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STRUCTURAL FRAMEWORK OF SELECTED REGIONS OF THE WESTERN MEDITERRANEAN

2. BALEARIC ISLANDS : SOUTHERN PROLONGATION

48.3. BALEARIC ISLANDS: SOUTHERN PROLONGATION[1]

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INTRODUCTION

In a recent note (Mauffret *et al.*, in press) we described the extension of the acoustic basement south of the Balearic mainland. One series of arguments (position, morphology, and magnetism) led us to advance the hypothesis that the acoustic basement represents a prolongation of the Balearic continental basement towards the south at least as far as 38° 30'N latitude. The prolongation appears to be marked by a large topographic rise between the 1000 and 2600 meter isobaths. Figure 1 (Mauffret *et al.*, in press) schematically shows the continuation toward the south of this supposed Balearic continent. DSDP Leg 13 Drill Site 124 was located near 5°E longitude and 39°N latitude at the inferred southeast extremity of the sunken "Balearic continent". With reference to seismic reflection profiles (Flexotir) taken during the survey Polymede I, we discuss here the morphology of the basement in this zone and describe the sedimentary cover.

MORPHOLOGY OF THE BASEMENT

The map of the basement (Figure 1) shows two distinctive zones. The *first zone* is north of 39°N latitude and shows the sinking of the basement in the direction of the Algerian-Provencal basin. The basement sinks along a generally north-south trend down to a depth of 5 sec where it disappears under the abyssal plain. Profile 1 (Figure 2) intersects the high part of the Balearic basement and shows a very complex morphology formed essentially by a series of peaks on the boundaries of small sedimentary basins. At least some of these peaks are probably of volcanic origin. Many are marked on a magnetic map (Vogt *et al.*, 1971) by strong positive anomalies (for example, the massif at 01:00 on Figure 2).

The *second zone* of basement morphology lies to the south of 39°N latitude. The basement sinks along the trend of a basin having a northeast-southwest orientation. It is evident from Profiles 2 and 3 (Figures 3 and 4) that the basement presents a relatively undisturbed morphology and slopes very gently (<2°) towards the center of the basin. The central part of the basin has a maximum depth of 5.2 sec in the North, and 5.7 sec in the south. This basin seems to be enclosed on its eastern border by an anticline striking north-northeast-south-southwest which separates it from the deep part of the Algerian-Provencal basin (Figure 1). The peaks of the basement, situated between 10:30 and 12:30 on Profile 2 (Figure 3), between 20:30 and 22:30 on Profile 4 (Figure 5), and between 4:30 and 7:30 on Profile 3 (Figure 4), may be aligned along this anticline and belong to an elevated platform whose width varies from 6 km in the northern area (Profile 2) to 18 km in the southern area (Profile 3). The platform is bordered by two practically symmetrical flanks whose inclination is about 3 degrees.

