48. STRUCTURAL FRAMEWORK OF SELECTED REGIONS OF THE WESTERN MEDITERRANEAN

PREFACE

The western Mediterranean drill sites of DSDP Leg 13 (i.e., Sites 121, 122, 123, 124, 133 and 134) were located on seismic reflection profiles obtained in the spring of 1970 during the "Polymede" cruise of the R/V *Jean Charcot.*

The high quality "Flexotir" recordings were highly instrumental in delineating the Upper Miocene salt layer (Auzende *et al.*, 1971) and proved invaluable to the success of the drilling campaign. In keeping with the spirit of this informal international cooperation, the scientific party from the Centre Océanologique de Bretagne (CNEXO) have been invited to incorporate the drilling results with their new geophysical data and present for the *Initial Reports* a series of brief synopses concerning the structural framework of various regions of the western Mediterranean visited by the *Glomar Challenger.*

W.B.F.R.

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48.1. ALBORAN SEA

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INTRODUCTION

The Alboran Sea (Figure 1) is a narrow sea (200 km wide), closed on the west by the "Arc of Gibraltar" and opening in the east into the Balearic Basin. The Betic chains extend along its northern border, the Rif chain extends along its southwest border, and its southern border is essentially formed by the Atlas Foreland. The Betico-Rif ensemble forms an arc having divergent structures (dipping away from the Alboran Sea). South of the sea, the Rif structures turn towards the northeast in contact with the autochthonous and semiautochthonous Atlas Foreland. The Rif and the Betic chains are affected by numerous northeast-southwest and northwest-southeast lateral faults whose role seems important (Kornprobst, 1971; Andrieux *et al.*, 1971; Jacquin, 1970), but is not explained yet. All of these structures are of Alpine age (essentially between late Eocene and middle Miocene).

The Alboran Sea poses three sets of problems as follows: (a) problems relating to the age and formation of the basin in relation to the surrounding mountains; (b) tectonic and sedimentary problems relating to the Messinian episode; and (c) problems concerning the interpretation of the recent movements, since the Alboran Sea, southern Spain, and Morocco are the seat of intense seismic activity. We will successively study: (1) the nature and the structure of the basement; and (2) the sedimentary covering, essentially with reference to Drilling Site 121 and to continuous seismic profiles.

THE BASEMENT

A topographic map of the basement (Figure 2) has been drawn using the Flexotir profiles obtained during the Polymede cruise of the R. V. *Jean Charcot* (1970) and the air-gun profiles of the R. V. *Glomar Challenger* and the R. V. *Conrad* (Ryan, 1969) as well as certain profiles of the Geomede cruise of the R. V. *Jean Charcot* (Glangeaud *et al.*, 1968).

In the description of the basement, we will distinguish the following units (Figure 2):

1) The Alboran Ridge, known to us as the southern Alboran Ridge.

2) The northern Alboran Ridge, parallel to the southern one and separated from it by a narrow basin – the Alboran Strait.

3) The Cape of Gate shelf and the Caldeira shelf – vast zones of shoals attached to the continent.

4) The eastern basin which is surrounded by these two zones of shoals and separated from the Balearic Basin by an important slope.

5) The eastern trench separating the southern Alboran Ridge from the Caldeira.

6) The northern marginal basin situated in the western half and limited in the south by a rise in the basement.

7) The western Alboran Basin divided into several basins by reliefs of basement.

8) The Rif margin.

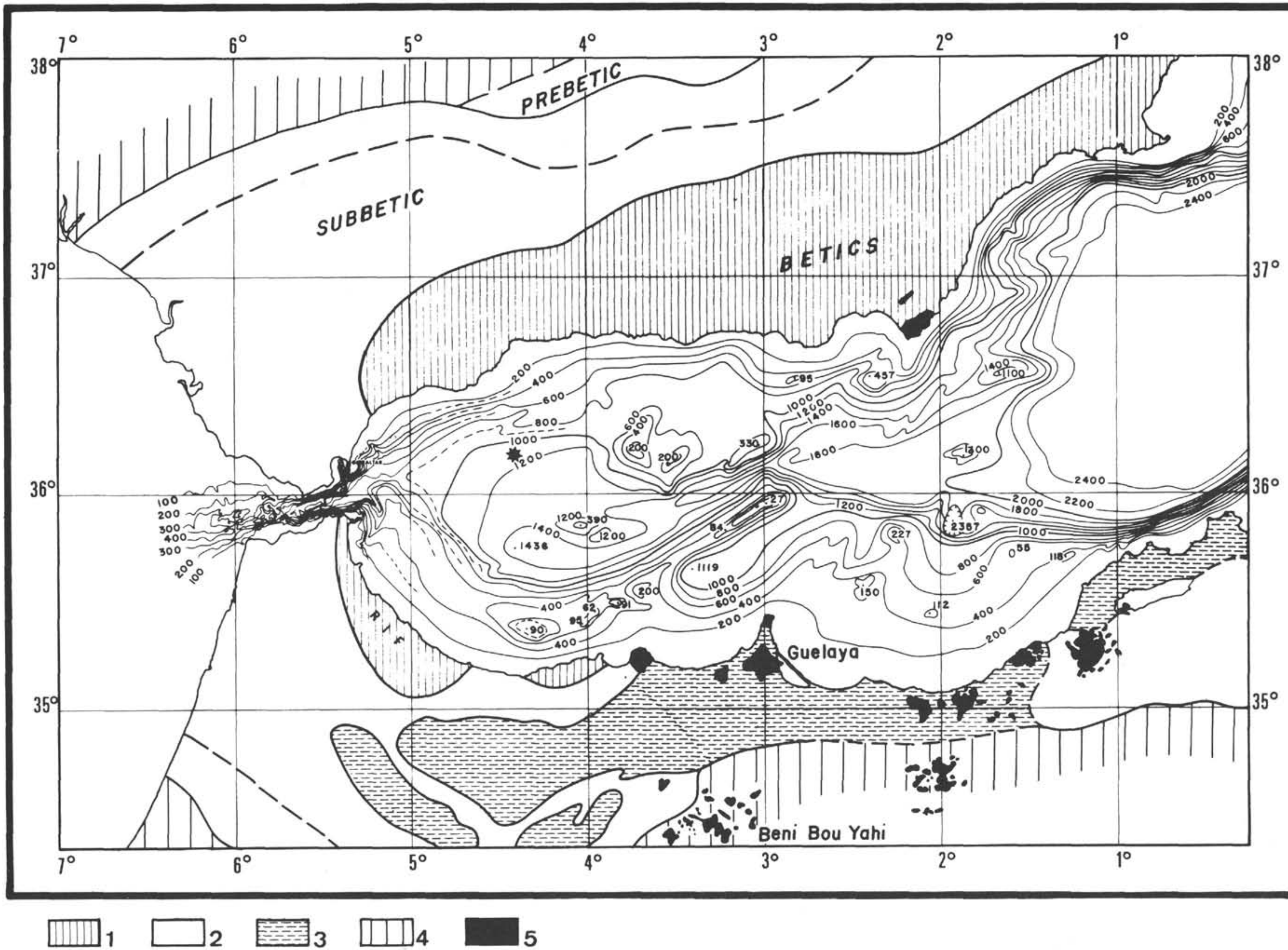

Figure 1. *Bathymetric map of the Alboran Basin (Ryan, Giermann, Vogt, as modified by S. Monti), and schematic structural features. (1) Rif and Betics: internal zones; (2) zone of gliding nappes; (3) external zone (autochtonous and semi-autochtonous); (5) vulcanites.*

