

RC 2911

Project ALBORAN SEA

Cruise report R/V Robert D. Conrad

Barcelona - Cadiz, Spain

November 22 to November 27th 1988.

Introduction

This project is to acquire multichannel seismic reflection profile data in the Alboran sea, Western Mediterranean. The project is a joint one between Lamont-Doherty and the University of Oxford. Funding for the project was provided by a consortium of oil companies that included Texaco, Amoco and B.P.. The purpose of the project was to determine the deep seismic structure of the basin and to better understand the origin of the structural highs and lows that have been identified in previous studies of the area.

The Alboran sea is a small basin located between the Betic and Rif mountains in Spain and Morocco. Previous workers consider the basin is floored by continental crust of probable Betic age.

Analysis of plate motions show that Africa and Iberia have been converging in a roughly N - S direction through most of the Tertiary, yet the Alboran sea between them appears to be an extensional basin on the basis of a thinned continental crust, extensive volcanic material and, tilted fault blocks. The Alboran sea is surrounded by the mountain chains of the Betic and Rif all of which show compressional features during the Tertiary.

We hope in this project to better understand the mechanism by which Neogene extension in the Alboran followed shortening in the adjacent mountain belts.

Personnel

The scientific staff in the cruise included:

A. Watts (Lamont-Doherty)

Chief Scientist

A. Mauffret (Univ. Paris, France)

J. Bott (Univ. Oxford)

L. Lonergan (Univ. Oxford)

M. Arguedas (Inst. de Ciencias del Mar, Barcelona, Spain)

C. Docherty (Inst. Jaime Almera, Barcelona, Spain)

J. Stennett (Lamont-Doherty)

Chief Science Officer

P. Bennett (Lamont-Doherty)

J. DiBernardo (Lamont-Doherty)

B. Francis (Lamont-Doherty)

M. Ilitche (Lamont-Doherty)

Equipment

The project was carried out during November 22nd to November 27th, 1988 on the Lamont-Doherty operated vessel Robert D. Conrad while she was on transit from Barcelona to Cadiz. Prior to the Alboran sea work the Conrad had carried out a two-ship seismic experiment in the Gulf of Valencia. The Conrad secured permission to carry out seismic work in both Spanish and Moroccan waters but was denied permission to enter Algerian waters.

The Conrad was equipped with the following:

- * DIGICON 2.4 km streamer with 96 traces and 25 m group spacings
- * DIGICON DSS 240 digital seismic recording system
- * Tuned 10 element BOLT airgun array (total volume 5346 cu in)
- * 4 PRICE Air Gun Master diesel and 1 DC drive air compressors
- * BELL AEROSPACE BGM-3 sea gravity meter system
- * VARIAN proton magnetometer
- * LORAN-C, US Navy TRANSIT and GPS positioning systems

Narrative

The Conrad arrived on site in the Alboran sea on November 22nd at 0345 hours in calm seas. The streamer was deployed while the vessel was heading to the south. By 1130 hours the air guns were in the water and the first line (Line # 823 CDP 5) was began at 1151 hours.

The start point for CDP 5 was located to the south of a deep (2300 m) NW - SE trending trough which has been interpreted as a "pull-apart" basin between two overlapping strike-slip faults (Mauffret pers.comm.). The single trace (from near the head section) monitor record showed a thick sedimentary succession in the basin and a deformation zone on its northern boundary.

By 2000 hours the weather had significantly deteriorated although the seismic data quality (as measured by the signal to noise on the monitor record) was still quite good. The rest of the line crossed a small topographic high in the central part of the basin. The line ended at 0235 hours on November 23rd, in the Golfo de Almeria, Spain.

The Conrad then proceeded to the SW to a point on the continental slope near Banco Chella where Elf-Aquitaine's Andalusia A-1 well had spudded in 1980 (Instituto Geologico y Minero de Espana, 1987). This well penetrated a 2.844 km section of Lower Miocene to Quaternary sediments overlying phylites and quartzites of the Betics. The monitor record over the well site was obscured by the sea-bottom multiple but stratified material could be identified up to and below the multiple on parts of the line.

