OCEAN DRILLING PROGRAM

LEG 103 SCIENTIFIC PROSPECTUS

GALICIA BANK

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INTRODUCTION

The continental margin of Galicia, northwest of the Iberian Peninsula (Figs. 1 and 2), is a sediment-starved passive margin. Above the acoustic basement, the sedimentary cover is thin (between 0 and 3 km; Fig. 3), and the rifted structure of the margin is reflected in the present-day morphology. In particular, the upper edges of the tilted fault blocks form bathymetric highs oriented north-south (Fig. 4). These conditions make this an attractive margin for ODP drilling because the basement and the oldest sedimentary strata are within drilling reach of the D/V JOIDES Resolution. The results of coring and logging here not only will elucidate the history of rifting, subsidence and sedimentation on this margin and the relation of these processes to the initiation and progressive opening of the adjacent North Atlantic, but also will bear strongly on the evolution of the more thickly sedimented--and hence less accessible--conjugate margin of North America.

Leg 103 is scheduled to sail from Ponta Delgada, Azores on 26 April 1985. The ship will drill a transect of sites across the Iberian margin, including one into a buried ridge of ultramafic rocks just landward of the ocean-continent crustal boundary and one through the entire syn-rift and pre-rift sedimentary sequences into continental basement within a tilted block. As time permits, an additional hole will be drilled into either another tilted fault block or the outer ridge. Leg 103 will end in Bremerhaven, Federal Republic of Germany on 20 June 1985.

PREVIOUS STUDIES

The Iberian margin has already been drilled once in 1976 (IPOD Leg 47B, Site 398; Sibuet, Ryan, et al., 1979). At this site the whole post-rift section (Lower Albian - Recent) and most of the syn-rift section (Hauterivian - Upper Aptian) were recovered. The drill did not reach the base of the syn-rift section, nor the pre-rift section and crystalline basement. The cores recovered from Site 398 show that:

a) The syn-rift sediments of the Early Cretaceous are detrital, and result in part from the erosion of a carbonate platform active during the Late Jurassic;

b) The youngest beds beneath the post-rift discordance are Late Aptian in age (~110 Ma). The J magnetic anomaly, also about 110 Ma, has been recognized on the seafloor to the west of the drillsite (Sibuet and Ryan, 1979; Guennoc et al., 1979). The regional data therefore indicate that rifting ceased and oceanic accretion began about 110 Ma in this region of the Atlantic;

c) The post-rift section begins with black mudstone and shale. It is an acoustically transparent unit composed mainly of distal turbidites rich in organic debris, deposited in intermediate depths between Early Albian and Middle Cenomanian times. These sediments fill in depressions which remained on the margin after rifting (acoustic unit 3; Fig. 5);

d) The Upper Cretaceous and Lower Cenozoic (Middle Cenomanian - mid-Eocene) sections are incomplete and condensed. These are essentially pelagic deposits, which appear on the seismic profiles as strong parallel reflectors (acoustic unit 2; Fig. 5).

e) The upper Eocene to Recent section (acoustic unit 1; Fig. 5) is locally unconformable on older strata (Pyrenean discordance, clearly visible to the north of the Iberian Peninsula; Grimaud et al., 1982). Unit 1 consists of pelagic sediments with intercalated turbidites.

Seismic reflection profiles show that the substrate of the margin is made up of tilted crustal blocks (Montadert et al., 1974; 1979; Fig. 6). Seaward-facing scarps along the uptilted edges expose the crystalline basement, which dredge samples (Groupe Galice, 1979; Boillot et al., 1979) show to be comparable to sialic rocks cropping out on land in Galicia.

At the foot of the margin, and in line with anomaly $_o$J, is a north-trending basement ridge which approximately follows the 13^o meridian (Fig. 3) This ridge crops out locally on Hill 5100 (Fig. 4); on east-west seismic profiles it resembles a diapir (Fig. 7). A large sample was recovered by dredging on the western side of Hill 5100, and consists of serpentinized lherzolite (Boillot et al., 1980). This suggests that, in this region, the basement underlying the sediments includes rocks from the upper mantle. We wish to discover how these rocks were emplaced at this high level and whether they preserve any pre-emplacement deformation structures.

The ridge of basement which underlies Hill 5100 is situated between the Iberian abyssal plain on the west, where all the geophysical data suggest the existence of typical oceanic crust, and the Galician margin of thin continental basement to the east. We are interested in studying the transition from oceanic to continental crust along this passive margin. Are the rocks in the ridge derived from sub-continental or sub-oceanic mantle?

Dredge hauls taken from strata overlying the continental basement reveal the presence of unfossiliferous red sandstone (Triassic?) and of platform carbonates (Upper Jurassic) (Boillot et al., 1979; Mougenot, personal communication). Seismic reflection profiles suggest that these strata were deposited in a Triassic (?) and Jurassic sedimentary basin that was later broken up by the Early Cretaceous rifting event that shaped the major structural pattern of the present-day margin.

SCIENTIFIC OBJECTIVES

Based on only a single lherzolite sample dredged from the ridge at the foot of the margin, crustal rifting seems locally to have uncovered the upper mantle. It is important to verify this tentative conclusion by obtaining fresh drill samples from the ridge. Study of the mineralogy, chemistry and structural petrology of cores from the ridge should further our knowledge on the following topics of general interest:

a) the mechanisms of tectonic rifting (comparison of crustal and lithospheric stretching);

b) hydrothermal alteration (serpentinization) of the rocks of the upper mantle at the beginning of oceanic accretion;

c) the nature of diapirs at the foot of the margin, in many places attributed to evaporites, but which in some places could have resulted from serpentinite mobility;

d) the significance of lower crustal or mantle rocks at the top of ophiolites. In the Alps, for example, ophiolites believed to have been initially situated near the continental margin commonly consist of serpentinites directly covered by post-rift pelagic sediments, as suggested for the lherzolite ridge at the foot of the Galician margin (Passerini, 1965; Lemoine, 1984).

The fundamental processes that control the evolution of a passive continental margin, such as lithospheric thinning, faulting, subsidence, and eustatic swings of sea level, cannot be clearly understood without a knowledge of the timing of events. Cores from sites drilled on Leg 103 should yield reliable data on the very early history of the margin and on the timing of the transition from rifting to the beginning of oceanic crustal accretion. Coring will also provide important information on the timing of the paleoenvironmental changes in this region of the Atlantic. Additional specific questions include:

a) the rates and amounts of subsidence from the Triassic to the late Jurassic, as clues to the history of crustal thinning before the onset of oceanic crustal accretion;

b) the timing of the first appearance of marine waters in what was later to become the oceanic rift, and the provincial relations of the biota of those waters;

c) the timing and rates of drowning of the late Jurassic carbonate platform;

d) the timing of significant transgressions and regressions, shifts in coastal onlap relations and the development of unconformities, to evaluate the relative roles of eustasy and vertical tectonic movements in determining the stratigraphy of this margin;

e) the determination of the age and physical significance of the many key seismic reflectors, as a prerequisite to regional correlation and regional interpretation of the observed seismic stratigraphy; and

f) the timing of significant changes in important oceanographic variables such as temperature, oxygenation, fertility, bottom-current activity, and dissolution of carbonates.