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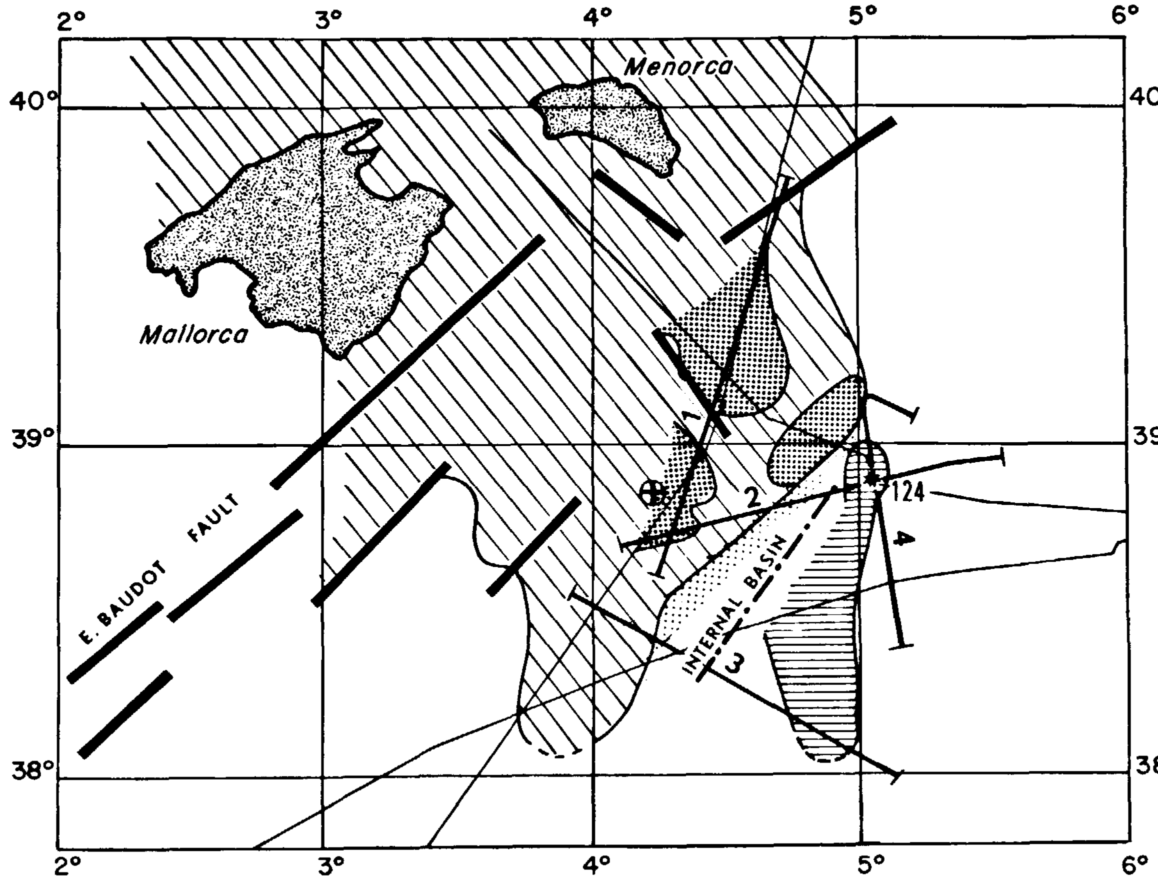

Figure 1. *Schematic map of the southern extension of the Balearic block (Mauffret, Auzende, Olivet and Pautot, in press) with the tracks of the* Jean Charcot, Robert D. Conrad, *and* Glomar Challenger. *1, 2, 3, and 4, are the Profiles presented here. The axis of the internal basin is indicated. Shaded area: continental basement. Stippled area: high zones of continental basement. Horizontal shading: linear rise of the basement. Cross into a circle: positive magnetic anomaly (Vogt, Higgs and Johnson, 1971).*

DRILL SITE 124

Drill Site 124 is located on the western flank of the peak that appears on Profile 2. The cored sections show that the upper 350 meters consist, from top to bottom, of Quaternary-lower Pliocene series of graded sands and marl oozes with sand silt laminae. The sediments below 350 meters are an evaporitic series represented by dolomitic marls with intercalations of anhydrite bands. The drilling was continued for 72 meters in the evaporitic formations.

SEDIMENTARY COVER

From the sedimentary point of view, we distinguish the following three sectors: the upper zone, the internal basin and its borders, and the zone in contact with the Algerian-Provencal basin.

The Upper Zone

This zone is represented on Profile 1. There are small sedimentary accumulations between the peaks of the basement, and it is difficult, because of the complexity of the setting, to divide the sedimentary series into well defined units. The morphology of the deep horizons observed in these basins seems to be closely related to the morphology of the basement and also to tectonic movements. The surface horizons (100-200 m thick) lie discordantly on the preceding beds. They constitute a series of filling whose morphology is apparently shaped by deep currents ("contourites", Heezen, Hollister and Ruddiman, 1966). We note that one of the features of the topography of these small basins is the formation of sedimentary ripples, principally at the level where the peaks of the basement outcrop. Many cracks and channels are present.