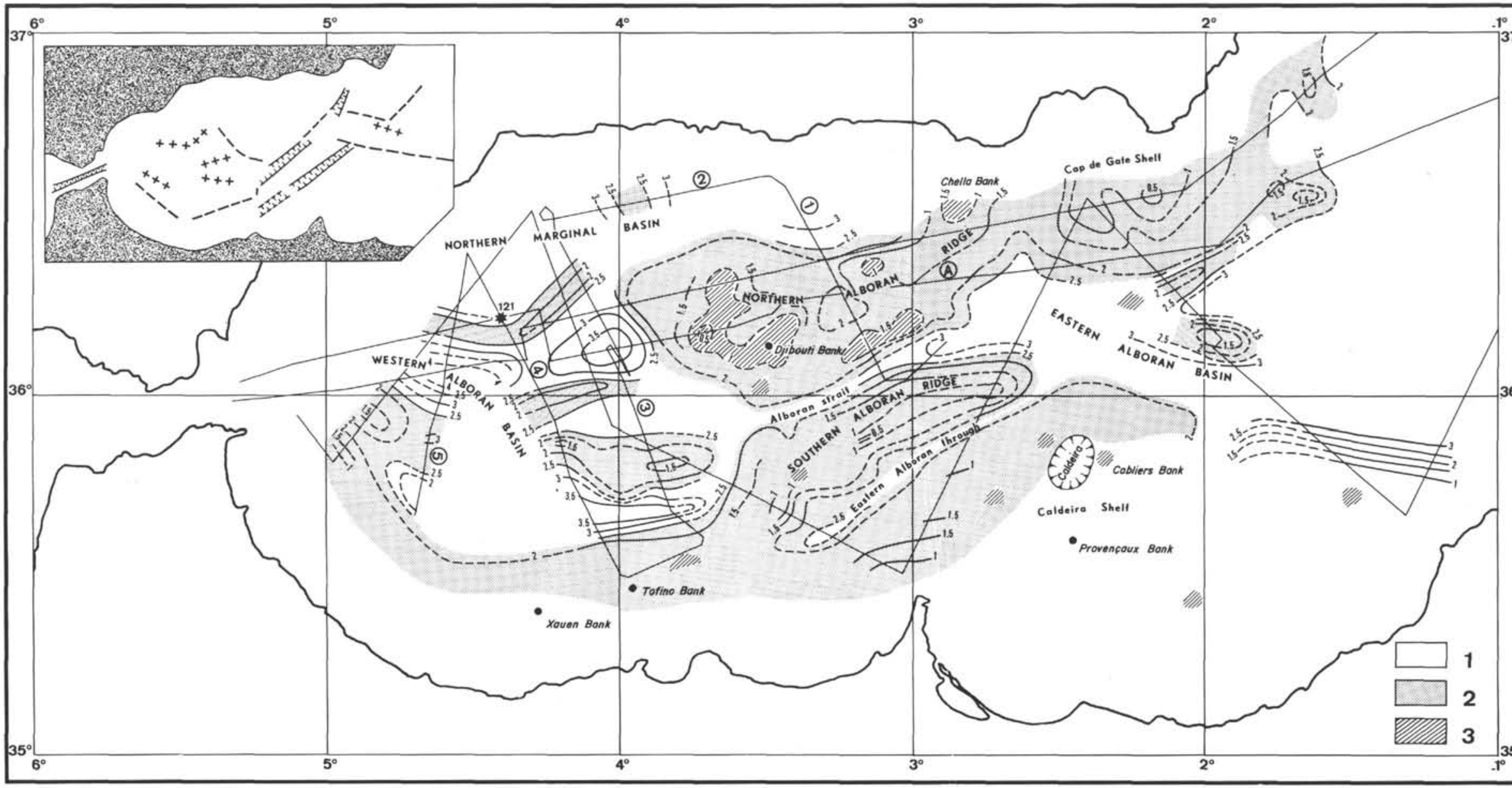

Figure 2. *Topographic map of the acoustic basement. Basement isochrons are in second d.t. from the water surface. Numbers 1 to 5 give the position of the* Jean Charcot *seismic profiles presented here. A. is the* Glomar Challenger *profile. Dashed-lines: substratum higher than 2.5 sec. d.t. Stippled lines: probably vulcanites. Black dots are the position of the dredge hauls (Giermann* et al.*).*

The ridges and shoals have been the subject of several types of observations (notably direct observations in the "diving-saucer" (*soucoupe plongeante*), and dridges). These observations, published by Gierman *et al.* (1968), have been used for interpreting our seismic reflection profiles. Regarding the basins, only the western basin has been studied in detail as our data for the eastern basin are too scarce. We will successively describe the ridges and shoals, the separating trenches, and the basins.

The Ridges and Shoals

The Southern Alboran Ridge

The southern Alboran Ridge is a structure, from 10 to 20 km wide, which extends northeast from the Moroccan coast for about 180 km. This ridge is bordered by two narrow trenches more than 1000 meters deeper than the ridge. Gierman *et al.* (1968), using the evidence from seismic reflection profiles, have described this ridge as an "elongated horst formed by more ancient sedimentary layers, perhaps inclined towards the southeast and pierced by volcanic extrusions". From a diving saucer, these authors have indeed observed outcrops on the Xauen Bank which represent the southwest extremity of the Alboran Ridge. The strata of consolidated sediment have a gentle dip. Some calcareous pebbles have been collected, as well as some andesitic, which indicate outcropping of volcanic rocks.

On the other hand, Gierman *et al.* (1968) assume that the ridge is cut by transverse faults. The middle part is depressed for about 200 meters, and the Xauen Bank is separated from the shore by a trench deeper than 400 meters. The map drawn by these authors shows numerous volcanic structures distributed on the ridge as well as on Alboran Island. The Tofino Bank, on the southwest block of the ridge, has been studied in detail by Gierman *et al.* It appears as a cone of about 400 meters with a diameter at the base of 8 km and surrounded by a circular depression. The top is truncated by a surface of abrasion at 120 meters from which rises a peak of about thirty meters. Some pebbles of andesitic type were collected.

A majority of the volcanic structures of the other shoals have the same appearance. They are conic guyots several hundred meters high with diameters at the base of about 10 km.

The North Moroccan Shelf or Caldeira Shelf

We have little information about this zone, except for the observations of Gierman *et al.*, because no seismic profile entirely crosses it. The bathymetric map (Figure 1) shows a slightly sloping shelf to a depth of about 900 meters. The shelf is limited by a steep nearly rectilinear slope, oriented WNW-ESE, which joins the extremity of the the southern Alboran Ridge to the Cape of Fegalo.

Gierman *et al.* (1968) have described a caldera at the northwest extremity of this shelf. Its diameter is about 30 km and maximum height is 750 meters. The caldera, which is opened to the north, is filled by more than 1000 meters of sediment. Several seamounts, probably volcanoes, are reported to lie beyond the caldera. A metamorphic rock with amphibole has been dredged in a shoal (the Provencal bank) situated to the southeast of the caldera.

The Northern Alboran Ridge

The northern Alboran Ridge extends for 120 km towards the southwest from the Almeria Gulf. To the southeast for 40 km (as far as about 3°35'W longitude), this ridge has a nearly rectilinear border which is parallel to that of the southern ridge. The southwest border has a distinct northwest-southeast orientation. On its northwest edge, which is less clearly defined, a deep basin opens (Figures 2 and 3). The ridge itself is covered for the most part by more than 500 meters of loose sediment. Only the volcanic structures emerge. Gierman *et al.* (1968) observed about 15 of these structures, several of which mark the southeast limit of the ridge (Figures 2 and 3). Some others belong to a large massif situated at the southwest border. Dredging on one of these structures, the "Djibouti Bank", led to the recovery of samples of andesite (temporary identification by Gierman *et al.*) and a sample of calcareous sandstone with metamorphic components. Figures 3 and 4 show the appearance of the substratum of this zone and the volcanic structures which disturb it.

