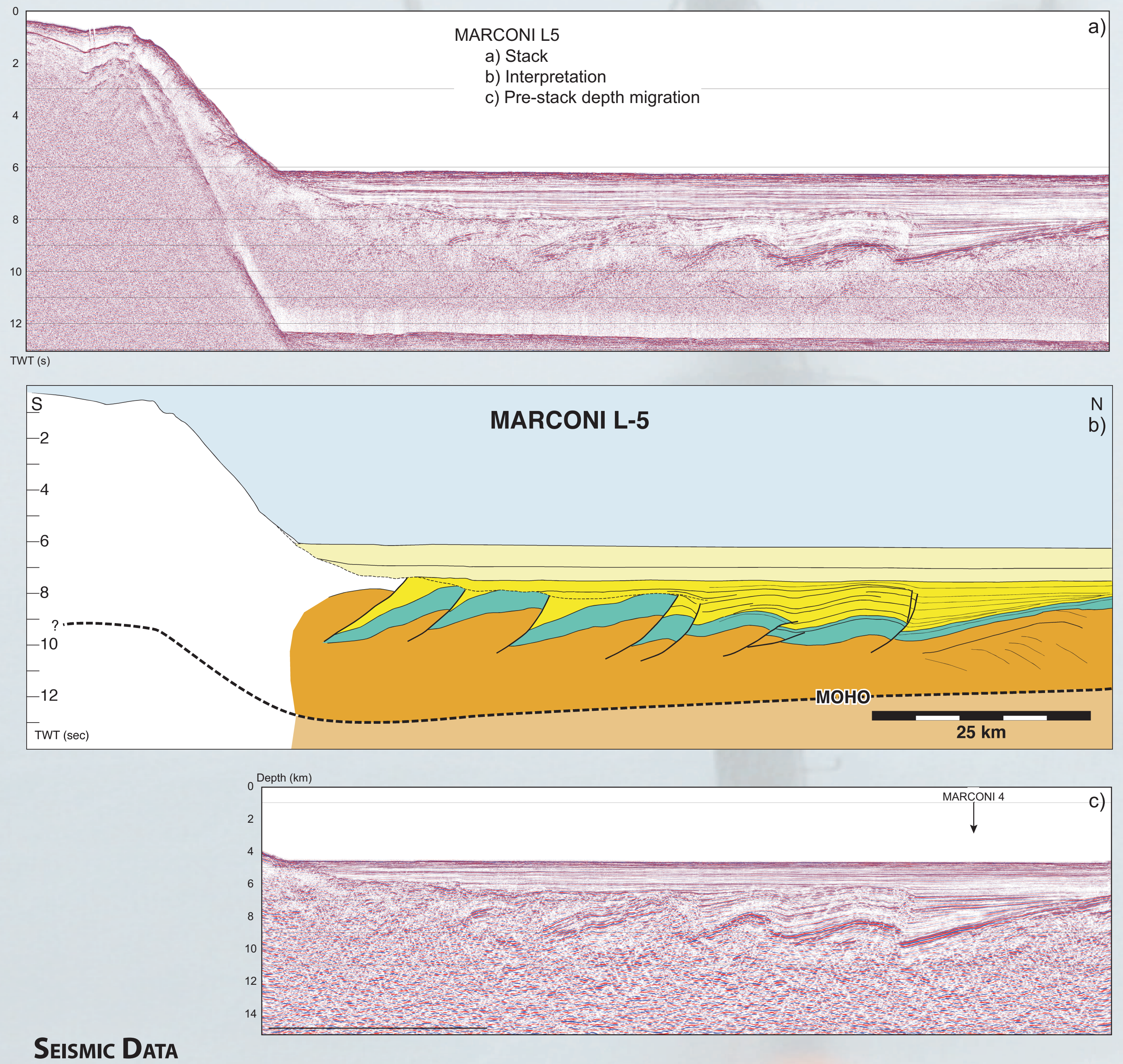
Other geophysical data from previous ESCIN and IAM Projects are also represented in red colour.

b) Location map of the MARCONI project seismic reflection network and land stations. The three seismic reflection profiles interpreted in this poster are labelled in white.