The Internal Basin and its Borders

The internal basin extends northeast-southwest, to the west of the presumed anticlinal alignment of the basement. At its northeast extremity, it is reduced to a channel about 2.5 km wide which connects with the abyssal plain of the Algerian-Provencal basin. The channel progressively flares out towards the southwest and on Profile 3 its width is about 50 km. At the northeast, the maximum thickness of

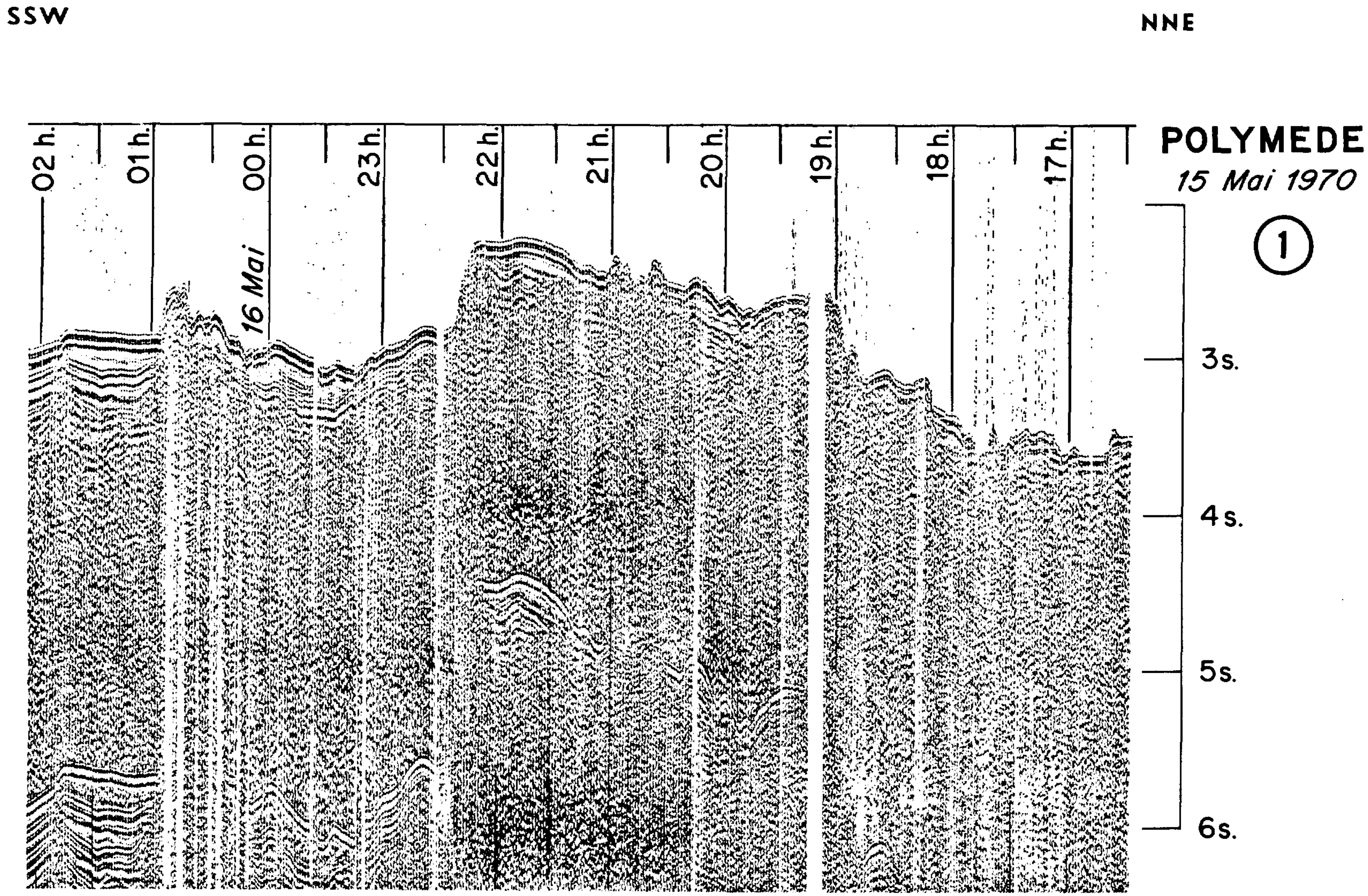

Figure 2. *Profile 1. Uprise of continental basement. Pocket sediment occur between some peaks of the basement.*

