# C-19 WIDESPREAD LGM AXIAL INCISION IN SUBMARINE CANYONS OF THE WESTERN GULF OF LIONS

J. BAZTÁN[2], S. BERNÉ[1], M. CANALS[2], J-L. OLIVET[1], M. RABINEAU[1], J-P. RÉHAULT[3], J. LOFI[1]

[1]IFREMER

[2]Barcelona University, GRC en Geociencias Marinas, Dept. Estrat. y Paleontología, Fac. de Geología, 08028 Barcelona, Spain

[3]Bretagne Occidentale University

## Summary

A detailed morphological analysis of the submarine canyons in the Western Gulf of Lions shows the widespread occurrence of an axial incision excavated within the main valley. Such an incision is interpreted as a relict feature dating from the Last Glacial Maximum when sediment transfer from river mouths to canyon heads was enhanced due to sea level lowstand and to increased continental runoff.

## Introduction

Submarine canyons in the Northwestern Mediterranean continental margin are known since long (Bourcart, 1948; Got et al., 1969). The Western Gulf of Lions is one of the margin segments where more and larger canyons occur (Canals and Got, 1986) forming a rather complex grid draining sediments down to the base of slope. Recently a new bathymetric map of the area, with contour equidistance of 20 m, based on full coverage swath bathymetry data, has been published (Berné et al., 1999). The data were obtained during the cruise CALMAR-97 on board the RV L'Atalante, led by IFREMER in 1997.

The present work uses the same data, complited with swath bathymetry data from CAMAR 1999, to undertake a study with unprecedented detail of the morphology of the submarine canyons in the Western Gulf of Lions. The quality of the bathymetric data, combined with IFREMER's fast and high-resolution seismic reflection profiles, have proved to be very useful in identifying poorly-known morphosedimentary elements and thus to interpret the timing and the processes responsible for their formation.

## Overall characteristics of the Western Gulf of Lions canyons system

Six main canyons cut the continental slope and the outer shelf up to water depths as shallow as 100 m in some cases. Five of these canyons follow a general WNW-ESE to NW-SE trend, while the sixth is oriented 150°N (Fig. 1). The five first canyons, named Cap de Creus, Lacaze-Duthiers, Pruvost (a tributary of Lacaze-Duthiers), Aude (a tributary of Lacaze-Duthiers too) and Herault in a clockwise sense, tend to converge towards the base-of-slope, where they become less incised delivering their sediments to form a thick pile. The sinuous Sete Canyon cuts into the sediment pile above mentioned and prevents any further eastward extension of the

canyons west of it (Fig. 1). Three of them become in fact hanging tributaries of the Sete Canyon. These are the Cap de Creus and Lacaze-Duthiers canyons, that merge together just prior joint the lower Sete Canyon in its lower course, at a depths in excess of 2000 m, and the Herault Canyon that enters the Sete Canyon through its slightly shallower mid-course, at about 1.900 m depth.

**Axial incision**

One of the most outstanding morphological features within the Western Gulf of Lions are the deeply entrenched axial incisions observed (Figs. 2). These incisions, which are excavated in the floor of the canyon, display thalweg gradients ranging from 5% to 3% in their upper course to 2% to 1% in their mid-course, and to less than 1% in the lower course till they vanish (Fig. 3b). Such axial incision cannot be perceived in full detail on classical medium- to high-resolution seismic reflection profiles (Figs. 2b, 3c and 3d) and contour maps, but it is clearly seen in very high-resolution profiles (Fig. 2c) as well as shaded-relief images made from grids at 125m grid node spacing derived from swath bathymetry data (Fig. 2a, 3a and 3b).

The course of the axial incision varies from slightly sinuous, such as in the Cap de Creus Canyon (Figs. 3a and 3b), to meandering, like in the upper course of the Aude Canyon, where bottle-neck meanders can also be observed (Fig. 2a). The incisions can be as deep as 100 m with respect to the nearby canyon floor.