DRILLING PROGRAM

The drilling program planned for ODP Leg 103 is as follows:

a) One shallow (~300 m penetration) single bit hole on the ridge from which lherzolite was dredged (Fig. 7 and 8; Site GAL-2A or GAL-2B, respectively). This hole will provide us with data on the petrologic nature of the ridge, and on its possible heterogeneity. Sampling unaltered lherzolites would permit petrographic and chemical studies to constrain the place of origin of the ultrabasic rocks and structural fabric studies to obtain clues to their original history of deformation in the mantle as well as their later deformation as they were emplaced, possibly as diapirs, into the crust.

b) A very deep (~1750 m penetration) multiple reentry hole, all the way through the post-, syn-, and pre-rift strata and into crystalline basement (Fig. 9; Site GAL-4B). The cores and downhole logs from this hole should tell us nearly the entire history of the margin, from the succession of rifting phases during the Mesozoic, through the drowning of the carbonate platform and the progressive or sudden changes in the environment during the initiation of seafloor spreading. Cores from the crystalline basement will permit comparisons with the exposed basement of Galicia.

Other sites, which will be drilled if time permits, include the following:

a) one shallow (~400 m penetration) single bit hole (Fig. 10; Site GAL-3A) at the summit of the tilted block of the margin closest to the ocean, in order to understand its nature (continental basement? pre-rift sediments?); and/or

b) an additional shallow-penetration hole on the lherzolite ridge (either GAL-2A or GAL-2B, whichever was not drilled at the beginning of the cruise).

An alternate back-up plan in the event that drilling at Site GAL-4B cannot penetrate well into the carbonate platform sequence (estimated to lie below 1300 m), is to drill at Site GAL-4A up dip from Site GAL-4B and near the summit of the same tilted fault block (Fig. 9). The top of the carbonate platform is close to the seafloor here. Though reaching crystalline basement at Site GAL-4A might require a multiple reentry hole, time constraints would probably only allow us to core it as deeply as possible as a single bit hole.

Leg 103 will thus sample a transect of the Galician passive margin (Figs. 11 and 12). It should yield new insights not only on the development of undeformed passive margins but also on the geology of folded belts derived from these.

LEG 103 OCEAN DRILLING PROGRAM

Galicia Bank

Location of Proposed Sites

Drill Sequence	Site Number	Latitude	Longitude	Water Depth	Locality	Hole Type
#1	GAL-2B	$42^{\circ}05'$N	$12^{\circ}53'$W	5200m	lherz. dredge site	Rotary coring to 300m
#2	GAL-4B	$42^{\circ}08'$N	$12^{\circ}11'$W	4450m	tilted block	Re-entry; core to 1750m
#3	GAL-3A[1]	$42^{\circ}00'$N	$12^{\circ}29'$W	5060m	tilted block	Rotary coring to 400m
#3	GAL-2A[1]	$42^{\circ}00'$N	$12^{\circ}52'$W	5200m	lherz. dredge site	Rotary coring to 300m
ALT	GAL-4A[2]	$42^{\circ}08'$N	$12^{\circ}13'$W	4650m	tilted block	Rotary coring to 1000m

[1] GAL-3A or GAL-2A will be drilled if time permits.
[2] ALT = Alternate drillsite to be occupied if deep objectives are not reached at GAL-4B.

SITE OCCUPATION SCHEDULE

LEG 103

Site	Location	Travel Time (Days)	Drilling Time (Days)	Departure Date (Approximate)
Depart:	Ponta Delgada			26 April 1985
Underway		3		
GAL-2B	42°05'N 12°53'W		5.1	4 May 1985
GAL-4B	42°08'N 12°11'W		43.6	15 June 1985
GAL-3A[1]	42°00'N 12°29'W		7	
GAL-2A[1]	42°00'N 12°52'W		5.1	
Underway		4.5		
Arrive:	Bremerhaven			20 June 1985
		7.5	48.7 days	55 days

Alternate Site:

GAL-4A	42°08'N 12°13'W		8.9-20.3[2]	

[1] 3A or 2A will be drilled if time permits.

[2] Variable time estimates at alternate Site GAL-4A depend on whether it is drilled as a single-bit or a multiple re-entry hole.

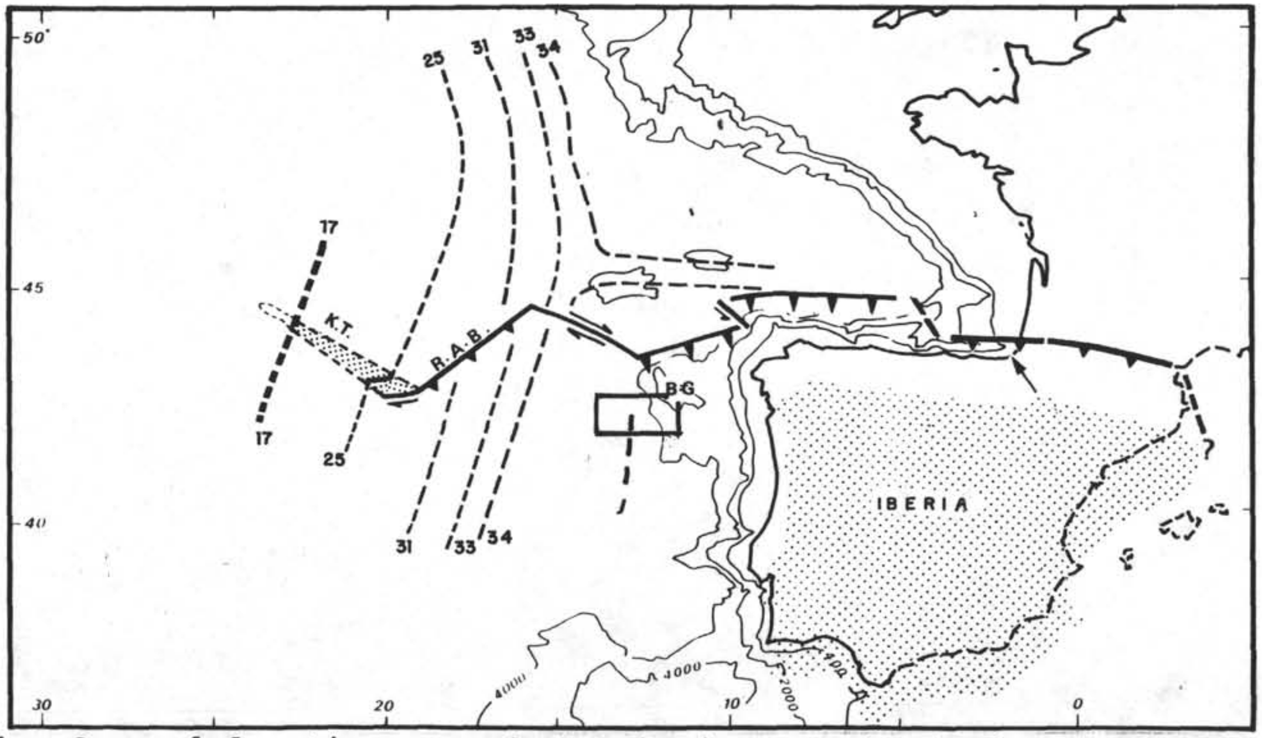

Fig. 1: General location map of the Iberian margin showing magnetic anomalies in the northeast Atlantic. Shaded area represents position of Iberia when anomaly 33 was formed. Arrow indicates direction of Iberian motion during Paleocene and Eocene time. B.G. = Galicia Bankdrilling area (Figs. 3,4,11); K.T. = King's Trough; R.A.B. = Azores-Biscay Rise. Modified from interpretation by Grimaud et al., 1982.