The Zone of Shoals of the Cape of Gate

Another zone of shoals extends about 40 km to the south of the Almeria Gulf and the Cape of Gate. It is separated from the preceding zone by a depression. The slope which limits it on the south is parallel to the opposite edge of the eastern basin (west-northwest–east-southeast). Near the Cape of Gate, the strike of the slope becomes northeast-southwest and is parallel to the coast. Some more or less prominent rises of the basement seem to mark the foot of this slope. A particularly strong relief is visible between 1°30' and 1°40'W longitude. The two air-gun profiles made by the *Glomar Challenger* show a disturbed basement and easily distinguished volcanic seamounts similar to the ones already described.

The Trenches

The Alboran Strait is a narrow deep trench with a well defined northeast-southwest orientation for about 40 km between the two Alboran ridges. It is very comparable in terms of its dimensions and orientation to the Strait of Gibraltar. We note that the trench, located between the Chella Bank and the Cape of Gate, has approximately the same trend as the Alboran Strait. The eastern Alboran Trench, visible for more than 100 km, also has a trend that is similar to that of the Alboran Strait and the trench.

The Basins

The Eastern Basin

Our data on the eastern basin are not numerous. A peak of the basement, about fifteen kilometers wide at the base, is clearly marked in the topography in the axis of the basin at about 2°W longitude. Another topographic peak situated to the west-northwest suggests a parallel alignment with the southern border of the basin. This alignment appears on the gravimetric map (Allan and Morelli, 1971).

The Northern Marginal Basin

Between 3°W and 5°W, the Spanish margin is characterized by the existence of a deep basin under the continental

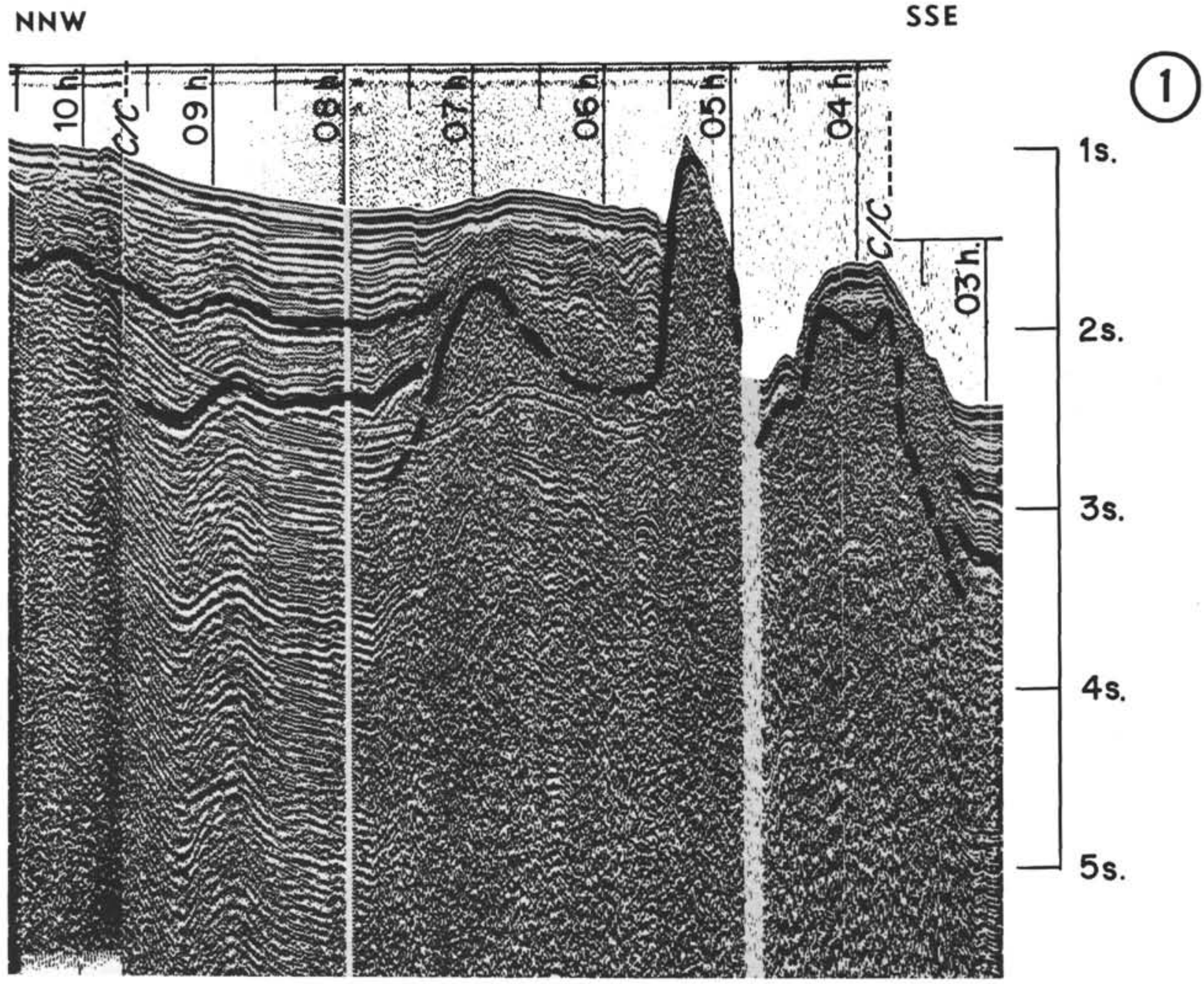

Figure 3. *Flexotir profile No. 1 on the Alboran shoal and on the northern marginal basin. Note the important seamount (probably vulcanic) in the northern part of the Alboran Strait. The two underlined reflectors in the sedimentary cover are probably the base of the Pliocene and the Quaternary.*

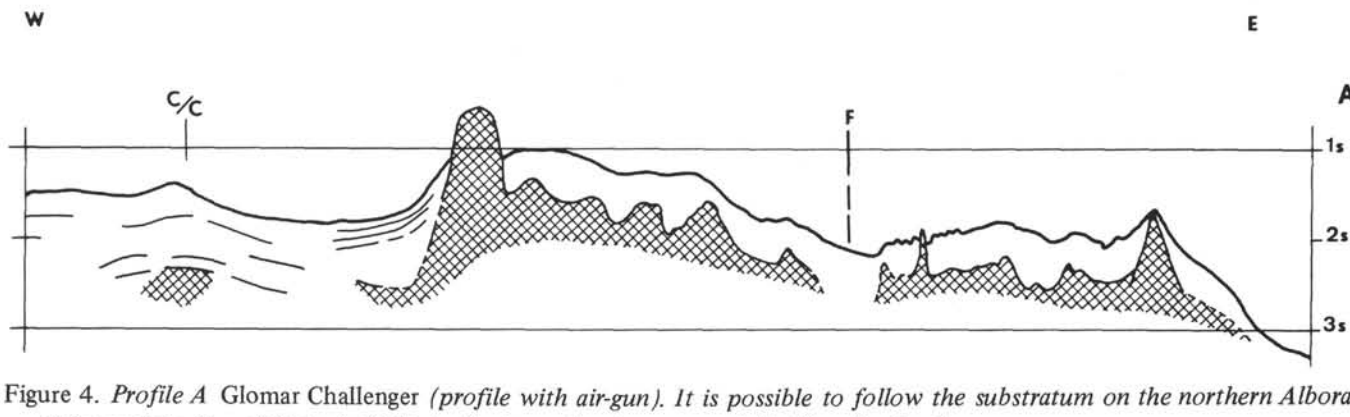

Figure 4. *Profile A* Glomar Challenger *(profile with air-gun). It is possible to follow the substratum on the northern Alboran Ridge and the Cap of Gate shelf. Note the two volcanic seamounts limiting the shoals.*

slope (basement > 3 sec). Between 3°W and 4°W, the basin is situated between the coast and the northern Alboran Ridge.