**Origin of the axial incision**

We interpret this widespread axial incision as formed by turbidity currents entering the head and uppermost course of the Western Gulf of Lions submarine canyons during the last lowstand period, when those events probably occurred at a higher frequency than at present. In other words, we explain these axial incisions as a relict sea-floor feature created of active transport processes during the Last Glacial Maximum. A lower sea level, combined with an increased continental runoff, caused more sediment yield to be delivered directly to the canyon mouths during glacial times. The widespread occurrence of the axial incision let us think that its formation has been led by global controlling factors, such as climatic-eustatic oscillations, rather than by local factors.

Wether or not the formation of this axial incision can trigger instabilities from canyon walls, where gradients in excess of 20% are common in the mid-course (Fig. 3b), due to undercutting is a question to which we do not have yet a definitive answer, but that certainly deserves attention. It is also of great interest the role that this axial incision may play as a potential trap for sediment fining-upwards sequences, and thus to improve our knowledge of present-day analogues for the understanding of hydrocarbon reservoirs in ancient turbidite systems.

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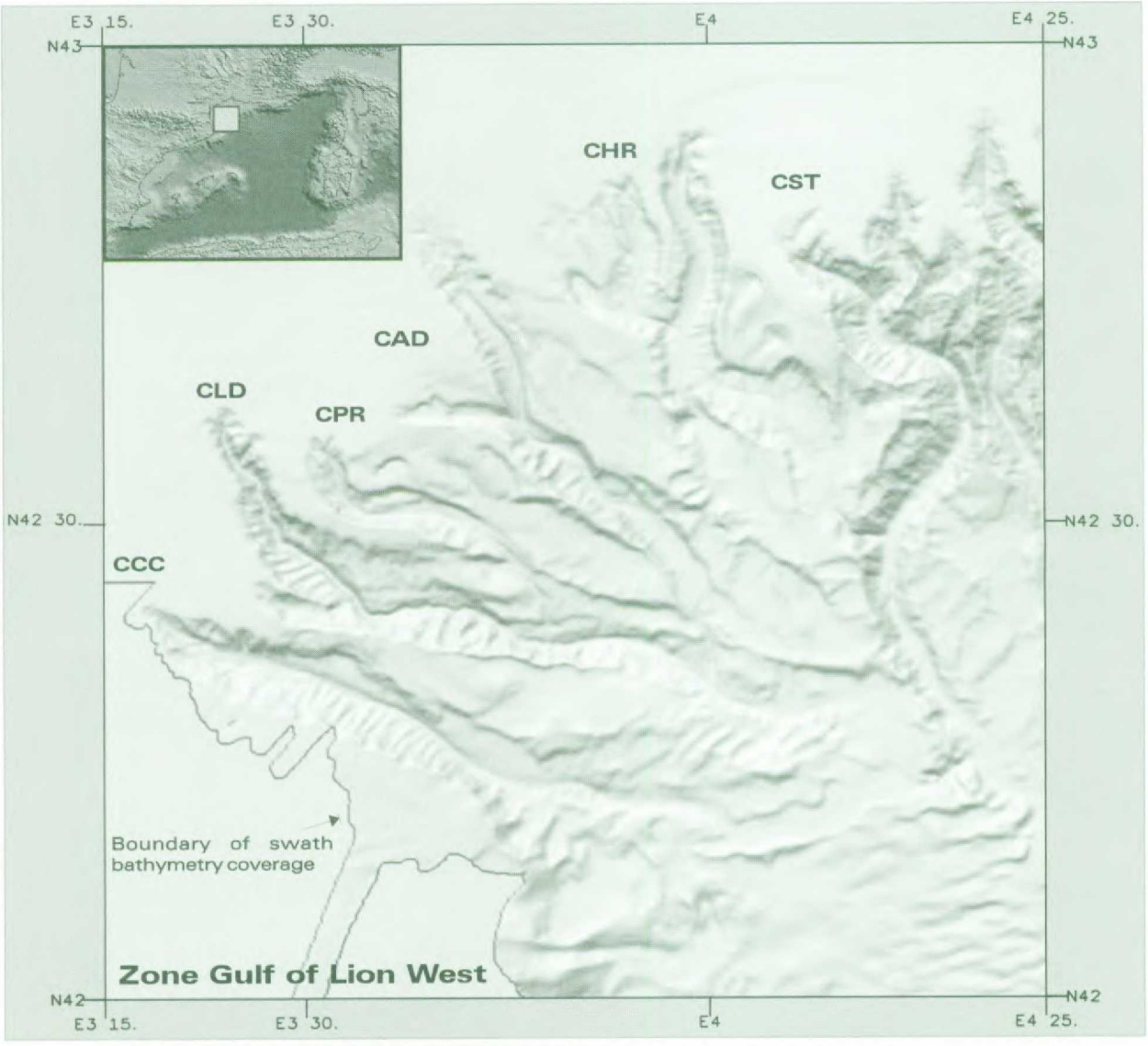