R.V. Hespérides before departure

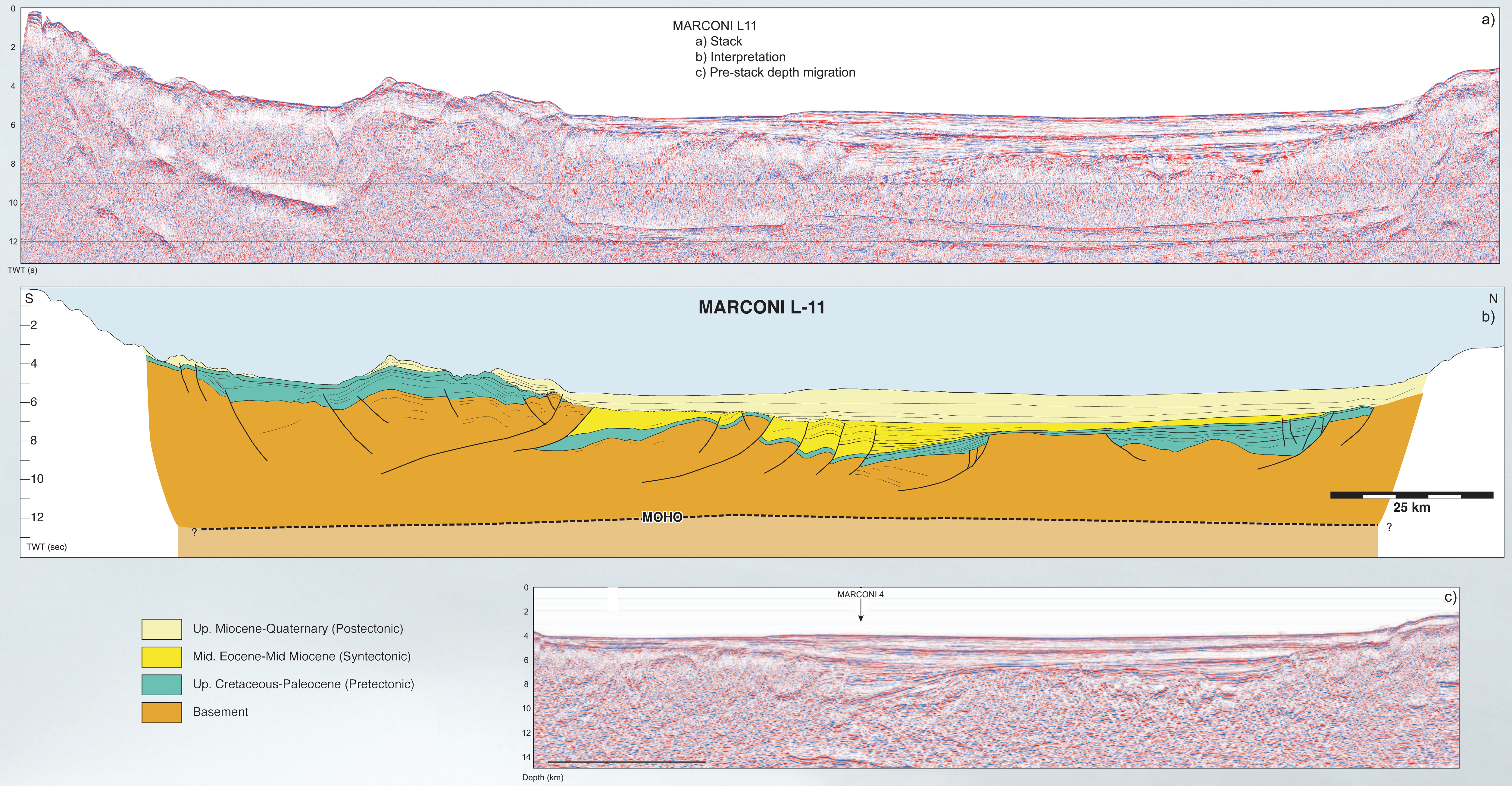
Streamer deployment

Airguns during seismic acquisition



MARCONI L5
a) Stack
b) Interpretation
c) Pre-stack depth migration

a)
TWT (s)
0
2
4
6
8
10
12
MARCONI L-5
S
N
b)
?
MOHO
25 km
TWT (sec)
Depth (km)
MARCONI 4
c)
14