In the west, the southern limit of the basin is formed by a rise of basement, which is well marked at the level of Profiles 3 and 4 (Figures 6 and 7) and has a northeast-southwest direction. The rise then turns to the west and becomes deeper (Profile5, Figure 8). An intrusion is visible in the interior of the basin at about 4°W (Profile 2, Figure 5). Perhaps this intrusion belongs to the same system as the rise. Drill Site 121 has recovered a sample of granodioritic rock from the flank of the rise.

The Rif Margin

Between the Xauen Bank and the Strait of Gibraltar, the continental slope has a northwest-southeast orientation. We observe a shelf about 20 km wide on the bathymetric map (between 400-600 m deep), suggesting the existence of a basin at this level.

The Western Basin

The western basin is included between the northwest-southeast Rif margin, the northeast-southwest Alboran southern Ridge, the northwest-southeast extremity of the northern Alboran Ridge, and the basement rise which limits the northern marginal basin.

This western basin is subdivided into secondary basins by bulges of the basement. Profiles 3 and 4 (Figures 6 and 7) show that the basement extends for. some tens of kilometers away from the position of the *Glomar Challenger* drill site. The whole of the basement in this unit may thus belong to the same feature and this possibility cannot be rejected without further evidence.

The orientation of the bulges from Profiles 3 and 4 is almost east-west. Profile 5 (Figure 8) shows a wide elevated zone which extends towards the northwest parallel to the southern margin (Figure 2). These elevated zones define two deep elongated basins and a small intermediate basin. Although the zones of basement relief seen on the different profiles may represent parts of an uninterrupted feature that runs through the western basin, the gravimetric map of Allan and Morelli (1971) shows a strong negative anomaly over the whole basin. This fact suggests that the basement relief is in the form of isolated peaks and that the basin is not simply divided by a ridge.

Anomalies of the Magnetic Fields (Figure 10)

A map of the anomalies of the magnetic field published by Vogt *et al.* (1971) can be compared to the map of the substratum which we have just described. This map shows a zone of strong positive anomalies at the center of the Alboran Sea. The axis of the zone corresponds to the axis of the Alboran Strait and the zone bends at the northeast and southwest. The model established by Vogt *et al.* and our observations of the distribution of volcanic seamounts indicate that the magnetic mass responsible for the anomaly is situated at the northeast edge of the trench (Figure 2 and Figure 3). The strong magnetic anomaly which is associated with the western basin corresponds to the peaks seen on the echograms which belong to the intermediate basement rise. The caldera (on the Caldera shelf) and the seamount to which belongs the Djibouti Bank are also the origin of strong anomalies. Finally, a positive northeast-southwest zone extends to the foot of the Spanish continental margin between 1°W and 2°W. It is without doubt related to the intrusions and volcanoes which we have described.

According to Gierman *et al.* (1968), the volcanism of the Alboran Sea is of a trachy-andesitic nature. Similar volcanism is known to have taken place extensively on the adjacent continent. It occurred in Spain, at the Cape of Gate, and in Morocco, in two zones of the Atlas foreland, one of which is situated near the coast (mount of the Guelayas) and the other in the interior (mount Beni-Bou-Yahi (Figure 1)). In these two zones, the trachy-andesitic extrusions produced important and characteristic volcanics of middle-Miocene age, while the Plio-Quaternary was distinguished by basaltic eruptions (Jeremine and Marcais, 1960, 1962). Important dioritic intrusions, also of Miocene age, are located on the south of the Guelayas (Marcais, in Durand-Delga *et al.*, 1960, 1962). We note that igneous activity of the same type occurred in the Burdigalian on the Algerian, Tunisian, and Sardinian margins. Therefore, since similar activity is noted over the whole circumference of the Algerian-Balearic basin, a common history is suggested.

According to Jeremine and Marcais (1960, 1962), the Moroccan volcanos do not appear to follow a fault line nor to be aligned in any other evident way. It seems probable, however, that these centers are related to some northeast-southwest activity; indeed, a series of tectonic trends have this orientation. It has been suggested by several authors (Glangeaud, 1952; Dubourdieu, 1960, 1962, for example) that the whole northern portion of the North African block has been affected by left-lateral north-northeast-south-southwest strike slip faulting. However, we notice that the fault directions observed in, around, and within the Alboran Sea are either northeast-southwest or east-northeast-west-southwest. For example, the Alboran Island and the Cape Gate seamounts form a volcanic alignment which is northeast-southwest. On the continent around the Alboran Sea, these faults seem to have been active in middle Miocene (Kornprobst, 1971; Jacquin, 1970). We suggest that all this faulting and related igneous activity date from the formation of the Alboran Basin. The observations made regarding the sedimentary fill of the basin corroborate this idea.

The description of the basement shows evidence of a relatively shallow area (basement between 0-2 sec) and a deep area (basement between 2-4 sec).

Our data regarding the shoals indicate that they are composed of continental material (samples of sedimentary and metamorphic rocks) which is no doubt quite varied in nature. The units involved are as big as the Sierra Nevada or the Rif.

Prolongation of the continents is limited by steep slopes, often, as we saw it, associated with volcanic massifs. In the eastern basin, in several places some intrusions occur at the base of the slope. These intrusions may be of the same nature as the one drilled by the *Glomar Challenger* in the western basin and may characterize the limits of the oceanic and continental areas.