**Fig. 1:** *Canyons system of the Western Gulf of Lions. The outer shelf is incised by the canyon heads, indicated by labels in capital letters. The lower slope is to the right lower corner of the image. The Cape of Creus (CCC) and the Lacaze-Duthiers (CLD) canyons merge in the lower slope prior to tribute into the Sete Canyon (CST). The Pruvost (CPR) and Aude (CAD) canyon are tributaries of the Lacaze-Duthiers Canyon. The Herault Canyon enters the Sete Canyon at its mid-course. The western canyons, from CCC to CHR, tribute into the Sete Canyon as hanging valleys. Note the axial incision and the gullied walls of the upper and mid courses of all the canyons. Some large landlslide scars can be also observed, as well as retrogressive incisions on the western flank of the Sete Canyon.*

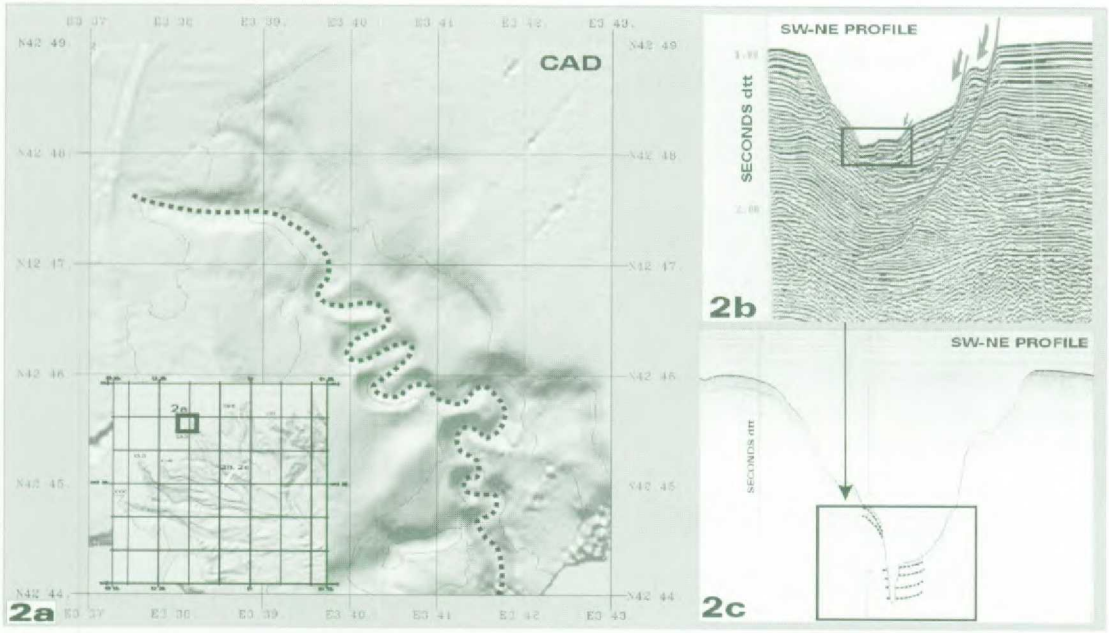


***Fig. 2:*** *Meandering axial incision in the eastern branch of the Aude Canyon head (2a and 2c) probably formed during the Last Glacial Maximum when much of the continental shelf was exposed and the paleo-Aude River mouth opened at the canyon head because of sea level lowstand. The axial incision can be followed down to mid canyon course. The eastern flank of the canyon is affected by deeply rooted mass-movements (2b). Sea location of 2b and 2c in the inset on the lower left of 2a.*