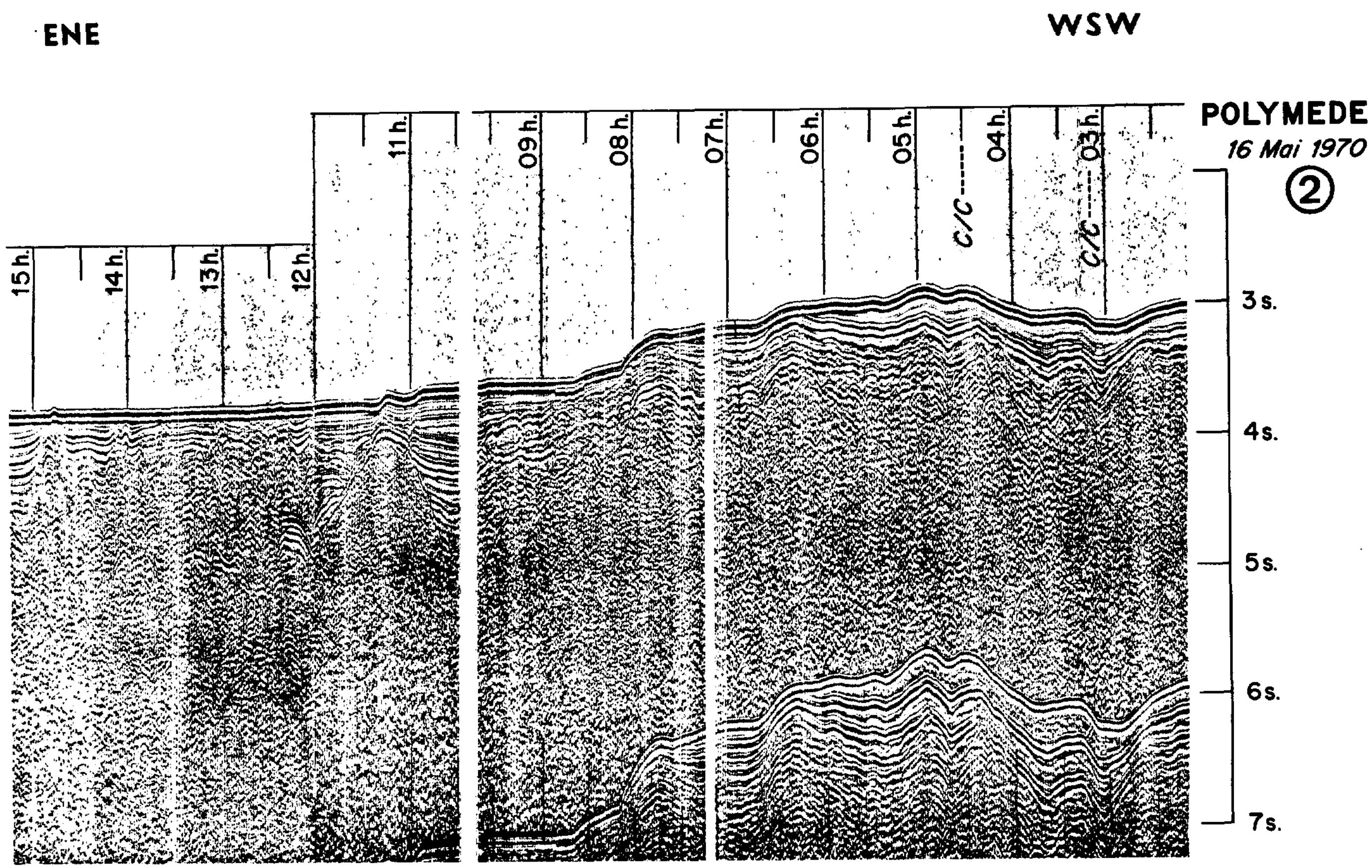

Figure 3. *Profile 2. On the western part of the profile, the Balearic basement is buried under about 800 meters of sediments. Between 08:00 and 09:00, we see an erosional surface (see text). Between 11:00 and 11:30, the rise of the basement where drilling Site 124 was located.*