The rest of the line (CDP 6) crossed the sea in a SW direction passing within a few km of Isla de Alboran. The island is located on top of a broad submarine ridge which

trends NE - SW and comprises of andesitic rocks. The monitor record revealed the contact relationships of the ridge to the surrounding basins, showing a possible deformed zone on its southern boundary. Previous authors have interpreted the Alboran ridge as a "pop-up" feature that is associated with the Trans-Alboran shear zone (Larouziere et al., in press).

After crossing the basin to the south, Conrad was about to change course and head back to the Spanish coast when it was learnt by telex that the request for clearance to work in Moroccan waters had been approved. Conrad then headed directly south to a point in the bay between Cap Quilates and Cap de Trois Fourches on the Moroccan coast. The monitor record showed a thick sequence of offlapping sediments on the shelf of probable Neogene age.

The new line (CDP 7) began at 0217 hours in calm waters in the lee of the Moroccan coast but the weather soon began to deteriorate. By 0645 on November 24th a succession of telemetry errors led to the abandoning of the line and firing stopped shortly after. At this point Conrad was about 20 km from Isla de Alboran so it was decided to head for the island in case there was a lee for protection. By the time the vessel had circled the island, the seas had improved a little and we were able to retrieve the streamer to try and locate the telemetry error. No obvious problem was found in the streamer, although several of the connectors between the active sections and the digitising canisters were opened and cleaned. The line was re-joined at about 0700 hours - slightly more than 1 day after leaving it.

CDP 7 crossed the narrow basins that flank the Alboran ridge and crossed a broad volcanic province before reaching the Spanish margin near Nerja. Here a thick sequence of offlapping sediments were observed on the margin through the water multiple.

After a short connecting line (CDP 8) across the slope to a point south of Malaga, the Conrad headed south to the Moroccan coast for the second time (CDP 9). The track was planned to cross DSDP site 121 which was drilled on a basement high by D/V Glomar Challenger (Ryan et al, 1970). The drill recovered a 400 m thickness of Quaternary sediments, 250 m of Pliocene and a 100 m thick Messinian sequence overlying (?) betic basement. CDP 8 showed a rapid thickening of sediments from the slope off Spain toward the basement ridge forming a small basin. Evidence of channeling into Messinian sediments was found to the north of the ridge. The channels were apparently infilled by Pliocene and younger sediments. Previous workers have suggested the channels were cut by corrosive bottom counter currents following the "refilling" of the mediterranean sea through the Straits of Gibraltar. After crossing the drill site, Conrad proceeded south. At 1130 it was observed that the sediments suddenly thickened again and evidence was found for onlap onto the basement and a broad unconformity. The geometry of the sediments below the unconformity suggested that they once continued across the ridge into the basin to the north. If this is the case, then considerable material must have been removed from the ridge following the Messinian.

The CDP profile (#9) continued south across the deep Alboran basin toward the Moroccan margin. The approximate axis of the basin was reached at 2030 hours where at least 3 secs (2-way time) of sediments were identified on the monitor trace. The line continued south across a major deformation zone at the northern boundary of Xeuán bank. A major fault was observed near the Moroccan coast which may represent the offshore continuation of the internal Rif thrust front on land.

After the turn at 0230 hours on November 27th several diapiric structures were observed (CDP # 10). It could not be determined whether they were salt or clay diapirs. They were not associated with magnetic anomalies suggesting they were not volcanic

intrusions. The rest of the line crossed the deep Alboran basin, the largest accumulation of Pliocene and Quaternary sediments in the mediterranean. At 1130 hours a large diapir was crossed close to where SHELL had previously reported finding several diapiric structures (Mulder and Parry, 1977). The strata above the diapir appear deformed and at least two major unconformities could be documented in the Pliocene and Quaternary sediments. The unconformities were recognized on the basis of reflector terminations which showed offlap patterns. Again, the diapir was not associated with a magnetic anomaly (or a gravity anomaly) suggesting the possibility that they are of clay or mud origin. The top of the Messinian was recognized on this (and other lines) as a diffuse reflector at about 2.5 secs (two-way time) which is significantly deeper than the SHELL interpretation.