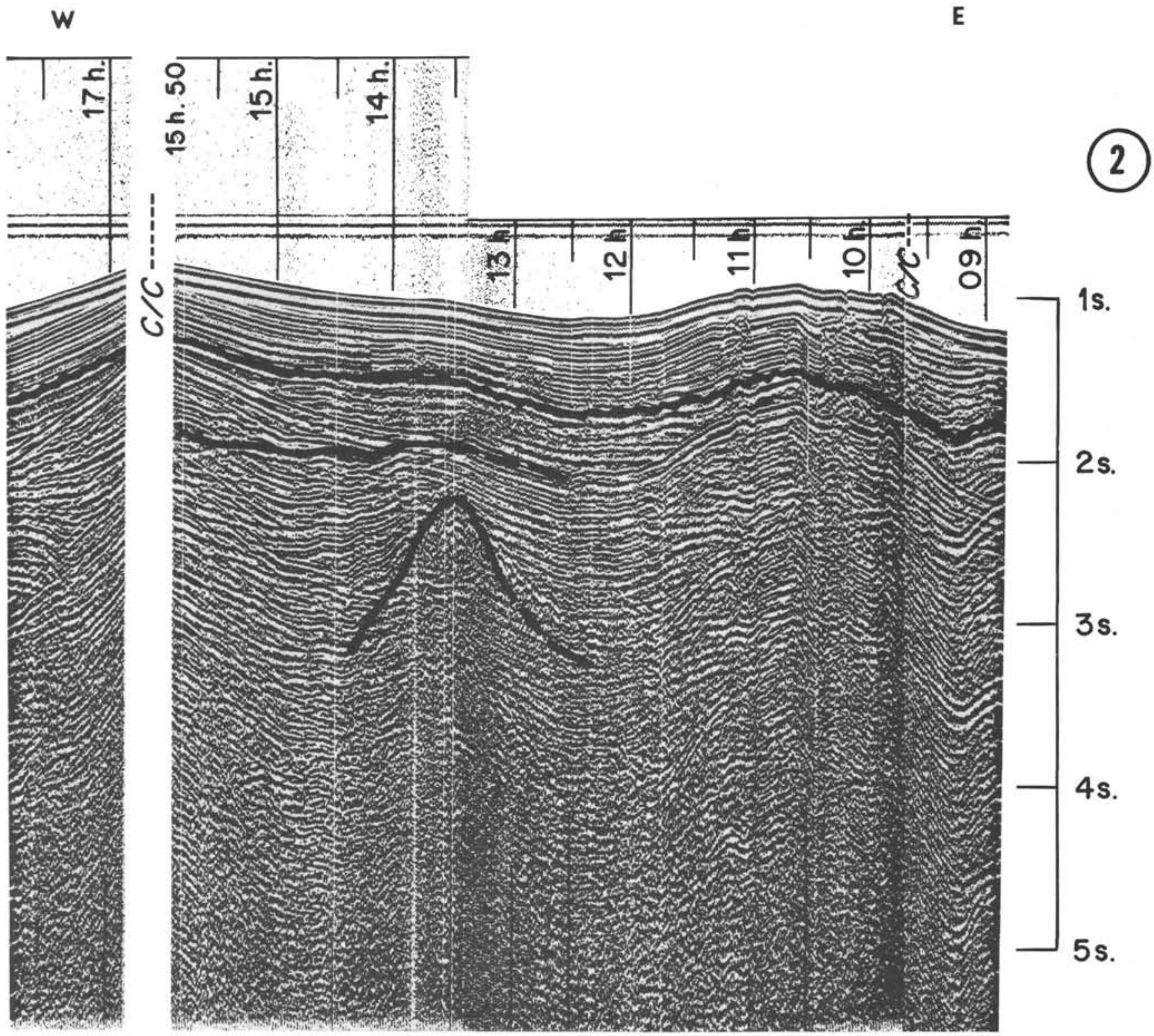

Figure 5. *Profile 2 (Flexotir* Jean Charcot*). This profile is on the northern marginal basin. Note the relief of the basement in the middle of the basin. Underlined reflectors may represent the possible base of the Pliocene and the Quaternary.*

THE SEDIMENTARY FILL

Great sedimentary thicknesses are located in the two large eastern and western basins, which are connected by the Alboran Strait, and in the northern marginal basin (Figure 1).

The western basin shows a flat bottom at about 1200 meters. All of the basement relief is covered with the exception of some peaks in the southeast part. Between these peaks and the Moroccan continental slope, a deeper channel appears (1400-1500 m). It extends to the northeast into the Alboran Strait. The Alboran Strait turns to the northeast and emerges at about 1800 meters in the eastern basin. The surface of the eastern basin, between 1800 and 2000 meters, shows a slight declivity to the east. The slope (500 m of declivity) begins at about 1°30′ West and leads to the Balearic Abyssal Plain at about 2500 meters. We observe the existence of a channel between the relief of the basement situated at about 2° West and the Moroccan continental slope. It will be seen later that the foot of the southern margin of the basins reflects the recent tectonic evolution and not the rate of currents as one might think.

In the western basin, the greatest thicknesses are situated at the foot of the Moroccan margin (1.5 to 2 sec) and also in the basin lying to the northwest (>2 sec) (see Profile 5, Figure 8 and Figure 2). In the northern marginal basin, the thicknesses are more than 2 seconds. In the eastern basin, the thicknesses seem to be about 1.5-2 sec (Profile 1, Figure 3). The accumulation in the shoal zones is particularly

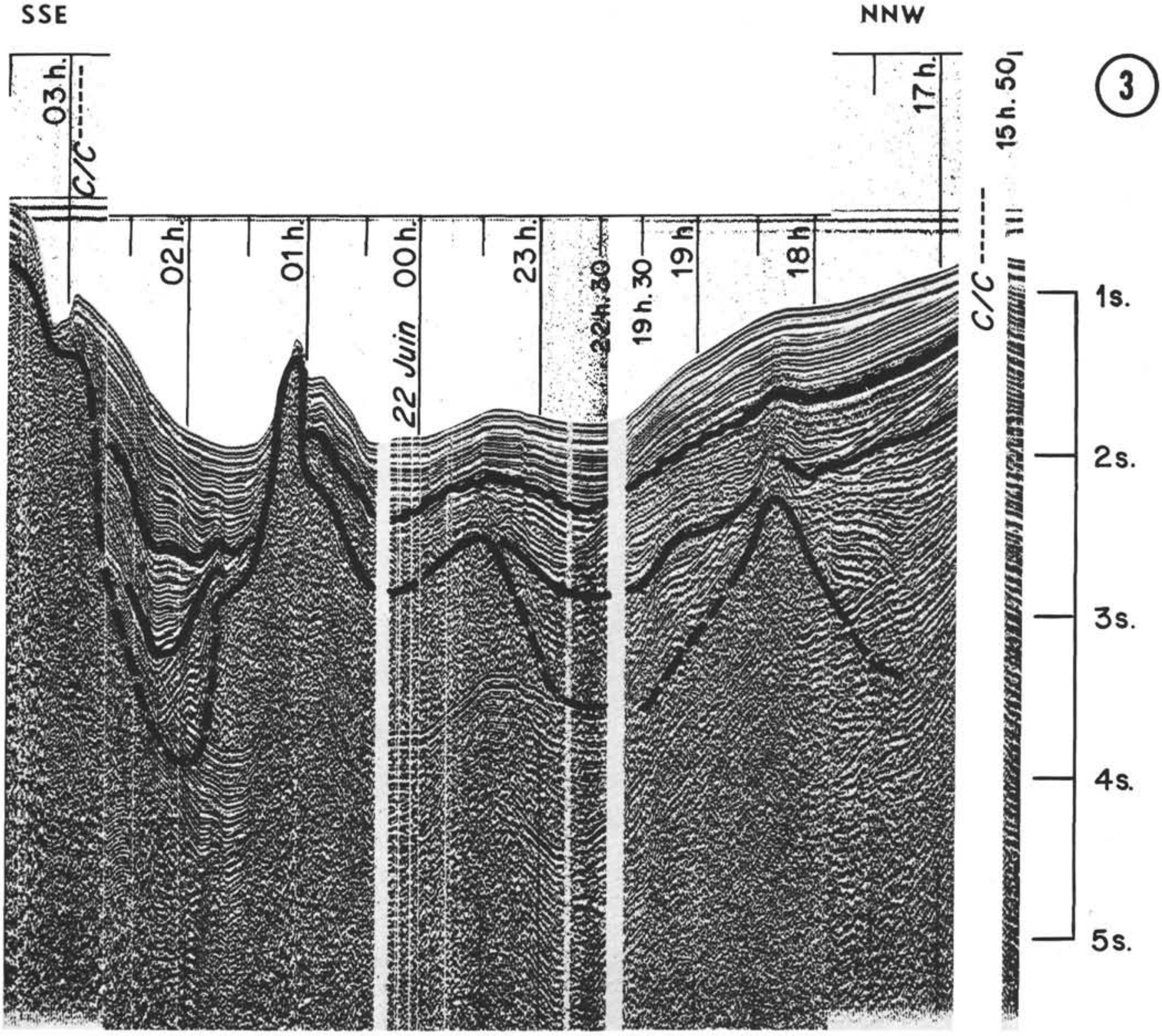

Figure 6. *Profile 3 (Flexotir* Jean Charcot*). Substratum, possible base of the Pliocene and the Quaternary are underlined. One can see the Messinian erosion surface in the northern part.*

important on the northern Alboran Ridge where it reaches 1 sec. It is about 0.5 second on the shelf of the Cape of Gate while on the southern ridge it seems very diminished.

Drill Site 121

Drill Site 121 is situated at the foot of the northern slope of the western basin on the slope of the basement rise which limits the marginal basin. Profile 4 (Figure 7) passes about 300 meters to the west of the drilling point. The drilling operation penetrated 865 meters of sediment before reaching basement. The following three series were recognized: (a) the Quaternary series–290 meters of pelagic marl ooze with a sedimentation rate of 20 cm/1000 years, (b) the Pliocene series–380 meters of marls and turbidite sands with a sedimentation rate of 23 cm/1000 years, and (c) the Tortonian series–195 meters of consolidated marls lying on basement.