MARCONI L11
a) Stack
b) Interpretation
c) Pre-stack depth migration

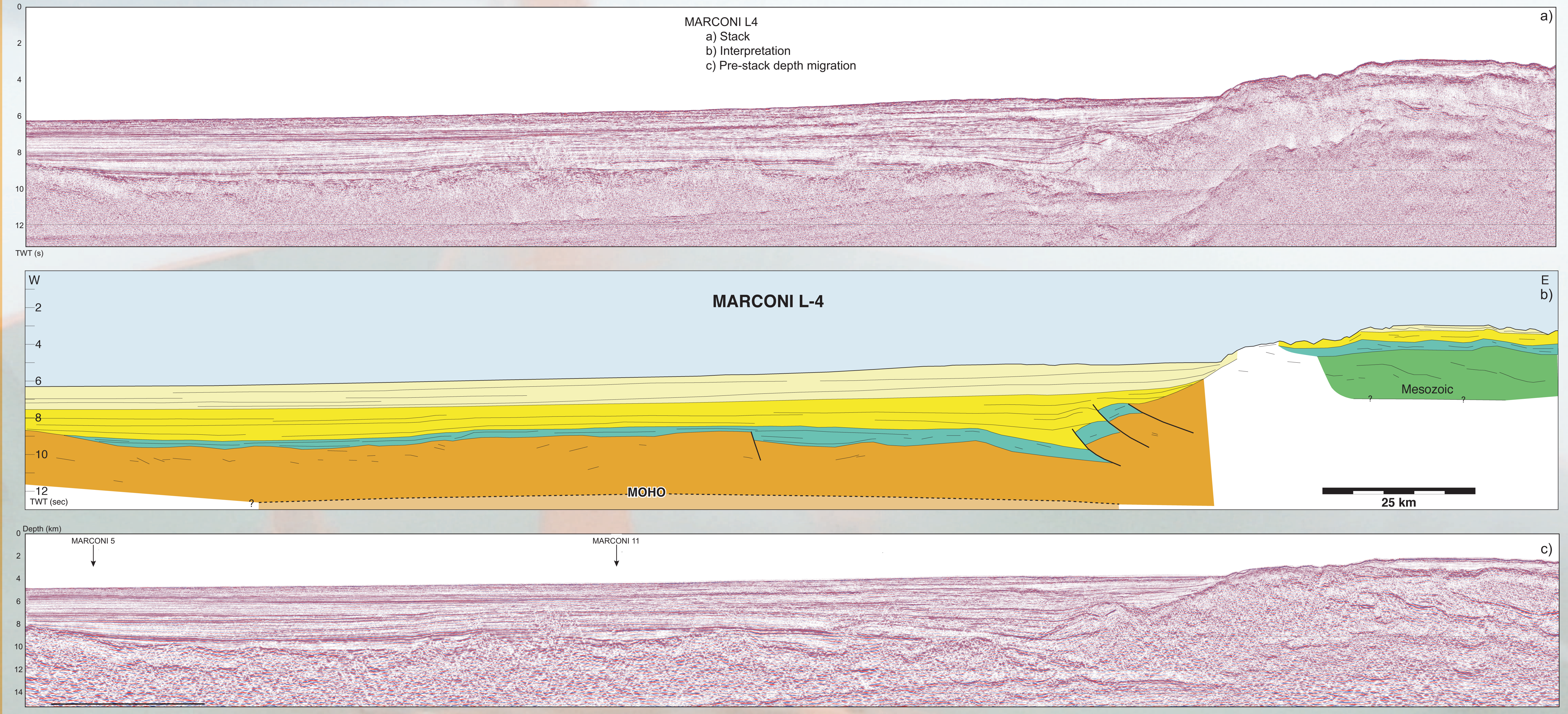
a)
TWT (s)
MARCONI L-11
S
N
b)
MOHO
25 km
?
TWT (sec)
Up. Miocene-Quaternary (Postectonic)
Mid. Eocene-Mid Miocene (Syntectonic)
Up. Cretaceous-Paleocene (Pretectonic)
Basement
MARCONI 4
c)
Depth (km)

Seismic Data

The first panel of each profile displays the stacked section. The interpreted line is below and the third panel shows the pre-stack depth migrated section (PSDM) along the Bay of Biscay.