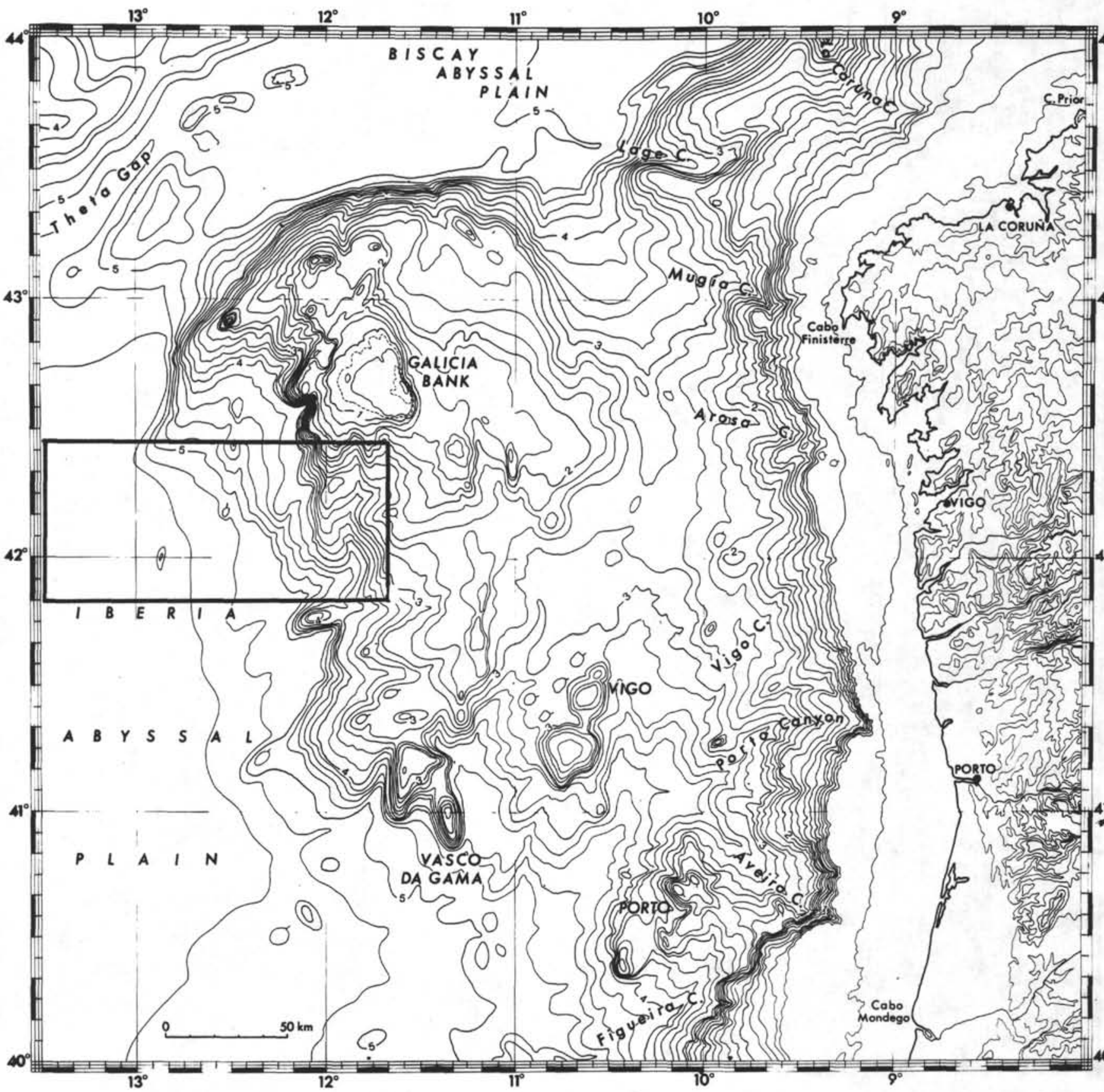

Fig. 2: Bathymetry of the continental margin northwest of the Iberian Peninsula, showing location of Leg 103 drilling area (Figs. 3,4,11). Bathymetric contours are in kilometers. Modified from Vanney et al., 1979.

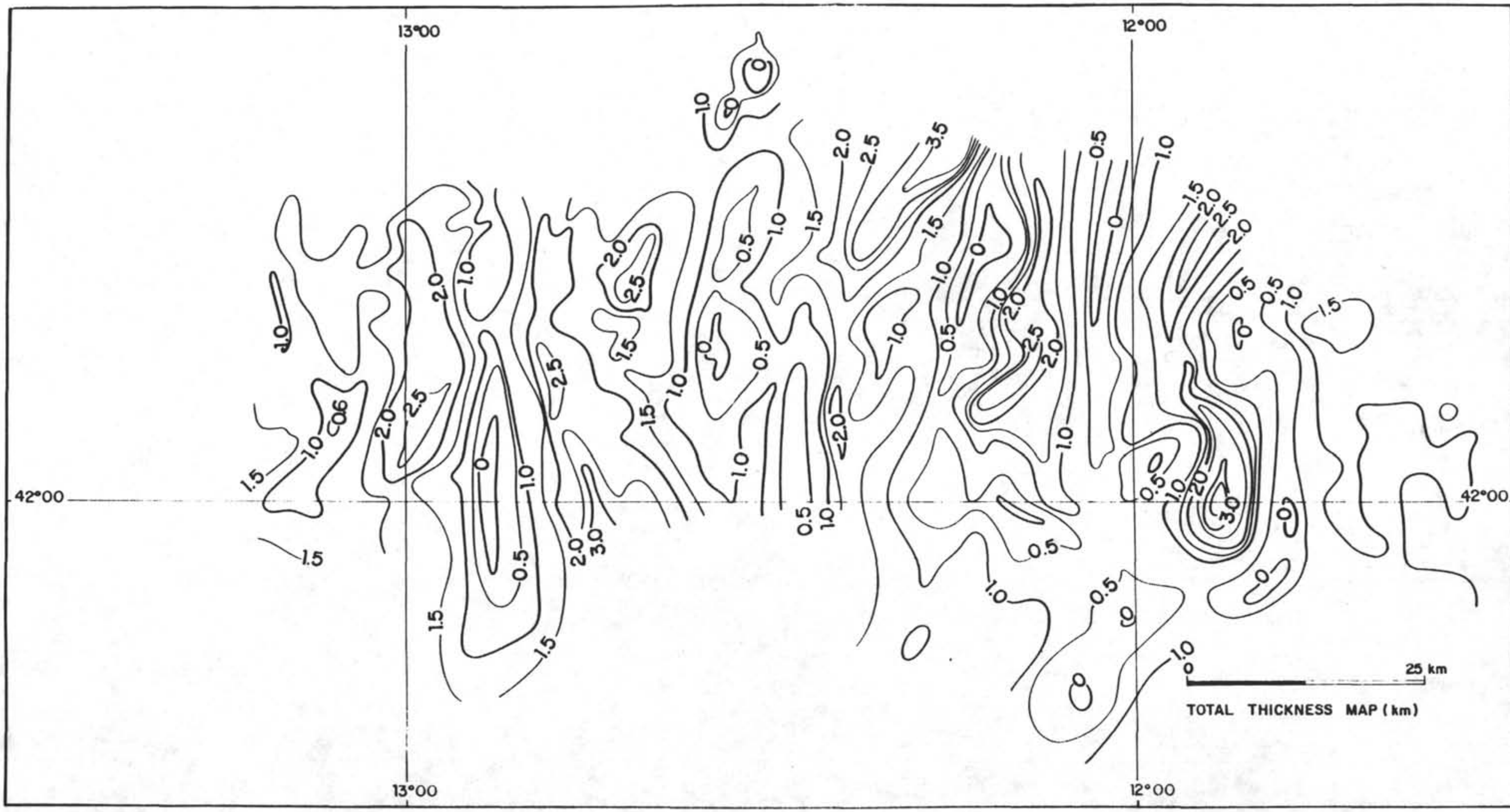

Fig. 3: Map of total sediment thickness above acoustic basement. Contour interval = 0.5 km. Map location shown in Fig. 2.