The CDP line # 10 was continued to a point latitude 36° 5.9' longitude 5° 0.7' where the line ended. We had planned to terminate the survey at this point. However, we observed that the traffic in the Straits of Gibraltar was relatively light, the seas calm and the visibility was good. It was therefore decided to attempt a CDP line through the straits in order to obtain a transect of the Betic and Rif mountain belt. The line began at the end-point of CDP 10 and continued to the SW along the center of the traffic lanes. The main feature of the profile was a steep fault to the east of Europa point which seem to bound the Quaternary and Pliocene sediments of the Alboran basin. Sediments are thin beneath the channel. The betic basement appeared to have several prominent reflectors which mostly dipped to the west.

Weather

The general weather conditions for the cruise was as follows:

Date/Time	Force	Line
November 22nd 1200	3	Stream gear
November 23rd 0000	6-7	CDP 5
November 23rd 1200	6-7	CDP 6
November 24th 0000	6-7	CDP 6
November 24th 1200	7	Abort line - Heavy seas
November 25th 0000	5-6	Rejoin line
November 25th 1200	5-6	CDP 7
November 26th 0000	6	CDP 8
November 26th 1200	3	CDP 9
November 27th 0000	4	CDP 9
November 27th 1200	3	CDP 10

Results

The total line length of the underway geophysical data (gravity, magnetic and bathymetry) collected was 534 nm (989.87 km). The total line length of Common Depth Point (CDP) data was 440 nm (814.88 km). The CDP data was collected to the following specifications:

Shot interval:	23 secs
Guns (10 chambers):	5346 cu in
Average survey speed:	4.2 knots
Shot Spacing:	50 m
Recording window:	20 secs
Sampling rate:	4 millisec
Field Tape format:	SEG-Y, 6250 BPI

General comments

There were no major equipment failures during the leg. The only problem encountered were intermittent telemetry failures of the DIGICON streamer. Usually these occurred at 1 to 5 hour intervals and resulted in a loss of about 3 to 4 shots. Attempts were made to correct the problem on Nov 25th but they were not successful. The connectors between the digitising canisters and the active sections were suspected of leakage but after checking they were found to be in good order. The greatest number of failures occurred during rough seas indicating an intermittent weather related problem perhaps due to excessive stressing of the cable. The weather for the survey started well but deteriorated in the middle. The best weather was toward the end of survey. Even during the bad weather the signal to noise ratio of the seismic data appeared to be high, based on the single trace monitor record, and good results can be expected following processing.

References

- Larouziere, F.D., Bolze, J., Bordet, P., Hernandez, J., Montecat, C., d'estevou, P. The Betic segment of the lithospheric Trans-Alboran shear zone during the Late Miocene. Tectonophysics, in press.
- Mulder, C.J. and Parry, G.R., Late Tertiary evolution of the Alboran sea at the eastern entrance of the straits of Gibraltar. Int Sym. on the Structural History of the Mediterranean basins. Split (Yugoslavia). Editions Technip, Paris 1977., 401 - 430.
- Ryan, W.B.F. et al. Western Alboran Basin - Site 121. Initial Reports of the Deep Sea Drilling Project. Vol 23, Part 1, 43 - 89. 1970.

Line	COP	ESP	CDP	Time	Date	Shot	Pitlog	Latitude	Longitude
823	0	0	5	1051	Nov 22	29291	2333.0	35 45.7	01 56.7
823	0	0	5	0235	Nov 23	31745	2398.9	36 46.8	02 23.8
824	0	0	6	0236	Nov 23	31750	2399.2	36 46.9	02 23.9
824	0	0	6	0215	Nov 24	35389	2496.9	35 19.3	03 11.3
825	0	0	7	0217	Nov 24	35397	2497.3	35 19.2	03 11.2
825	0	0	7	0645	Nov 24	39890	2514.5	35 35.5	03 19.9
825	0	0	7	0700	Nov 25	39895	2602.5	35 33.6	03 19.0
825	0	0	7	2354	Nov 25	42535	2670.3	35	
826	0	0	8	0035	Nov 26	42539	2673.9	36 42.3	03 52.7
826	0	0	8	0623	Nov 26	43410	2698.6	36 34.6	04 21.4
827	0	0	9	0625	Nov 26	43415	2698.6	36 34.5	04 21.6
827	0	0	9	0100	Nov 27	46277	2773.8	35 12.4	04 23.6
828	0	0	10	0130	Nov 27	46354	2775.9	35 11.4	04 23.8
828	0	0	10	1552	Nov 27	48522	2837.0	36 05.9	05 00.7
829	0	0	11	1622	Nov 27	48704	2838.9	36 04.7	05 03.3
829	0	0	11	1640	Nov 28	52458	2945.8	35 46.8	06 58.0