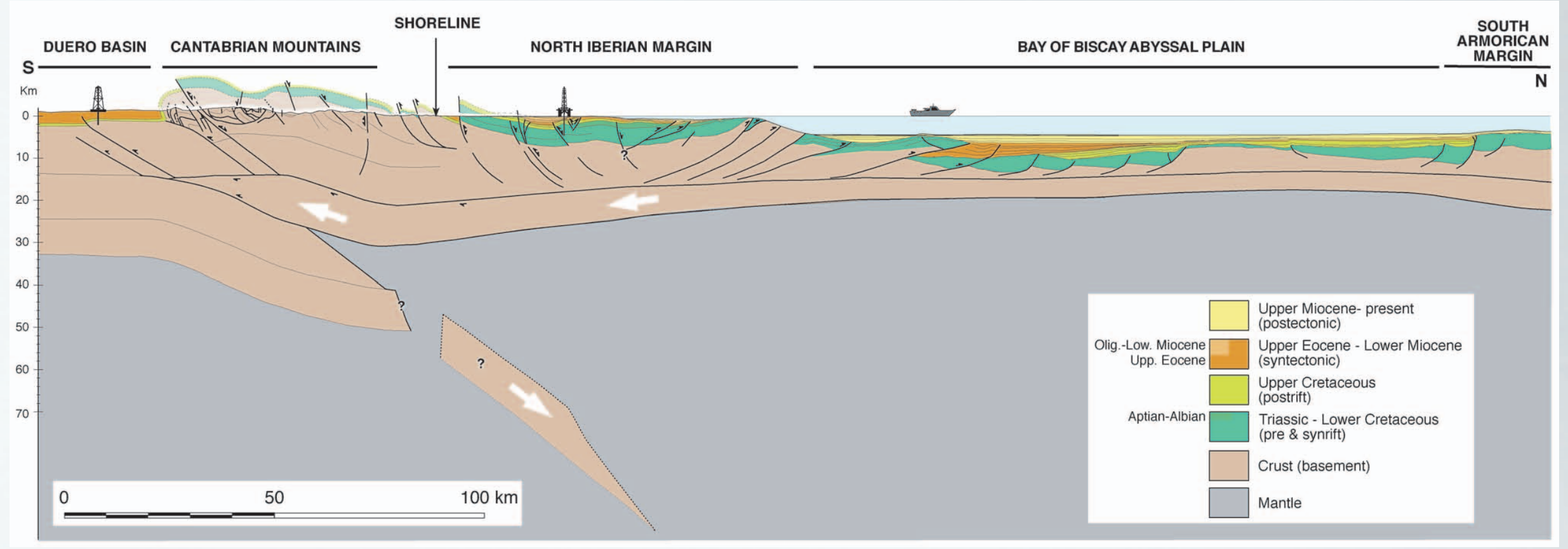
The seismic lines show good images of the thick sedimentary sequence observed in the abyssal plain, which includes three main sedimentary sequences separated by unconformities. They correspond to the pre, syn and post orogenic episodes that shaped the margin during the Alpine cycle and show the lateral structural variations in the deformation front from west to east.