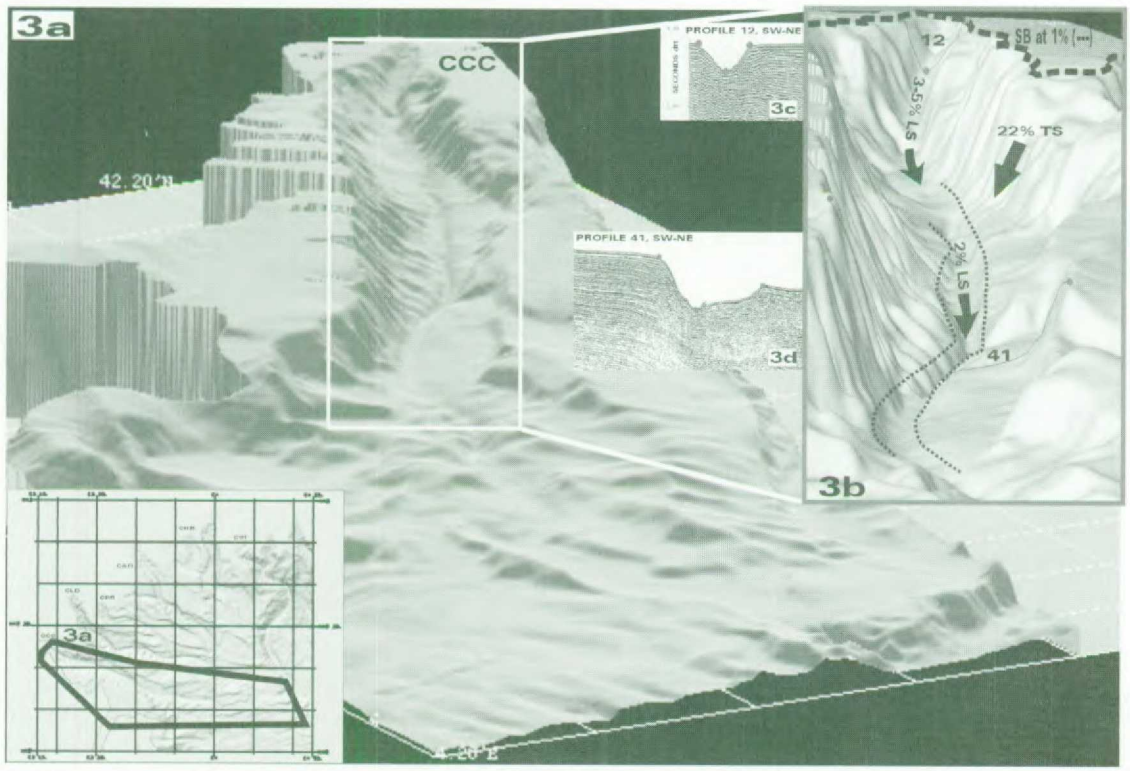


***Fig. 3:*** *3D views of the Cap de Creus Canyon (3a and 3b) clearly showing its gullied walls and the axial incision. At the lower course, the canyon widens and its flanks become less defined. The Sete Canyon appears at the lower right corner of image 3a. Shelf break is defined at 1% gradient (0.57°). Two air-gun seismic profiles show the seismostratigraphic structure of the canyon and near interfluves (3c and 3d). See the location of the seismic profiles on 3b image, where thalweg and canyon flank gradients are also indicated.*