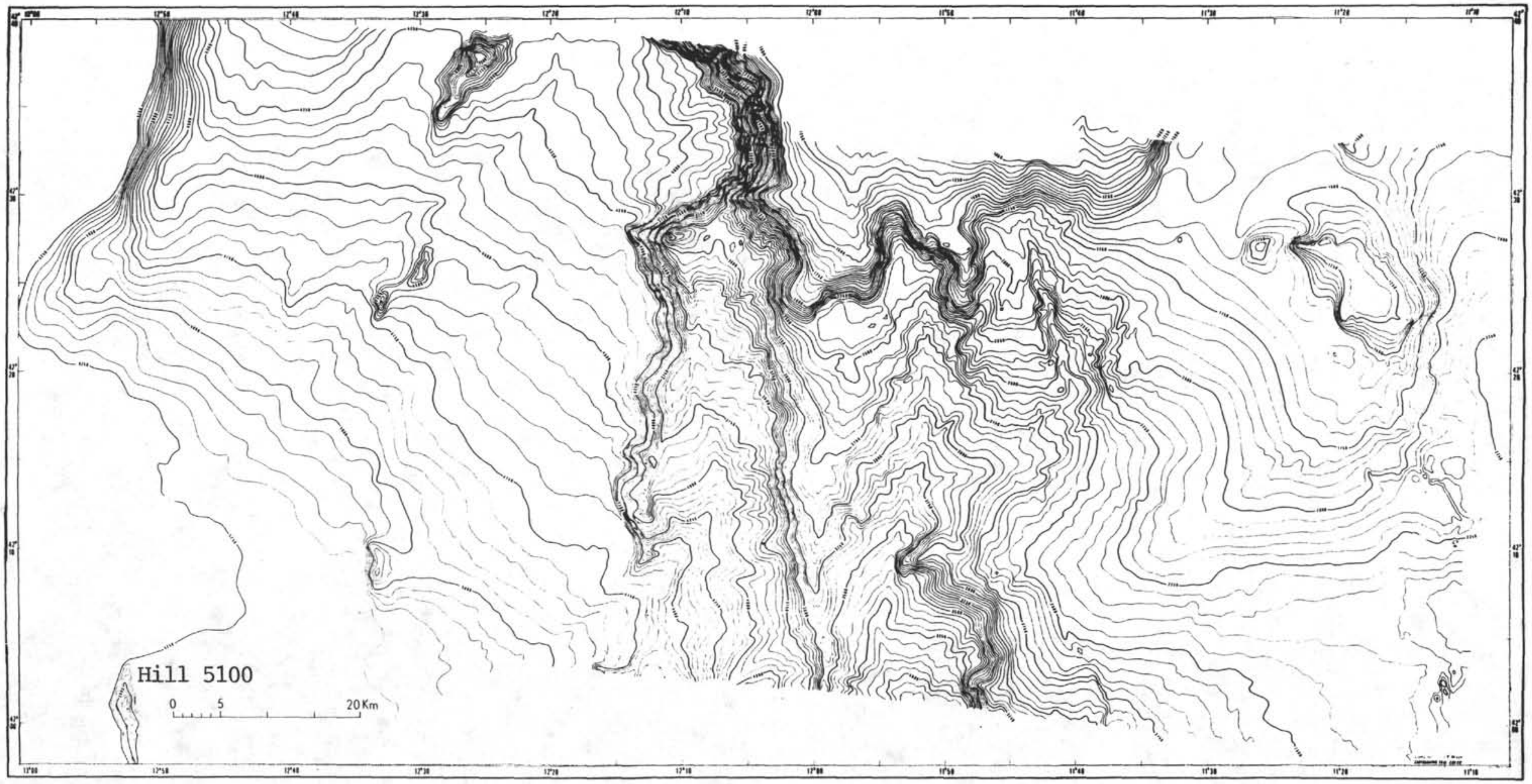

Fig. 4: Sea-beam bathymetry of the deep Galicia margin collected on "Seagal" cruise of the _Jean Charcot_ in 1982. Approximate map location shown in Fig. 2.