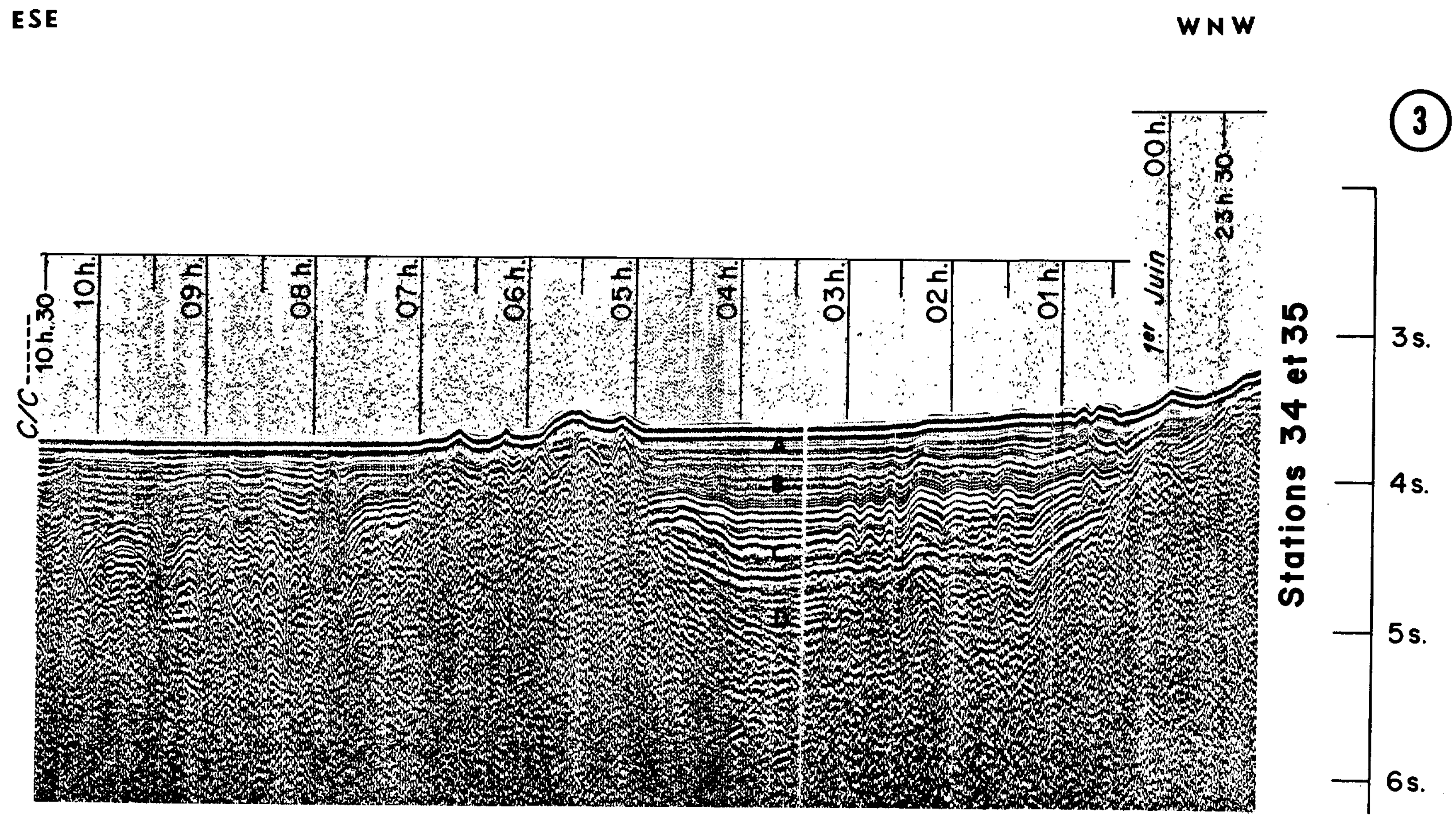

Figure 4. *Profile 3 Between the Balearic slope (WNW) and the anticline of basement (05:00 to 06:00) the internal basin, 50 km wide, shows a complete sedimentary sequence with a thickness of about 1.8 sec (A and B) Plio-Quaternary, (C) Messinian evaporites and salt, (D) Pre-Messinian layers.*