Based upon evidence from the cores, the Plio-Quaternary series seems to be complete. It seems, but we cannot affirm it because the recovery of sediment was bad, that the sediments deposited during the Quaternary are finer than those of Pliocene age. Indeed, we have in the Pliocene some beds of sands as thick as 1 meter. The Plio-Quaternary sediments are relatively soft in contrast to the consolidated Tortonian sediments; and an important hiatus, corresponding to the upper-Tortonian and Messinian ages, separates the two formations.

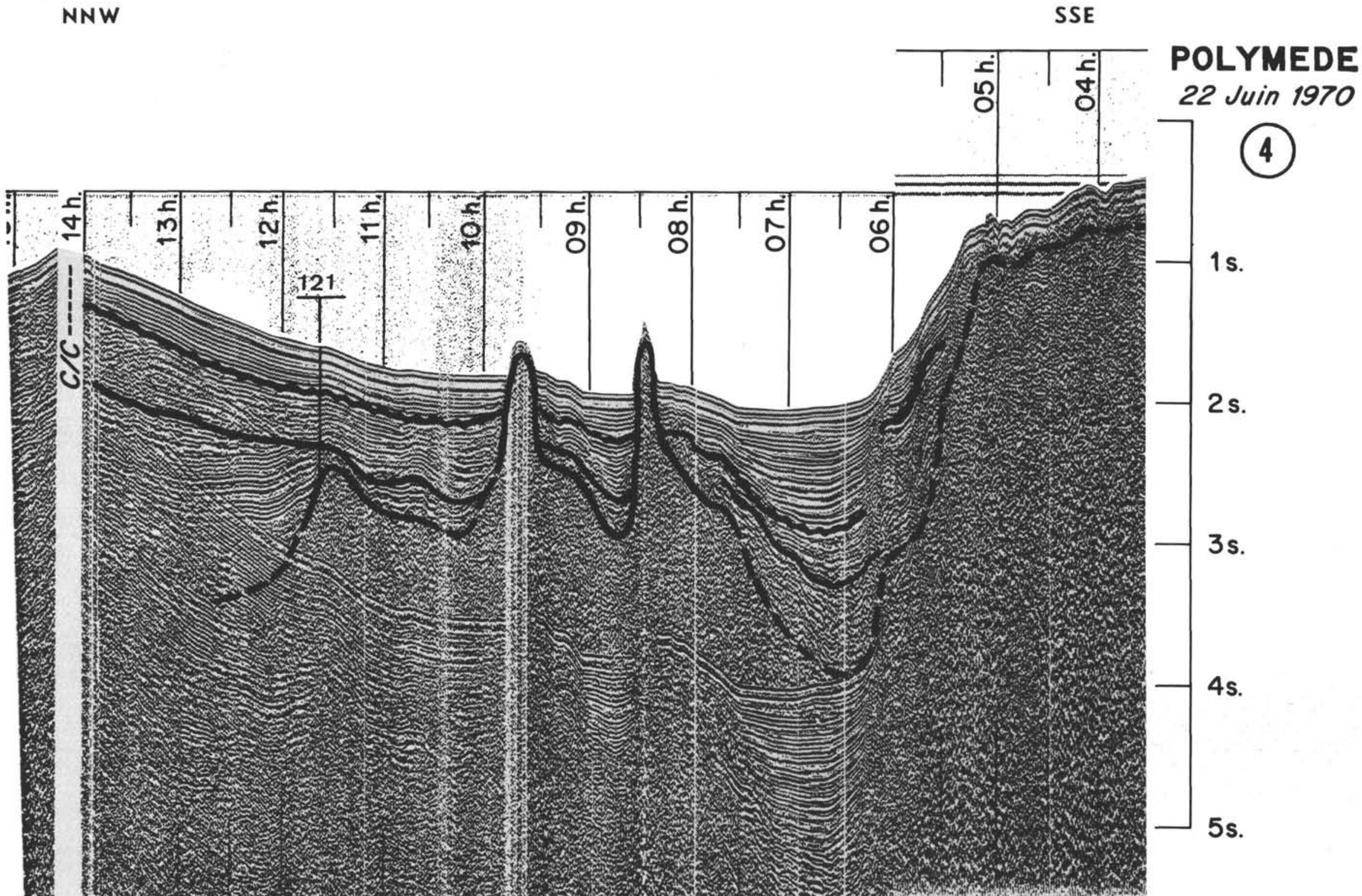

Figure 7. *Profile 4 (Flexotir* Jean Charcot*). Substratum, possible base of the Pliocene and the Quaternary are underlined. One can see the Messinian erosion surface.*

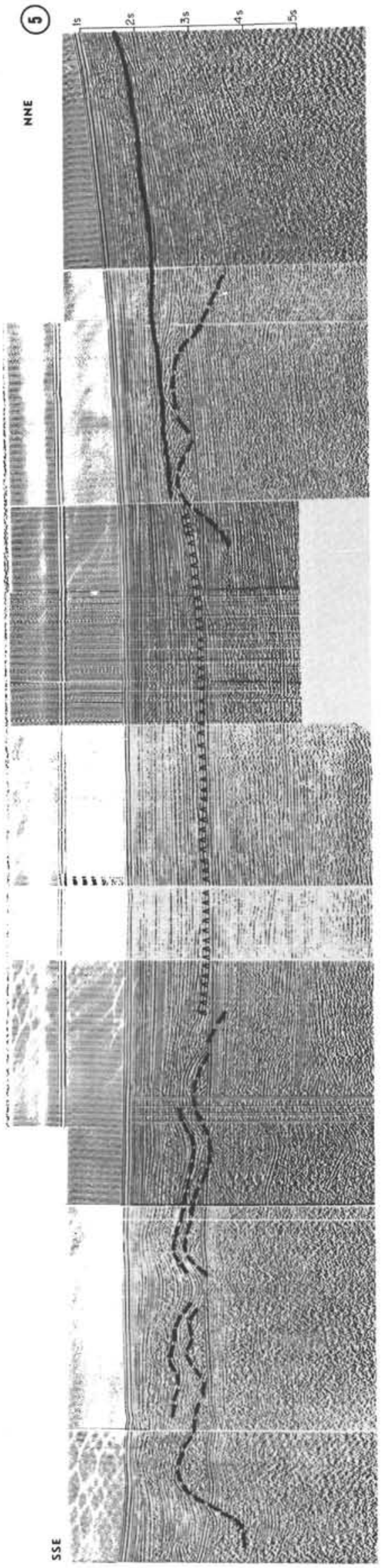

Figure 8. *Profile 5 (flexotir* Jean Charcot*). Substratum, possible base of the Pliocene and evaporites level are underlined.*

These observations are corroborated by the evidence of Profile 4 (Figure 7) near the drilling site which shows that the Quaternary series is composed of continuous and very regular reflectors. This series, subhorizontal at the level of the drilling site, is prolonged towards the north by a typically prograding talus. This series probably corresponds to irregular sedimentation with gaps and reshaping under the influence of strong currents.

The Pliocene lies discordantly on the Tortonian. The minimum thickness of the layer removed by erosion is estimated (Profile 4, Figure 7) to be 0.5 sec in the area of the drilling site.

Continuous Seismic Profile Data

From the data of the drilling operation and of the profiles, we may interpret the seismic profiles passing through the western basin. We will successively discuss: (a) the age of the pre-Messinian series, (b) the Messinian episode, and (c) the sedimentation and the Plio-Quaternary tectonics. The lack of data does not permit us to discuss the eastern basin.