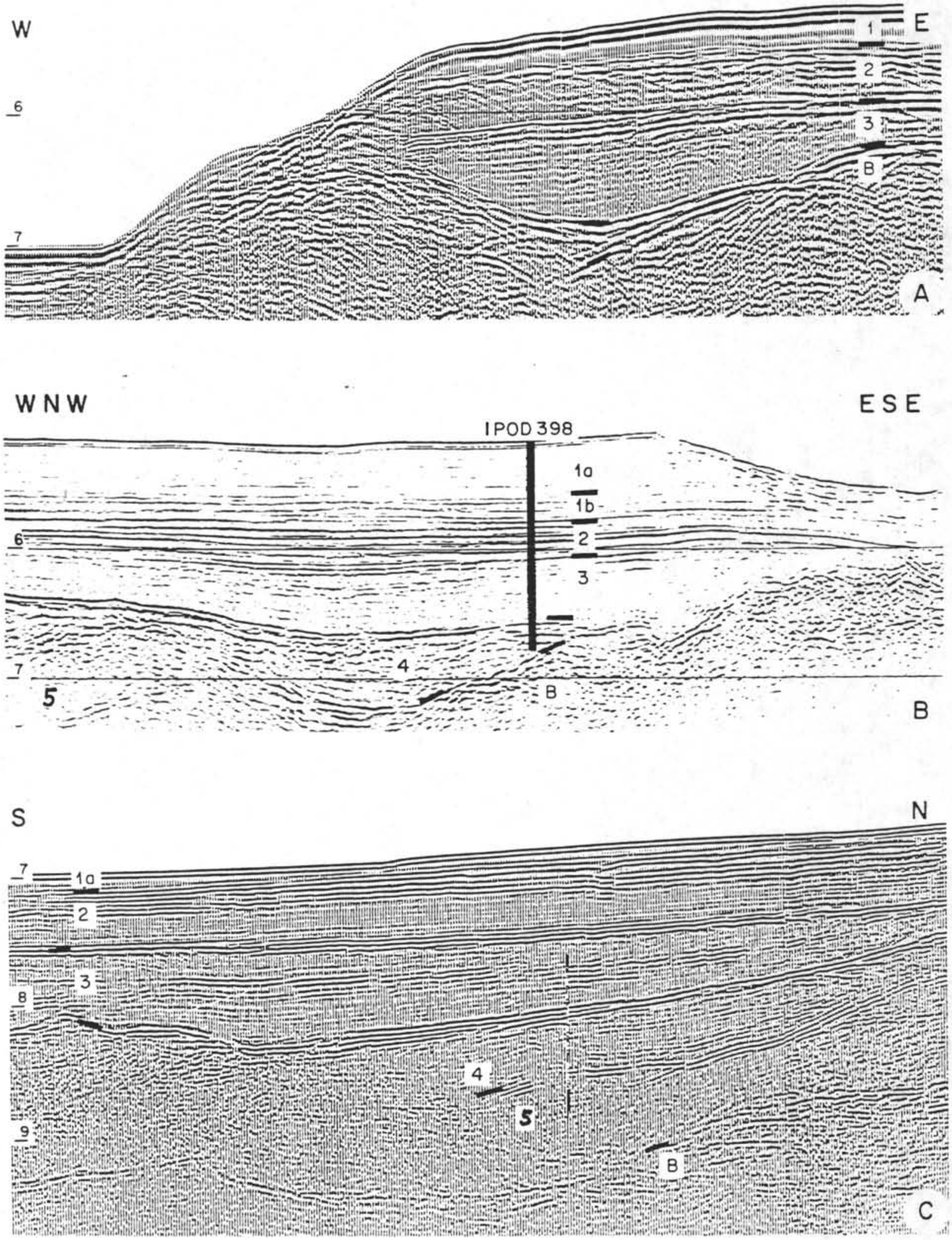

Fig. 5: Acoustic stratigraphy in vicinity of DSDP Site 398. 1,2,3,4: syn- and post-rift formations, described in the text. 5: pre-rift sediment. B: probable basement. Vertical scale = two-way travel time in seconds. From Groupe Galice, 1979.

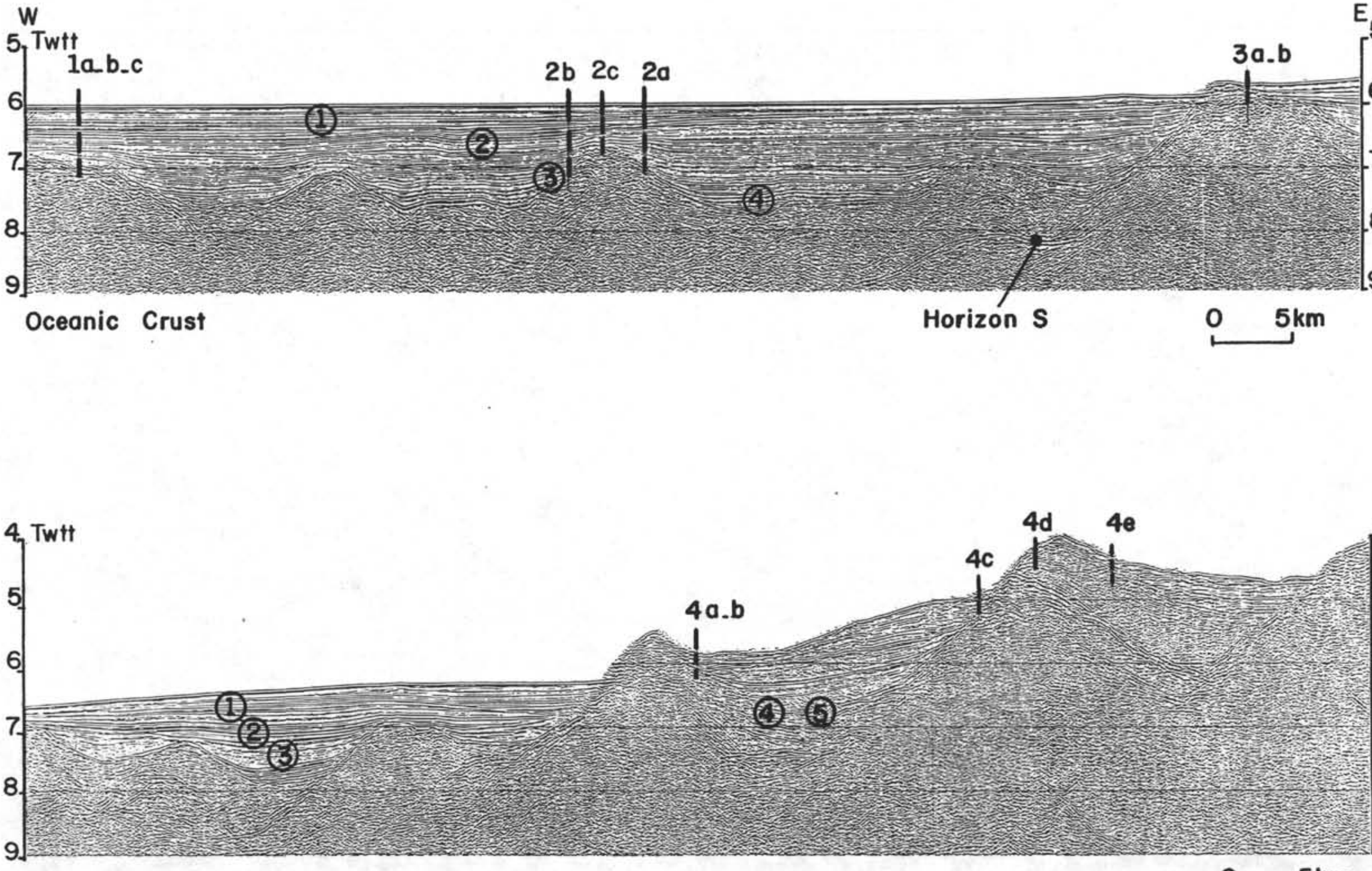

Fig. 6: Line GP11 seismic profile, 24 fold, stacked and migrated (according to Montadert, pers. comm.), showing section from the oceanic crust to the Galicia margin across the ocean-continent boundary, and tilted fault blocks described in text. Locations of all target drill sites are projected along this seismic line; GAL-2A, -2B, -3A, -4A, and -4B are all proposed for drilling during Leg 103. Vertical scale is two-way travel time in seconds. Vertical exaggeration = x3.3. Formations 1-5 are shown in Fig. 5 and briefly discussed in text.