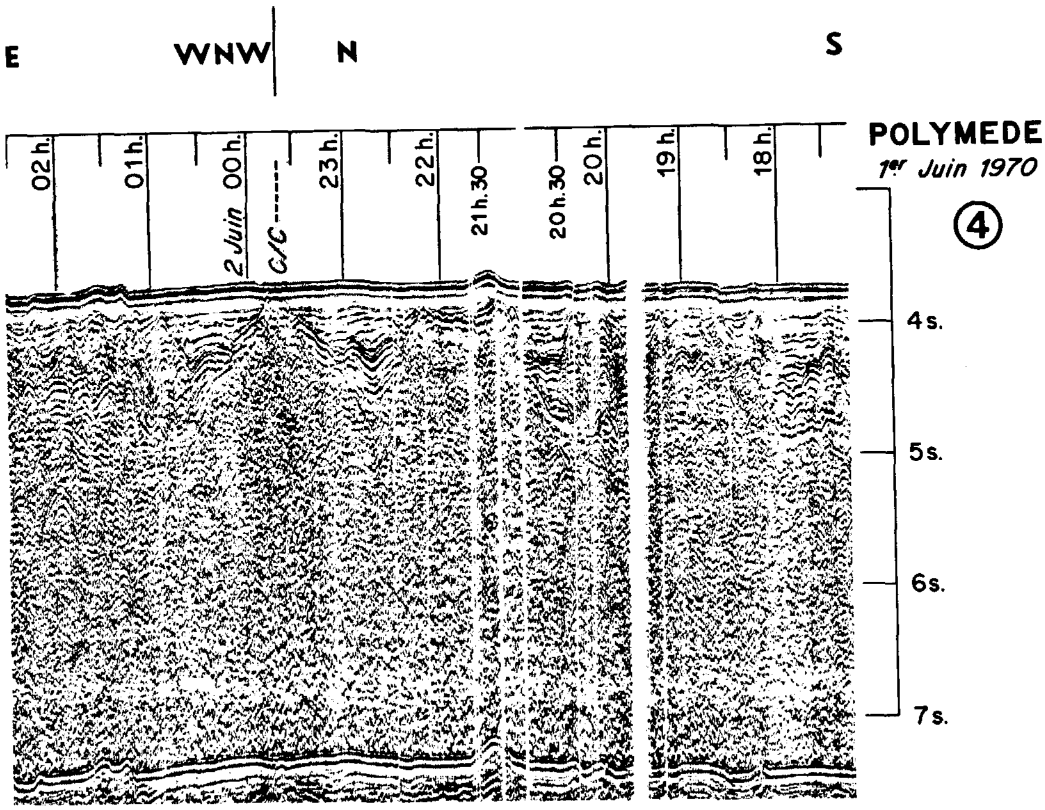

Figure 5. *Profile 4. The relief of the substratum between 23:00 and 0:00 may represent the eastern end of the Balearic block. Between 22:30 and 20:45, the massif belonging to the presumed linear rise of the basement where drilling Site 124 was located is limited westward by the internal basin. From one side to the other of this massif, there is a typical sedimentary series of the Algero-Provençal basin.*

sediment is close to 1 sec, while at the southwest it is greater than 2 sec. The sediments of the central part of the internal basin are similar to sequences north of the Balearic Islands (Pautot *et al.*, this volume) and in the deep part of the Algerian-Provencal basin (Auzende *et al.*, 1971). A superficial stratified unit having a thickness varying from 300 to 500 meters extends from north to south of the internal basin (cf. Units A and B, from north of the Balearic Islands).

An intermediate unit is represented by a succession of strong reflectors whose thickness is greater than 300 meters at the north and 600 meters at the south (Unit C). An opaque layer with upbending and an average thickness of 100 meters appears between the very intense reflectors of the intermediate sediments (Profile 3, Figure 4). A lower unit, between Unit C and the substratum, is revealed by more or less regular reflector levels uplifted on both sides of the basin, and slightly disturbed in the central part. The thickness of the lower unit is about 400 meters in the north (Profile 2) and 800-900 meters in the south (Profile 3).