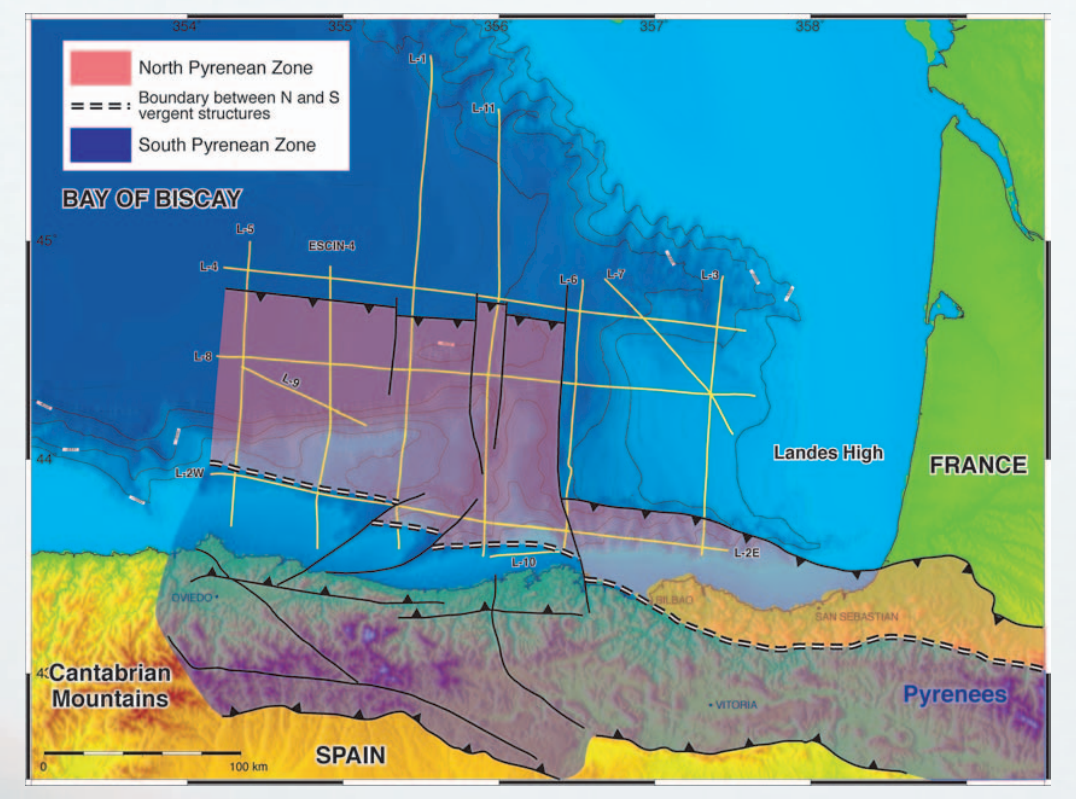
Interpretation of the profiles, indicates that the former rifted margin of the Bay has been completely destroyed during the compression process in the Tertiary. Compressional structures, accretionary features and unconformities are well documented in the data. The PSDM profiles indicates the depth and extent of the sequences providing good images of the submerged geology.



MARCONI L4
a) Stack
b) Interpretation
c) Pre-stack depth migration

a)
TWT (s)
W
E
b)
MARCONI L-4
Mesozoic
?
MOHO
25 km
TWT (sec)
Depth (km)
MARCONI 5
MARCONI 11
c)


DUERO BASIN
CANTABRIAN MOUNTAINS
SHORELINE
NORTH IBERIAN MARGIN
BAY OF BISCAY ABYSSAL PLAIN
SOUTH ARMORICAN MARGIN
S
N
Km
0 50 100 km
Olig.-Low. Miocene Upp. Eocene
Aptian-Albian
Upper Miocene- present (postectonic)
Upper Eocene - Lower Miocene (syntectonic)
Upper Cretaceous (postrift)
Triassic - Lower Cretaceous (pre & synrift)
Crust (basement)
Mantle


North Pyrenean Zone
Boundary between N and S vergent structures
South Pyrenean Zone
BAY OF BISCAY
Landes High
FRANCE
Cantabrian Mountains
Pyrenees
SPAIN

Interpretation and Conclusions

a) Cross-section of the Bay of Biscay along a longitude similar to Line 1. Land data (ESCIN-2 profile) and platform from Gallastegui 1998.

b) Tectonic sketch of the vergence of structures in the study area, which constitutes the western prolongation of the Pyrenees.

The North Iberian Margin in the Bay of Biscay shows a high variability from West to East due to the oblique compression and convergence in the Tertiary. The Armorican margin, at the eastern part of the Bay, has been also involved in the deformation, and shows reactivation of normal faults as thrust verging to the North. The southern rifted margin is now completely consumed and deformed in the present-day platform and continental slope.

Acknowledgements

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