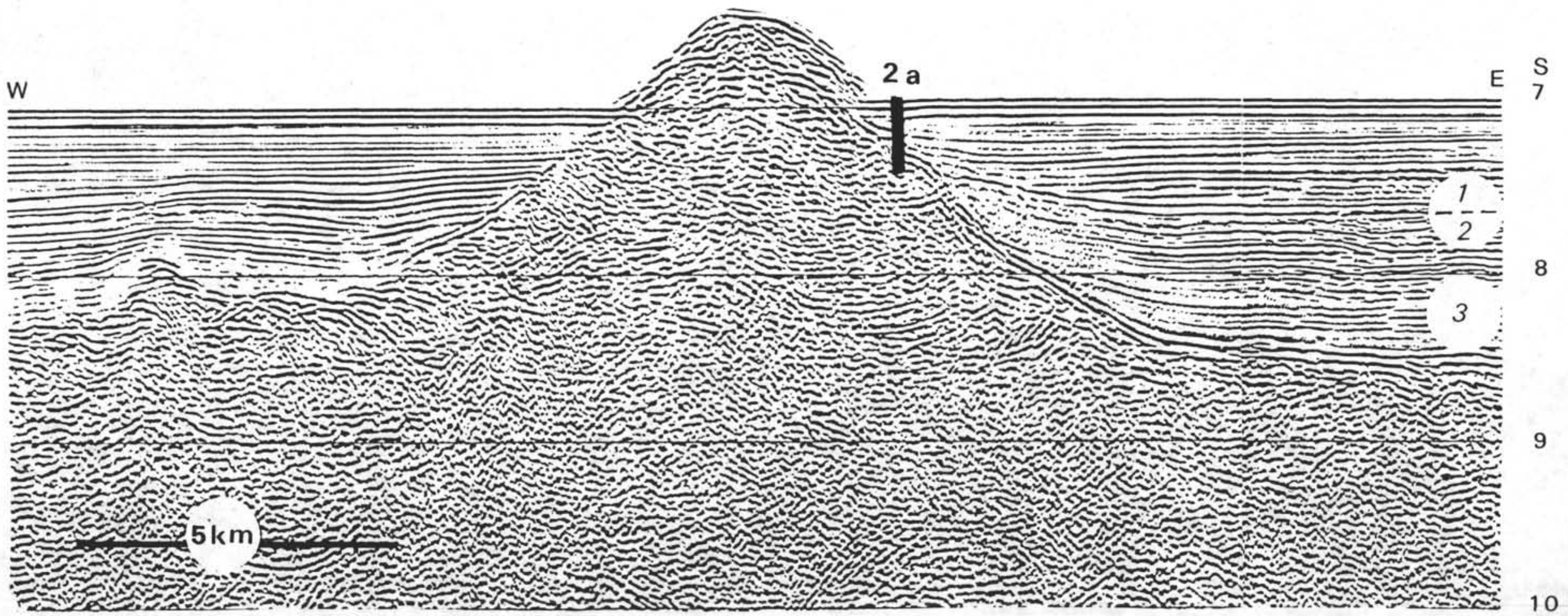

Fig. 7: Location of target site GAL-2A. Lherzolitic rocks have been sampled along the western flank of this feature (Boillot et al., 1980.

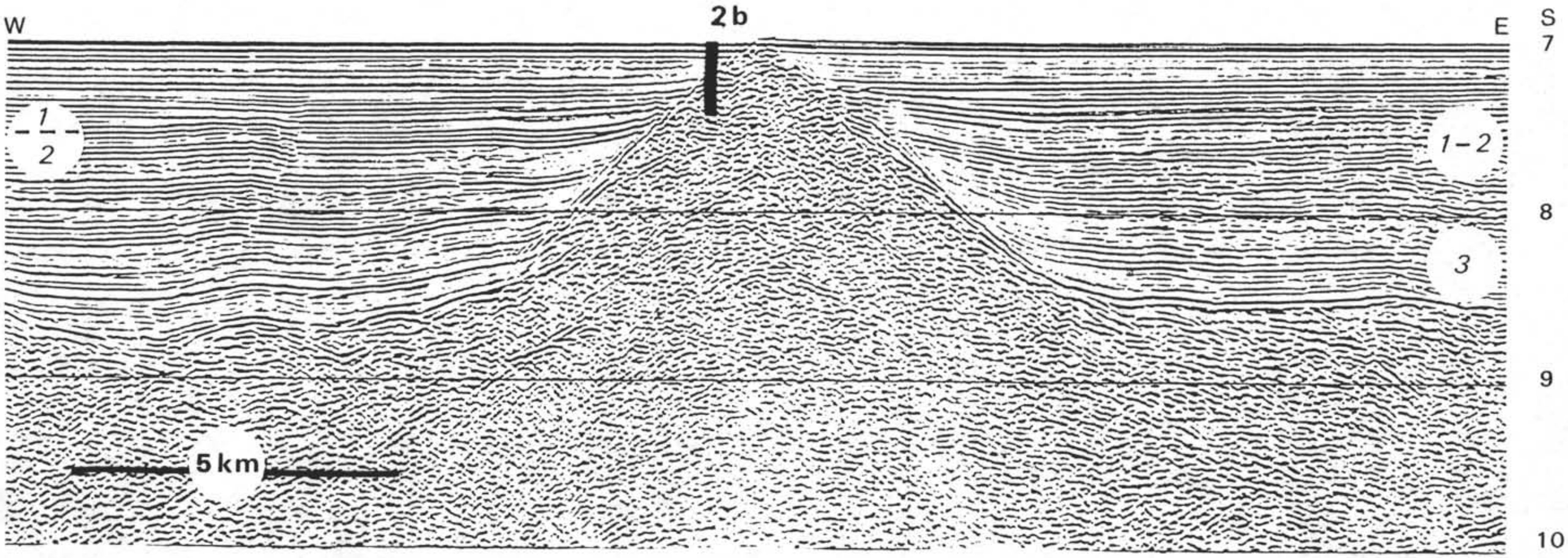

Fig. 8: Location of target site GAL-2B. To the south of this site, lherzolitic rocks have been sampled along the western flank of the ridge (Boillot et al., 1980; Figure 7).