The interpretation of the sedimentary sequences of the internal basin can be compared with that made of the sediments in the north Balearic Zone. The upper assemblage is of Plio-Quaternary age; the intermediate unit consists of evaporites and the Messinian layer of flowing salt. The lower assemblage is pre-Messinian sediment whose lower limit is not defined.

On the western border of the basin, on Profile 2, the lower and intermediate units covering the substratum are clearly uplifted and it seems possible that the intermediate unit, or the base of the upper unit, outcrops between 8:00 and 9:00 on Figure 4. Between 10:30 and 9:00, the upper unit thins until it disappears. Between 8:00 and the western extremity of the Profile, it is reduced to a layer about 150 meters thick. On Profile 3 (Figure 4) the lower and intermediate units lie directly on the substratum between 1:00 and 0:00. At this level, the base of the upper unit is uplifted and almost outcrops under a thin layer of surface sediment.

On the eastern border of the internal basin the sedimentary cover is reduced to a thin layer of recent sediment and the presence of the basement close to the surface is expressed in the topography (Figure 4 in particular).

The Zone in Contact With the Algerian-Provencal Basin

The sedimentary cover in the zone where the basement sinks in the direction of the deep part of the Algerian-Provencal basin consists of a succession similar to that described previously, but the observed thicknesses are greater. In particular, it seems that the thickness of the Messinian layer of flowing salt is in some places as great as 1000 meters (Auzende *et al.*, 1971), and the layer forms numerous domes, some of which reach the surface.

DISCUSSION AND INTERPRETATION

Certain conclusions follow from our detailed examination of the southeast corner of the Balearic mainland's prolongation.

It seems that the vast topographic rise which extends towards the south of the Balearic continent is itself continental in nature. However, it is probable, as indicated by the map of magnetic anomalies (Vogt *et al.*, 1971), that the presumed continental rocks are pierced by volcanic intrusions. To the north of 39°N latitude, the basement sinks towards the east under the abyssal plain of the Algerian-Provencal basin. To the south of 39°N latitude the sinking follows a northeast-southwest direction under a basin which borders the base of the continental margin. This internal basin, whose axis is oriented northeast-southwest, may be confined towards the east by a wall of basement trending north-northeast–south-southwest. The nature of this feature of the basement is debatable. It may be a question of volcanic intrusions at the base of the slope, such as that described in the Alboran Sea (Olivet *et al.*, this volume), or it may represent a horst of continental material. The absence of magnetic anomaly above the massif represented on Profile 2 might incline one towards this second hypothesis. However, it is also possible that the continental horst is injected by intrusions at some points (example of the Alboran Ridge; Olivet *et al.*, this volume).

In the sector where the basement is elevated (Profile 1), it is difficult to date the beginning of the subsidence of the south Balearic Rise because the sedimentary cover in the small basins may have been molted by deep currents and affected by slumping. In contrast, in the internal basin one may state that under the Messinian evaporites there still exists 400-800 meters of pre-Messinian sediments. The subsidence of this zone thus presumably began during the lower or middle Miocene.

As in the north Balearic depression, the episode of the isolation of the western Mediterranean basin in the Messinian age is marked in the internal basin by a layer of evaporites from which drilling operations at Site 124 has collected a 70 meter sample. To the south of the basin, this layer thickens to 500 meters. It is analogous to the evaporitic assemblage of the deep part of the Algerian-Provencal basin and shows diapiric phenomena.

A final point of interest is the existence of a surface of discontinuity within the Plio-Quaternary horizons on the western border of the internal basin, and also of the thin sedimentary accumulations of the high zone (Profile 1). It seems that this surface is closely related to prè-Pliocene movements which could have modified the morphology of the margin, to the uplift of the basement, or to the deepening of the internal basin. This changing of the morphology could have been accompanied by an intensification of current activity and by slumpings which could have eroded this surface or could have stopped deposition on this border.

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