Table: Summary navigation for CDP lines 5 - 11

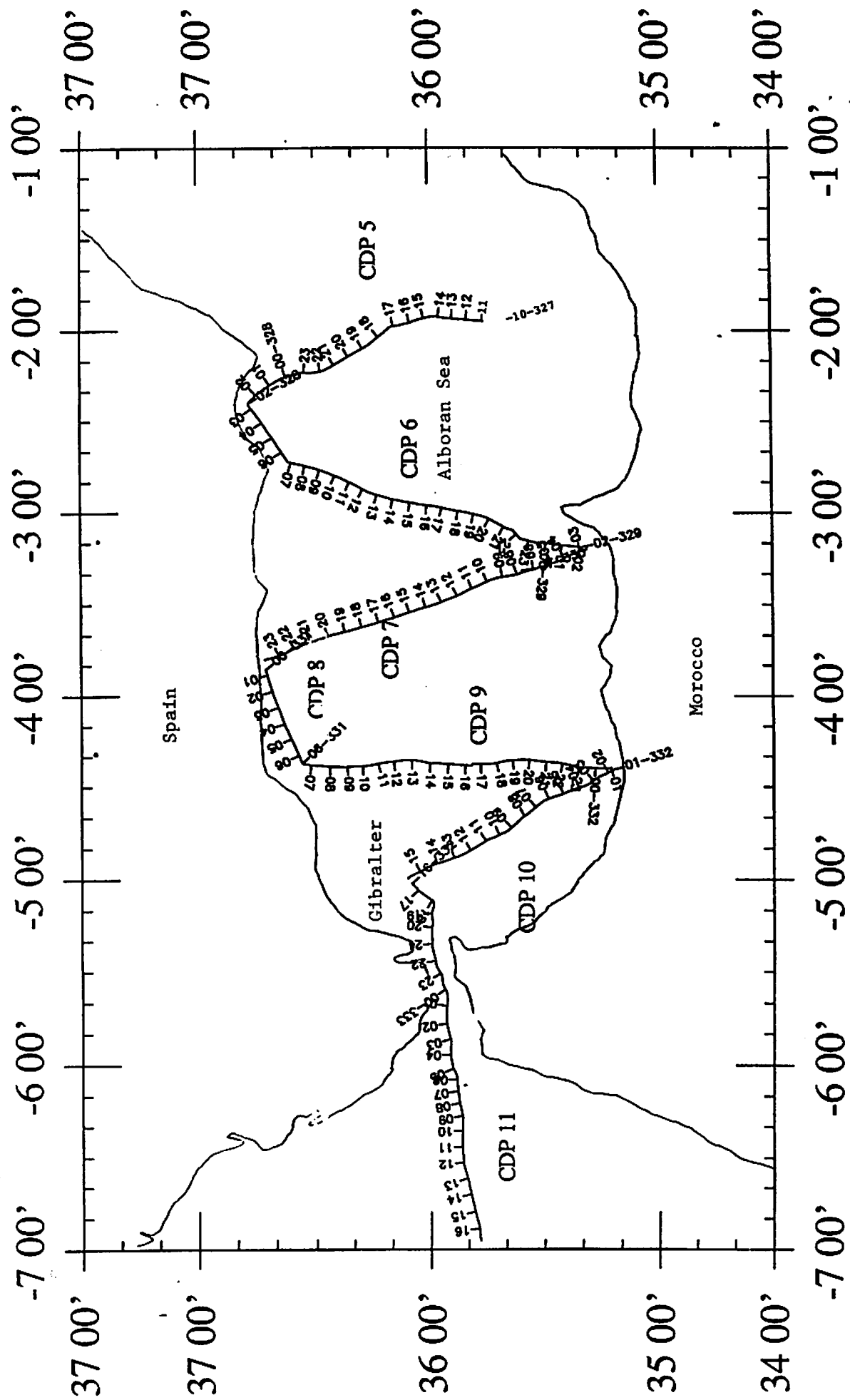


Fig. 1

Common Depth Point (CDP) Profiles - 23 secs Pop rate