The Age of the Pre-Messinian Series

The thickness of the pre-Messinian sediments above the basement is estimated at about 1.5 sec in the northern marginal basin, at 1 sec in the central part of the western basin and at 0.5 sec in the basin at the foot of the Moroccan margin. Unless we accept extremely slow rates of sedimentation, or the existence of gaps, we cannot think that the base of this series is older than the beginning of the Miocene. Besides, an estimate of the rate of sedimentation can be made in the northern marginal basin. The age of the most recent Tortonian sample collected from the drilling operation has been estimated at 10 to 11 my BP.

We have also estimated that the thickness removed by erosion at the level of the drilling operation is 0.5 sec. It is probable that (see below) the erosion took place during the Messinian, that is to say, about 8 my BP.

The 0.5 sec of eroded sediment represents a time of 2 or 3 my. On this basis, the assemblage of the infra-Pliocene series (1.5 sec) would represent a time somewhere between 6 and 9 my. before the Messinian episode. Sedimentation in the marginal basin would then have occurred between 14 and 17 my, that is to say it would be approximately contemporary with the granodioritic intrusion (15 my.) (see in this volume).

The Messinian Episode

The erosion of the upper Tortonian can be related to the Pontian-Messinian episode of the Mediterranean area. A determination as to the significance of this episode in the history of the Mediterranean has been the object of several recent studies (notably Montadert *et al.*, 1971; Auzende *et al.*, 1970; Nesteroff *et al.*, 1971; Le Pichon *et al.*, 1971). From these studies, it can be concluded that all of the deep part of the basin has been the site of evaporitic sedimentation resulting from confinement of the basin while margins have undergone subaerial erosion.

Three lines of evidence from the Alboran Basin support this interpretation: (1) A surface of erosion and an angular discordance occurs in the area of the drill site and over all the northern marginal basin. Le Pichon *et al.* (1971) have observed that the evaporation of a layer of water whose height is close to that of the actual layer ought, as a consequence, to have considerable uplift of the bottom of the basin by isostatic readjustment. During such a movement, the basin and the margin could have been separated. If this is true, then with respect to the Messinian in the Alboran Sea, we would have a satisfactory explanation for the angular discordance and for the surface of erosion. Profiles 3 and 4 (Figures 6 and 7) suggest that the rising of the central part of the basin resulted in the deformation and erosion of the margin. (2) In the central part of the basin there is a strong reflector (visible on the Profile 5, Figure 8) which represents either the continuation of the surface of erosion or the roof of an evaporitic layer. Indeed this reflector shows numerous analogies (regularity, intensity) with those constituting the roof of the evaporitic series in the marginal basins (example of the north Balearic depression, in this Volume). (3) In the southern part, the reflector noted at the base of the Pliocene is probably deformed and therefore cannot be recognized on Profiles 3 and 4.

On Profile 5, a discordance, comparable to the one observed in the northern marginal basin, is visible at the foot of the Moroccan continental slope. Towards the central part of the basin, this area of discontinuity is difficult to follow with certainty. Three main observations indicate that as in the north, it represents the base of the Plio-Quaternary. These are: (a) the thickness of the Plio-Quaternary is very reduced at the lower part of the Moroccan slope—200 to 300 meters as opposed to 1.5 sec in the central part, and nearly 1 sec on the northern margin; (b) some folding of the assemblage immediately below took place after the beginning of the Pliocene, since the Messinian surface is itself disturbed; and (c) the Messinian surface is situated at the same level (about 2 sec under the surface of the sea) to the north and south of the basin. It will be noted, however, that on the profiles more to the east (Profiles 3 and 4), the surface is at nearly 3 sec (see below). We may give a different interpretation for this Profile as follows. The assemblage of the Miocene series has been eroded and all the unconsolidated sediments belong to the Plio-Quaternary. The area of erosion sinks under the southern marginal basin at > 3 sec as in the southeastern part of the basin. The discordance could be Pliocene or Quaternary and the assemblage is intensely deformed. Figure 9 gives an interpretation of these observations.

The Plio-Quaternary Episode

The base of the Pliocene is marked by a clear discordance, by a strong reflector representing the roof of the Messinian evaporites, or by a surface of aerial erosion. The base of the Quaternary may be approximately related to a strong reflector which is visible over nearly all the basin. The contrast between the Quaternary series, which is very regular, and the Pliocene series which is more irregular and less fine, is very clear only on the northern margin where the assemblage did not undergo any important deformation since the beginning of the Pliocene.

In contrast, the southern part of the basin was deformed after the Messinian age. This deformation is essentially manifested by a deepening of the pre-Pliocene horizons at the foot of the Moroccan margin (Messinian surface > 3 sec, Figure 9) and by a thickening of the Plio-Quaternary series (1.5 sec in place of the 1 sec in the rest of the basin). In addition, detailed examinations of the profiles shows foldings, flexures, and discordances which testify to recent movements.

CONCLUSIONS

To conclude our observations, we note the following:

1) Wide shoals prolongate from the continent into the Alboran Sea. They probably are of continental nature. Indeed all the rock samples dredged could have come from continental basements.

2) The shoals have the same northeast-southwest and northwest-southeast trends as the surrounding mountains. An important trachyto-andesitic volcanism took place along the line of these shoals.

3) The age of the fractures and of the volcanism, estimated from data from the surrounding continent, is middle Miocene. Therefore, the age is contemporaneous with, or immediately follows, the last important tectonic phase. Our assumption that the formation of the basins took place at this time is corroborated by the thickness of the sediments and by the age of the intrusion that was drilled by the *Glomar Challenger.*

4) During Messinian time, the higher Alboran Sea was subject to erosion while halite accumulated in the Balearic Basin. While the salt layer in the Balearic Basin led to diapiric structures, no similar structures occur to the west in the Alboran Sea. However, an evaporitic layer comparable to the one found to the north of the Baleares may have been developed in a small basin west of the central basin in the Alboran Sea.

5) An erosional surface and an unconformity clearly appear on the northern margin. We assume that it can be explained by isostatic uplift of the basin following the removal of the water mass by evaporation as proposed by Le Pichon *et al.* (1971). This explanation implies that the basin was fairly deep at the time.

6) There is an area of deformation (essentially a downwarping with some folding) along the Moroccan margin. The deformation is post-Messinian and can be explained by compression of the Alboran area against the African continent as proposed for the Algerian margin (Auzende *et al.*, 1971).