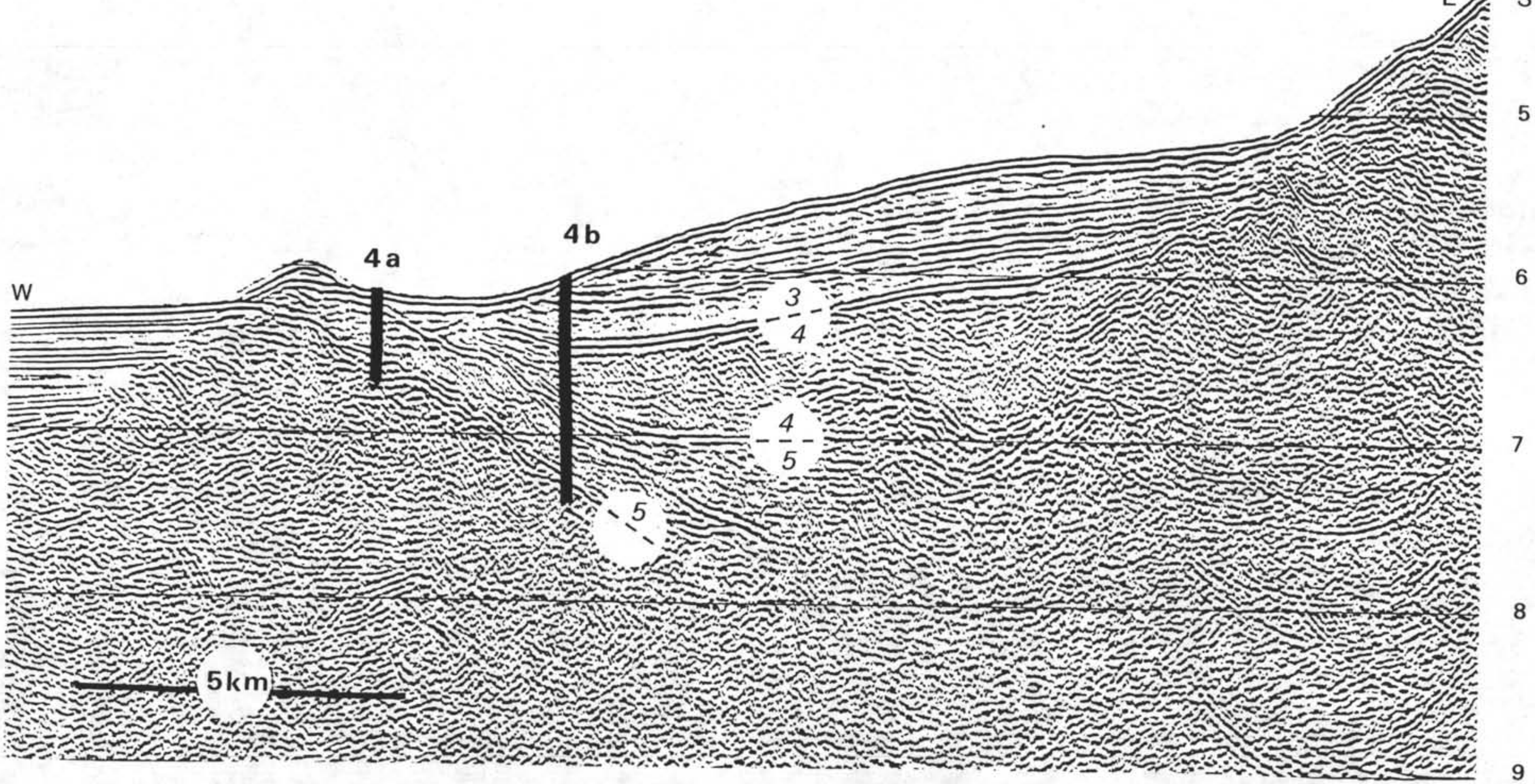

Fig. 9: Locations of target sites GAL-4A AND GAL-4B on a tilted block of the deep Galician margin. Note the pre-rift series (5) tilted with the basement block, and the syn-rift series (4). Formations 1-5 are also shown in Fig. 5 and discussed briefly in the text.

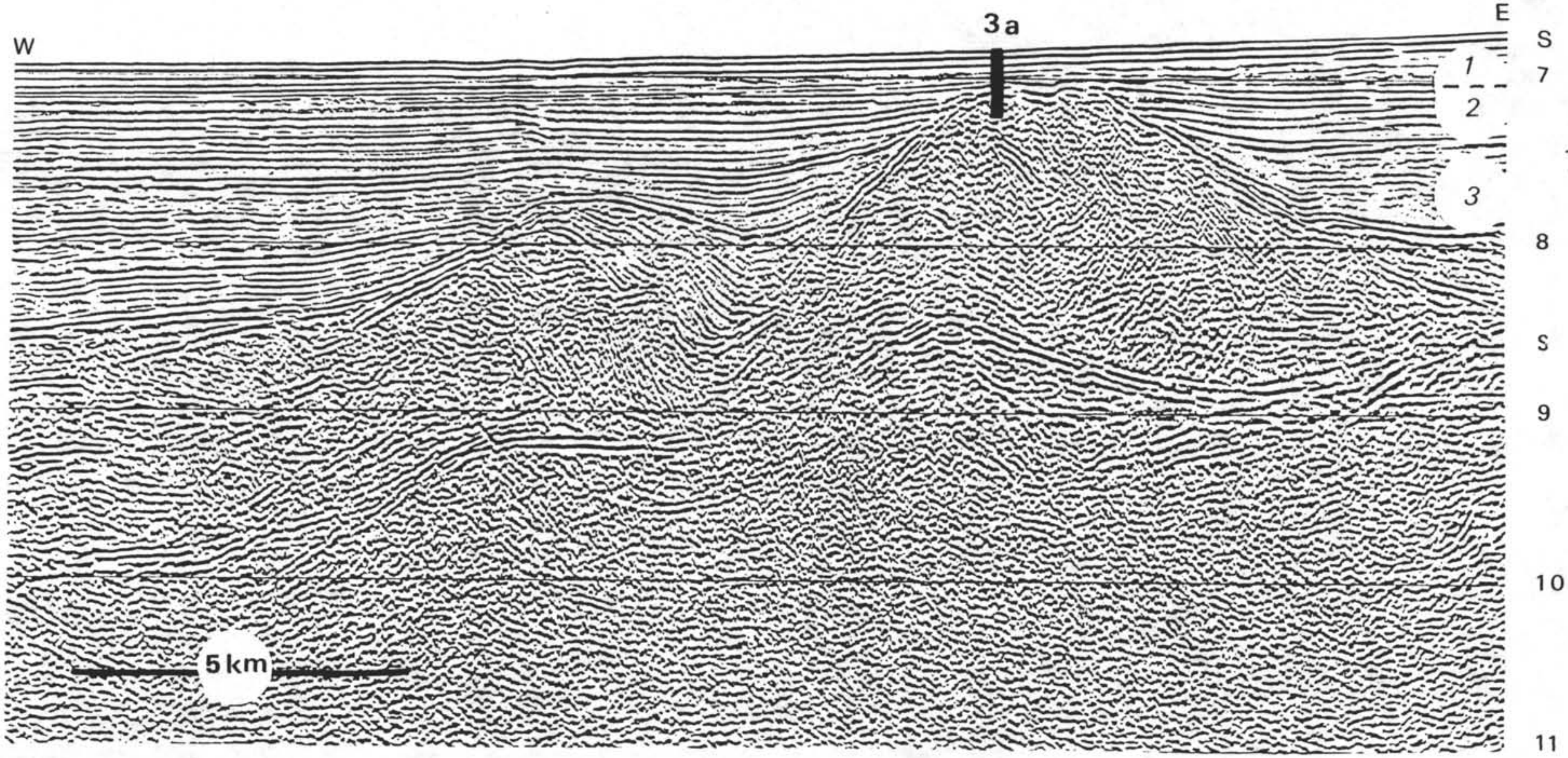

Fig. 10: Location of target site GAL-3A on the deepest tilted block of the margin near the ocean-continent boundary. Formations 1-3 are also shown in Fig. 5 and discussed briefly in the text.