INTERVAL 50M 48 FOLD DATA

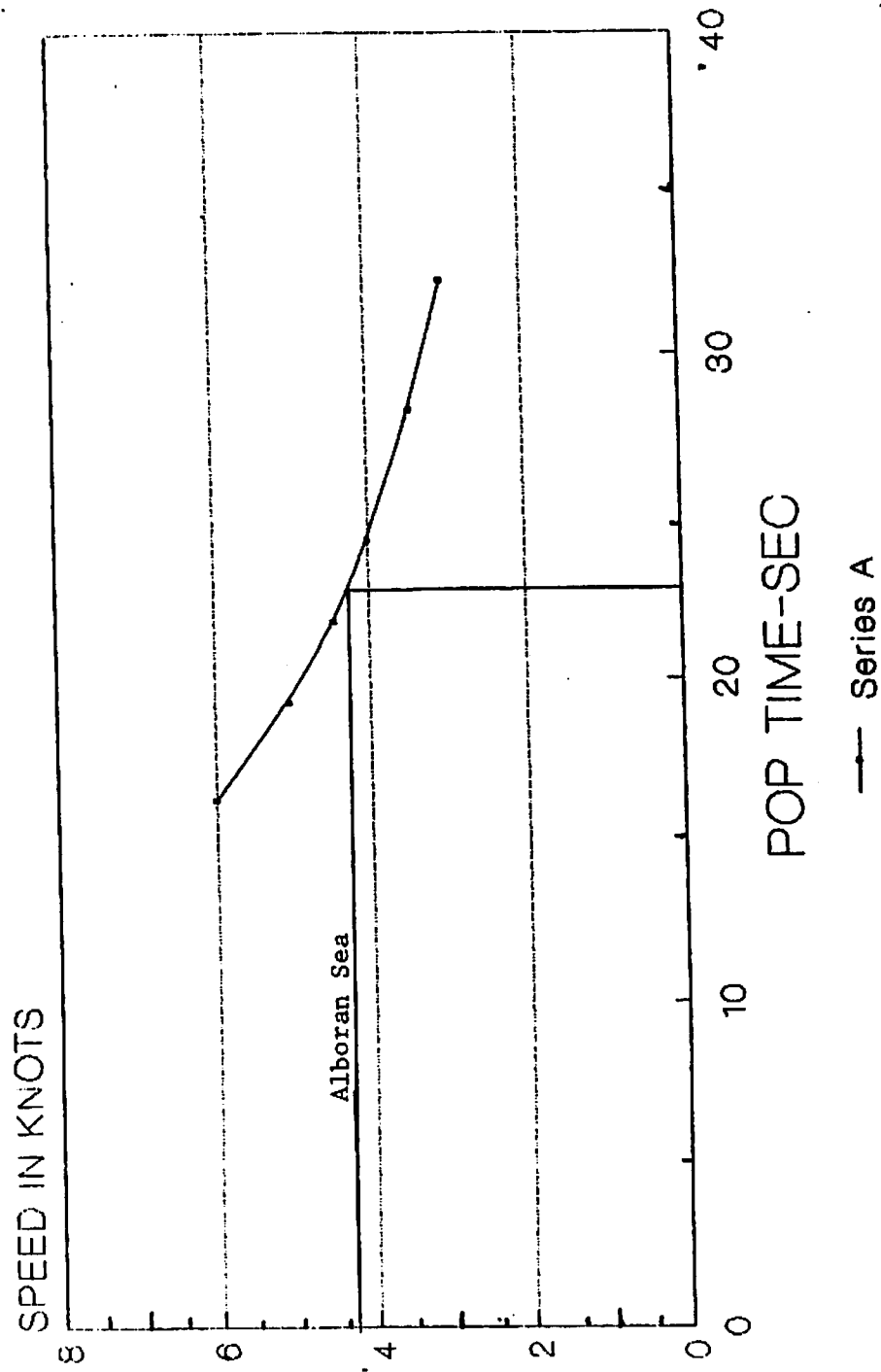


Fig. 2. Pop rate and speed used during Alboran Sea project for 25 group spacing.