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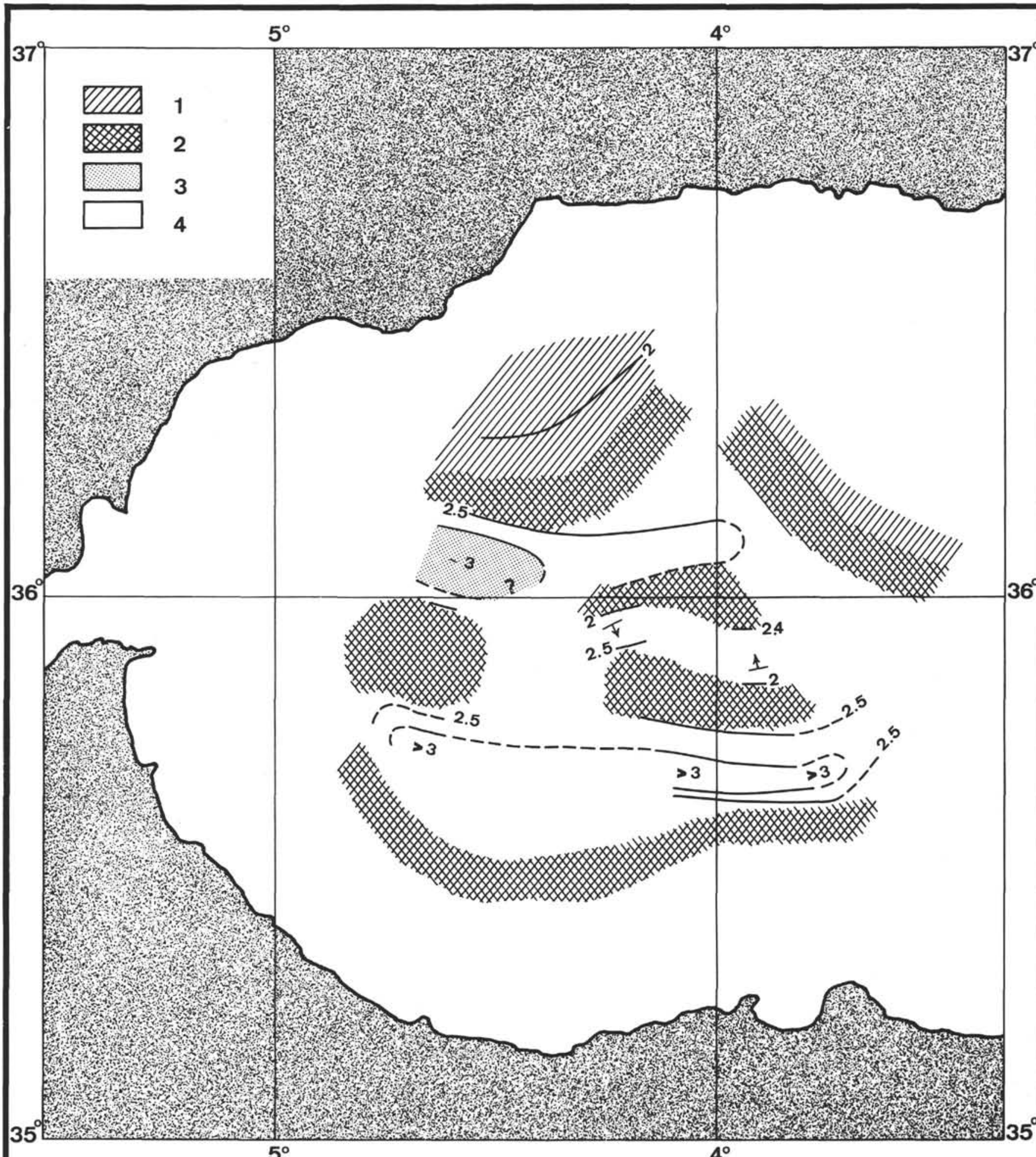

Figure 9. *Messinian surface isochrons (d.t.): (1) area with erosion surface (Messinain); (2) area where the substratum is covered by thin prepliocene sediments or no prepliocene sediments; (3) possible evaporitic basin; (4) folded area.*

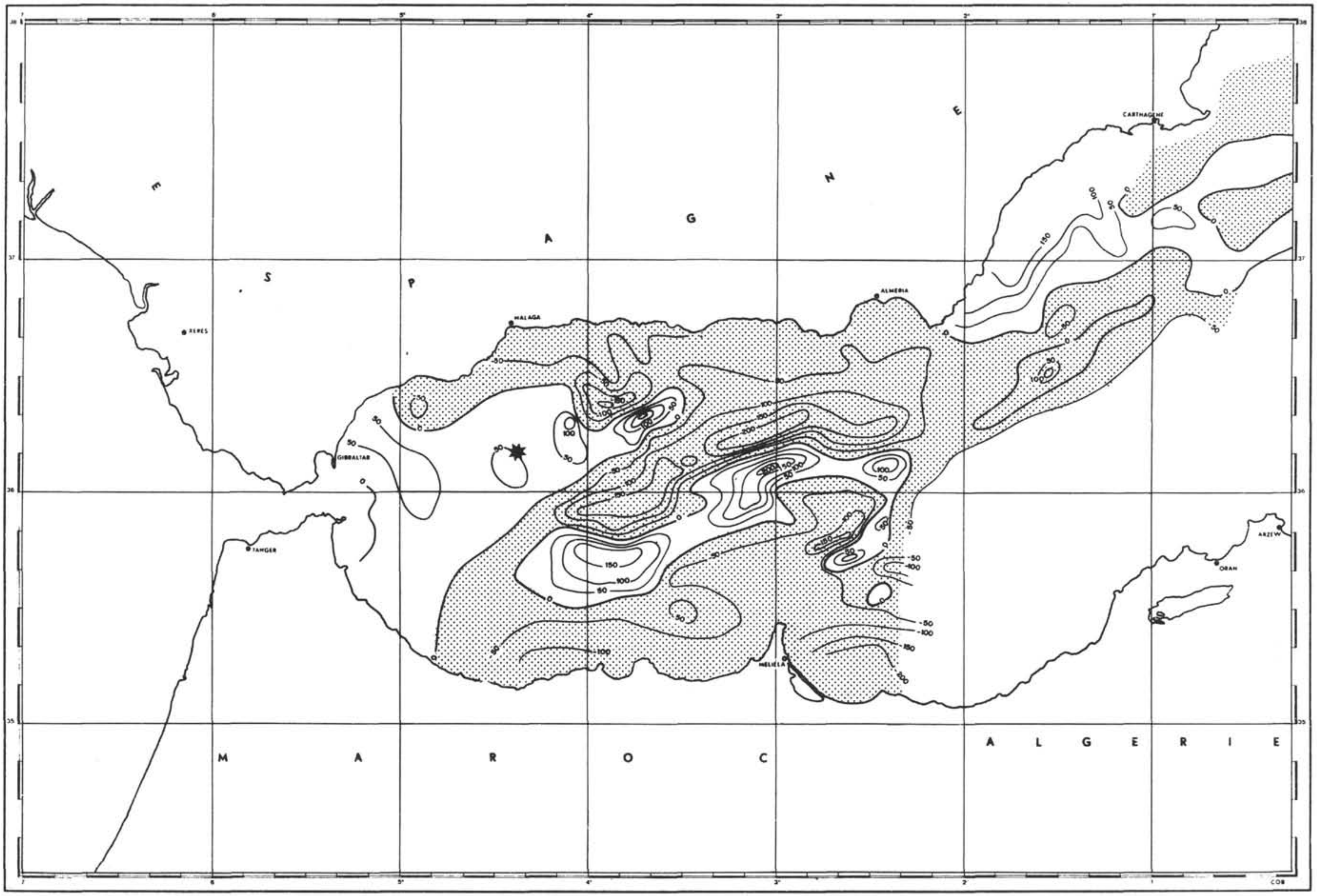

Figure 10. *Map of the residual magnetic field in the Alboran sea (after Vogt* et al., *1971). Contour interval is 50 gammas.*

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48.2. VALENCIA BASIN

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INTRODUCTION

The alignment of the Balearic Islands, stretching from the Spanish mainland towards the Corsican-Sardinian block, has long intrigued many geologists. Since Suess (1886), we know that the Balearic block (Ibiza, Formentera, and Majorca) is part of the Alpine system. Many authors (Kober, 1914; Staub, 1928; Kober, 1931) have subsequently attempted to comprehensively integrate the history of the Balearic block within the history of the Alpine chain.

In this paper, we will use data from marine geology and geophysics to define the location of the Balearic Islands during the diverse phases of distension, shearing, and compression between the European and African plates, which created the present western Mediterranean and the Alpine chain. In particular, we will try to explain the way in which the Balearic Islands have reacted to these diverse drift phenomena, and discuss the manifestations of these phenomena in this area.

In order to study the northern Balearic Basin, most of the geophysical techniques have been used (bathymetry, deep and shallow seismic reflection, seismic refraction, emplaced in the valley of a canyon where the layers at contact with the intrusive are thin and form a level.

The second rocky massif has a flat shape and presents different acoustical characteristics than that of the preceding massif because of the appearance of internal reflectors. In addition, we do not notice magnetic anomalies on this relief. Its nature is therefore uncertain. Site 123 is located in the valley of the canyon near this massif.

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