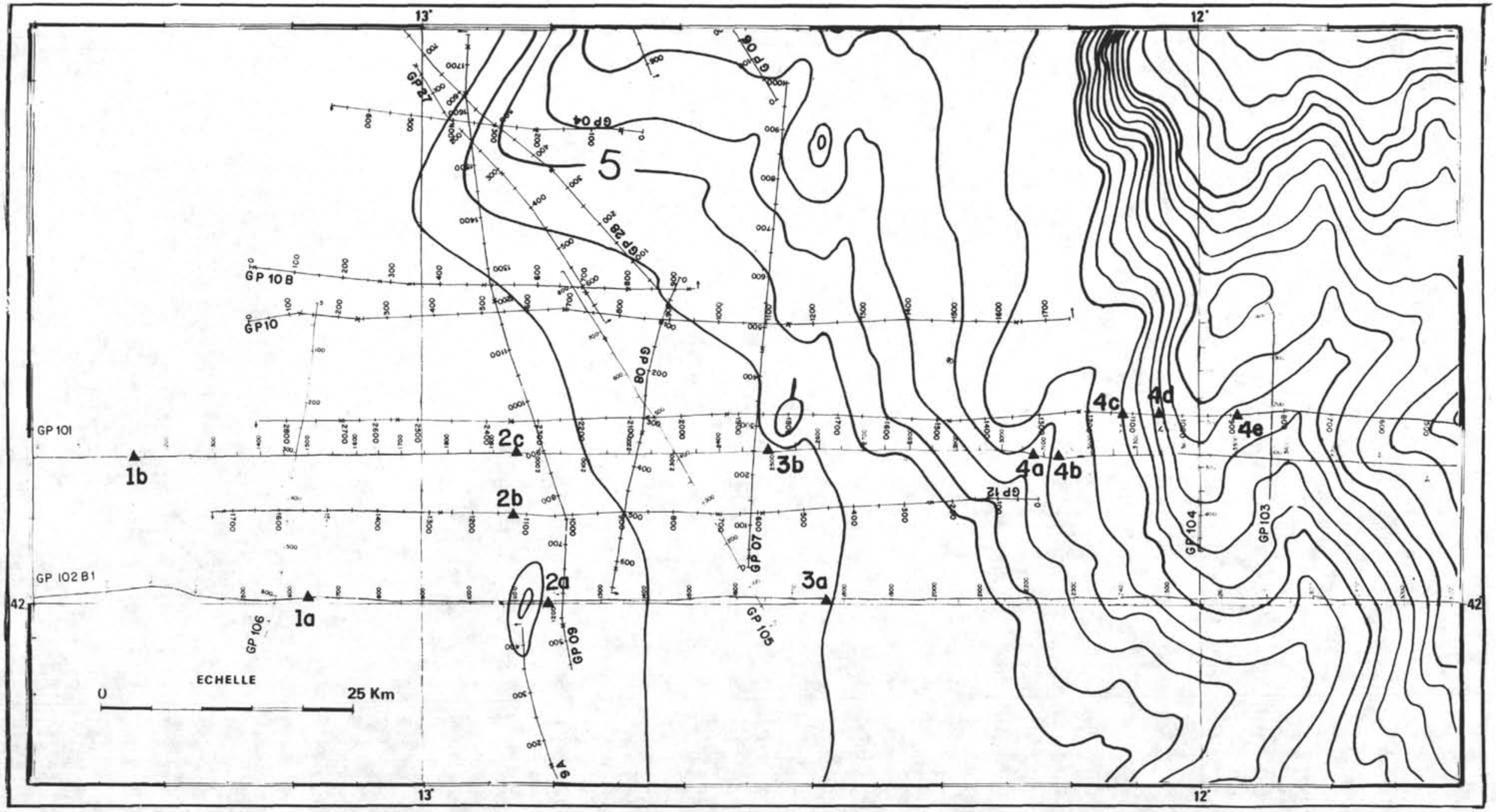

Fig. 11: Site survey location map, showing locations of all target Galicia Bank drill sites. Sites GAL-2A, -2B, -3A, -4A, and -4B are all proposed for drilling during Leg 103. Map location shown in Fig. 2.

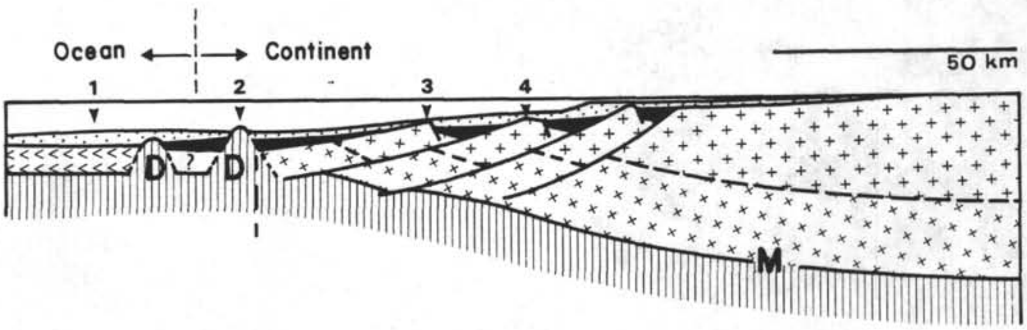

Fig. 12: Proposed model of crustal thinning beneath Galicia Margin. Thinning would essentially result from tectonic extension that induces listric faulting extending to the base of the crust. Close to the ocean-continent boundary the highly thinned continental crust may consist of granulite-facies crystalline rocks. Serpentinite emplacement by diapirism is favored by the proximity of the mantle. D: serpentinite diapir; M: Moho. Approximate locations of originally proposed sites 1-4 are shown; sites 2-4 are proposed for drilling on Leg 103 (From Boillot et al., 1980).

SITE NUMBER: GAL-2B

POSITION: 42°05'N 12°53'W SEDIMENT THICKNESS: 200 m

WATER DEPTH: 5200m PRIORITY: 1

PROPOSED DRILLING PROGRAM:

Continuous rotary coring through 200 m of sediment and 100 m of basement.

SEISMIC RECORD:

IFP-CNEXO migrated multichannel Line GP12, S.P. 1130 (Fig. 8).

HEAT FLOW: No

LOGGING: No

OBJECTIVES:

To obtain fresh ultramafic rocks from the lherzolite ridge.

SEDIMENT TYPE:

Mudstones overlying ultramafic rocks (lherzolites?).

SITE NUMBER: GAL-4B

POSITION: 42°08'N 12°11'W SEDIMENT THICKNESS: 1700 m

WATER DEPTH: 4450m PRIORITY: 1

PROPOSED DRILLING PROGRAM:

Re-entry; continuous coring to 1750 m through 1700 m of sediment and into basement.

SEISMIC RECORD:

IFP-CNEXO migrated multichannel Line GP101, S.P. 3130 (Fig. 9).

HEAT FLOW: No

LOGGING: Yes

OBJECTIVES:

The principle targets are the syn-rift and pre-rift sediments of the subsident continental margin.

SEDIMENT TYPE:

Claystones, black shale, and limestone overlying continental crystalline basement.

SITE NUMBER: GAL-3A

POSITION: 42°00'N 12°29'W SEDIMENT THICKNESS: 300 m

WATER DEPTH: 5060m PRIORITY: 2

PROPOSED DRILLING PROGRAM:

Continuous coring through 300m of sediments and 100m of basement.

SEISMIC RECORD:

IFP-CNEXO migrated multichannel Line GP102, S.P. 1770 (Fig. 10).

HEAT FLOW: No

LOGGING: Yes

OBJECTIVES:

To obtain more information about the earliest history of the margin.

SEDIMENT TYPE:

Mudstones overlying continental crystalline basement.

SITE NUMBER: GAL-2A

POSITION: 42°00'N 12°52'W SEDIMENT THICKNESS: 200 m

WATER DEPTH: 5200m PRIORITY: 2

PROPOSED DRILLING PROGRAM:

Continuous rotary coring through 200 m of sediment and 100 m of basement.

SEISMIC RECORD:

IFP-CNEXO migrated multichannel Line GP102, S.P. 1143 (Fig. 7).

HEAT FLOW: No

LOGGING: No

OBJECTIVES:

To obtain fresh ultramafic rocks from the lherzolite ridge.

SEDIMENT TYPE:

Mudstones overlying ultramafic rocks (lherzolites?).

SITE NUMBER: GAL-4A

POSITION: 42°08'N 12°13'w SEDIMENT THICKNESS: 900 m

WATER DEPTH: 4650m PRIORITY: 1 (ALTERNATE)

PROPOSED DRILLING PROGRAM:

Continuous coring through 600 m or until bit destruction (8.9 days) or, if time permits, reentry hole to 1000 m (20.3 days).

SEISMIC RECORD:

IFP-CNEXO migrated multichannel Line GP101, S.P. 3063 (Fig. 9).

HEAT FLOW: No

LOGGING: Yes

OBJECTIVES:

This site is located above the pinch-out of the syn-rift sediments, the principle target being the pre-rift sediments.

SEDIMENT TYPE:

Black shale, limestone, and sandstone overlying continental crystalline basement.

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