C2911 Barcelona-Cadiz Preliminary Data

Gravity file: vt.n329

Bathymetry file: bt.d329

Navigation file: n.329

Navigation file: n.329

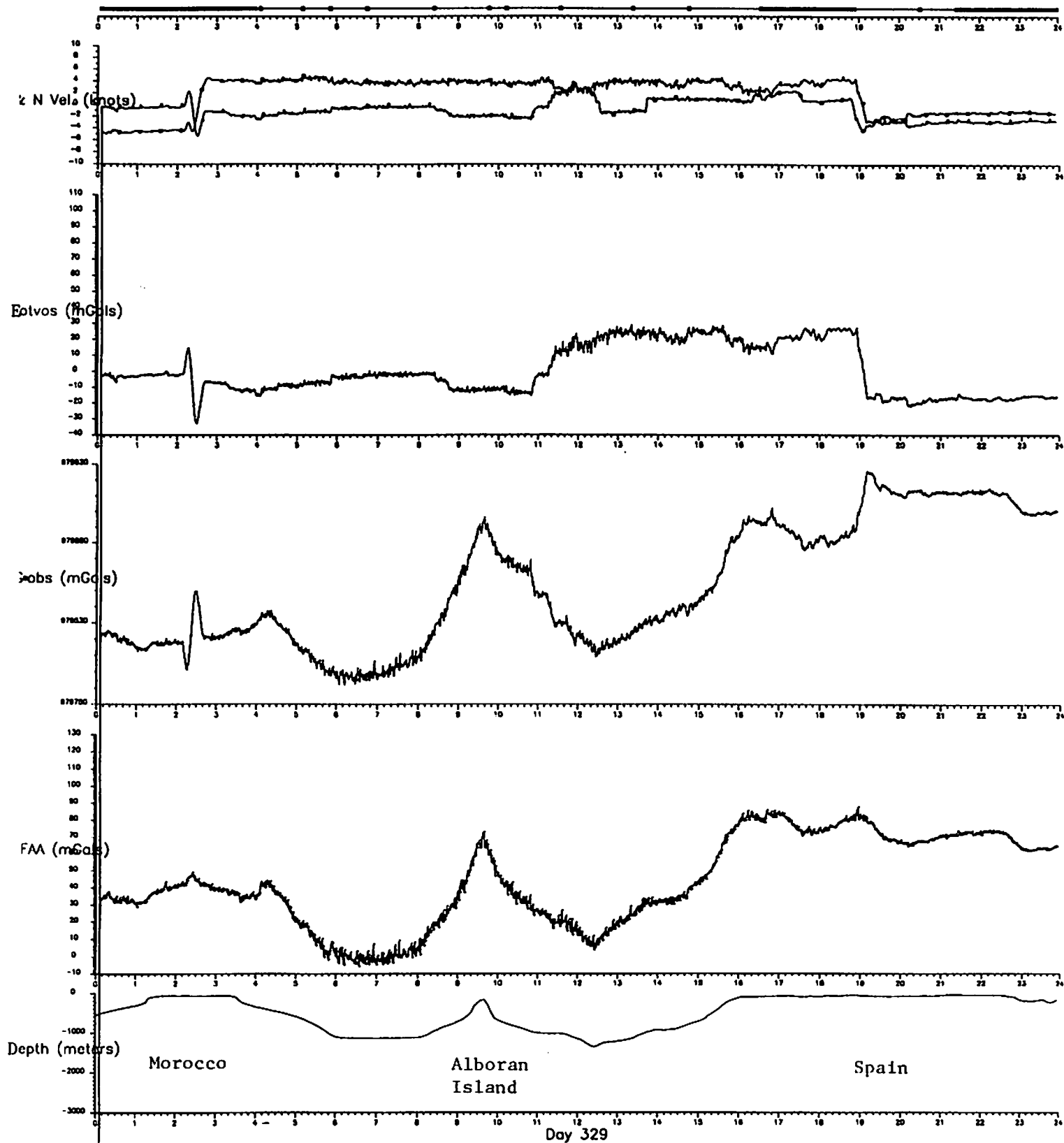
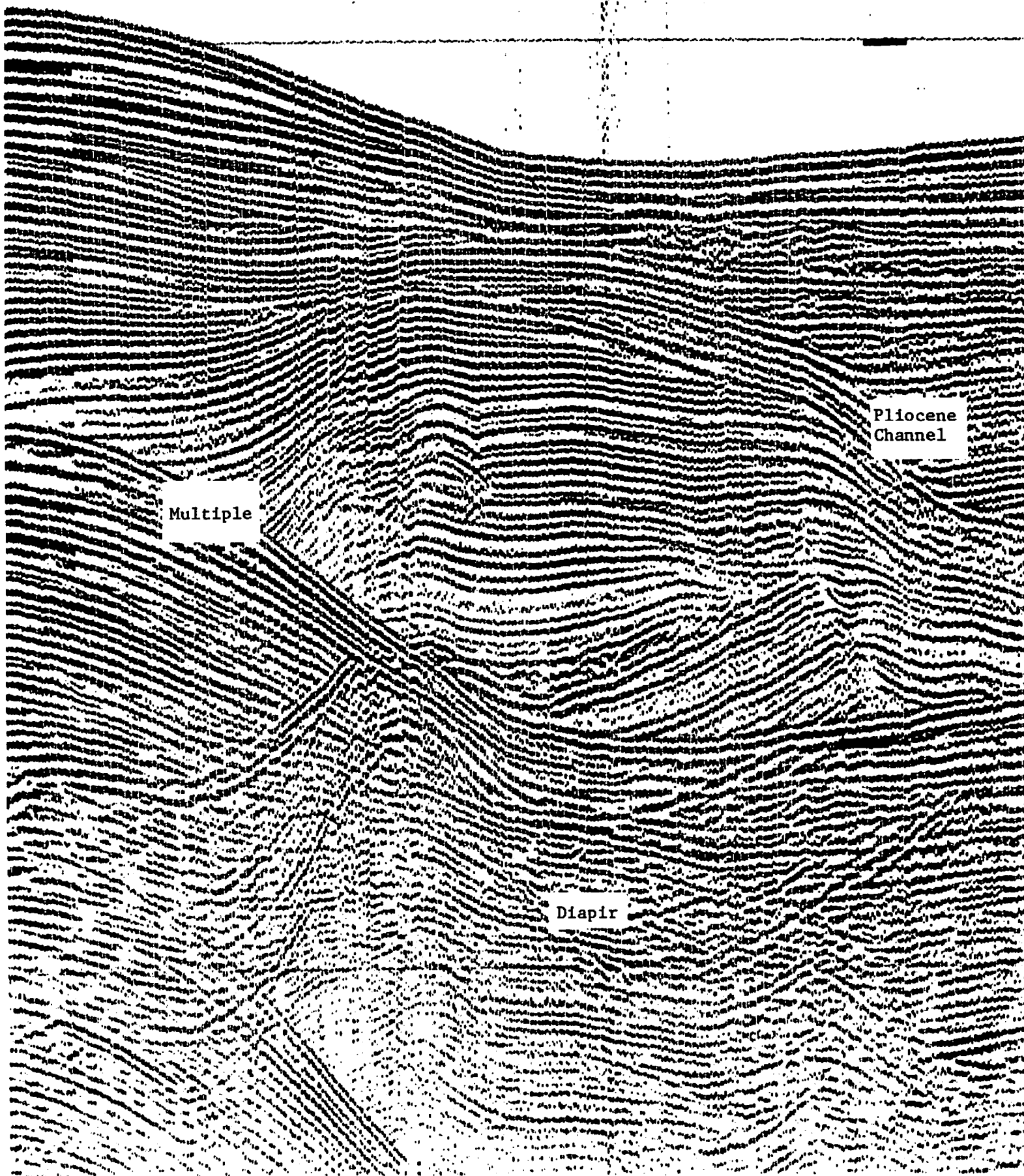


Fig. 3. Example of gravity and bathymetry profiles obtained during November 24th.

Fig. 4. Examples of single trace monitor record on ship. a) section showing diapiric structures on Moroccan slope and Pliocene channeling of the Messinian in the Alboran basin b) section through DSDP site 121 showing channeling of the Messinian in the Alboran basin. The vertical bars denote 1 sec. two-way time and the "width" of the section is approximately 18 km.

d)



DSDP SITE 121

