OCEAN DRILLING PROGRAM

LEG 102 SCIENTIFIC PROSPECTUS

DOWNHOLE MEASUREMENTS IN THE WESTERN ATLANTIC

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INTRODUCTION

The principle objective of Leg 102 is to acquire a comprehensive baseline suite of borehole geophysical data in old crust at DSDP Site 417 or 418 in the Western Atlantic (Fig. 1). Should this objective prove unobtainable, one of a number of previously proposed sites for this Leg may be considered for drilling: Site 603 (ENA-3), Site NJ-8 and Site NJ-6.

To meet these objectives, the D/V JOIDES Resolution will depart Miami, Florida on March 19, and steam to Site 418 to conduct downhole geophysical studies and a two-ship seismic experiment with the R/V Fred Moore. The ship will return to Norfolk, Virginia by April 10, 1985.

PREVIOUS STUDIES

AND

SCIENTIFIC OBJECTIVES

Site 417/418: Geophysics in Old Oceanic Basement

During the first 15 years of the drilling program, significant basement penetration (>250 m) was achieved at several sites in young crust but comprehensive borehole geophysical measurements were successfully conducted at only one (Hole 504B). These few measurements, however, have been of landmark importance. They demonstrate, for example, that:

1) In the vicinity of Site 504, Layers 2A, B and C correspond respectively, to rubble, pillow basalts and sheeted dikes;
2) The permeability of the crust near the borehole decreases by several orders of magnitude in the upper 500 m of layer 2 in response to a 10-fold decrease in porosity;
3) Underpressures measured in the crust are dynamically maintained by convection;
4) Convection in the basement near Hole 504B is confined to the high permeability zone near the top of the extrusives;
5) The velocity structure of Layer 2 at the site is controlled not by petrology but by variations in porosity with depth.

Although it is tempting to extrapolate these results to the ocean crust as a whole, it must be remembered that they are based on a case of one and that this case is biased toward young crust (site 504 is on 5.9m.y.-old crust). There is strong evidence that old crust is profoundly different (conductive

heat flow, the absence of layer 2A) but no comparable set of borehole geophysical measurements has been made in old crust. On Leg 102 it is planned to re-enter one of the two deep basement holes (417D or 418A) drilled on Legs 51 and 53 in 110 m.y.-old crust in the Western Atlantic (Table 1). The objective is to acquire a comprehensive baseline suite of borehole geophysical data in old oceanic crust. Specific scientific objectives include:

1) Determination of in situ velocity structure at a site in old crust. Are Layers 2A, B and C present and do they correspond to the same lithologies as in Hole 504B?
2) Determine permeability of the old oceanic crust.
3) Determine the porosity vs depth function of the site. This data, together with that from Hole 504B, will make it possible to determine the porosity-permeability and porosity-velocity systematics for Layer 2.
4) Determine the thickness of the magnetic layer in old crust.
5) Determine whether or not convection and underpressures persist in old crust.
6) Sample and determine the chemistry of water in equilibrium with old basement.
7) Determine the direction and magnitude of in situ stress.

To these ends, the ship will return to Hole 418A, which was drilled, through pillow basalts, massive basalts and into the top of the dike transition zone, to a sub-basement depth of 544 m on Leg 53 (see Fig. 2 and 3), but which now has a logging tool lodged in the overlying sediments. If the tool can be fished out, a suite of experiments similar to those run in Hole 504B will be run in 418A (table 2). A further objective of the leg will also then have been achieved the reopening of a second deep basement hole, similar to Hole 504B but in old crust, for eventual deepening. If Hole 418A cannot be reopened, the ship will proceed to 417D which is still presumed to be open 270 m sub-basement and the same experiments will be performed there. (A limited downhole measurements program was attempted in Hole 471D during Legs 51 and 53 but only the oblique seismic experiment and two logging runs near the top of the hole were successful). The specific experiments scheduled include:

Conventional Logging (LDGO): Standard industry tools will be

run to determine the velocity (Vp), density, porosity, resistivity, natural gamma radioactivity and equilibrium temperature structure of the section.

Multichannel Sonic Logging (LDGO): A 12-channel sonic tool will be run to determinate the compressional, shear and Stonely wave velocity structure of the section.

VSP/Oblique Seismic Experiment (WHOI): A combined VSP/Oblique Seismic Experiment, using a 3-component borehole seismometer, airgun and explosive sources and the R/V Fred Moore as the shooting ship, will be conducted in order to determine interval velocities, compressional and shear wave velocity gradients, seismic anisotropy, attenuation and look for the presence of sub-basement reflectors in the vicinity of the site. This will be the first full-scale test of VSP technology in the Ocean Drilling Program.

Large-Scale Resistivity Experiment (SIO): The large-scale resistivity experiment will be run in order to determine the large scale porosity of the crust.

Packer (SIO): Packer tests will be run at several depths in the hole to measure permeability, pore pressure and in situ stress. This will be the first use of a straddle packer in the drilling program.

Flowmeter (SIO): Flowmeter tests will be run at several intervals to measure the rate of flow of water (if any) in the hole. All previous estimates of flow based upon Deep Sea Drilling have relied upon temperature data.

Borehole Televiewer (LDGO): A BHTV will be run downhole in order to observe mesoscopic features such as pillows and dikes in the borehole wall and to determine the orientation of the in situ stress field from breakouts.

3-Axis Magnetometer (BGR): A 3-axis magnetometer will be run in order to determine NRM intensity, inclination and declination versus depth and alteration in the hole.

Magnetic Susceptibility Logging (USGS): A magnetic susceptibility tool will be run downhole to study susceptibility versus depth and alteration in the crust.

Heat Flow (WHOI/TAMU): The von Herzen HPC heat flow tool will be used to measure the temperature gradient in the basement and if time is available, in the sediments adjacent to the hole.

Water Sampler (TAMU): A small sediment bridge near the sediment basement contact in Hole 418A is thought to have sealed off the basement from bottom water invasion since the hole was drilled. If the logging tool can be removed and the bridge penetrated, the Barnes pore water sampler and the Schlumberger fluid sampler will be used to collect water in equilibrium with the basement.

ALTERNATE SITES

If the objectives at Site 418 or Site 417 cannot be reached, Site 603 (ENA-3D), previously planned for Leg 102, could be an alternate site with Site NJ-8 and Site NJ-6 (Figures 4, 5, 6, 7, 8).

TABLE 1

LEG 102 SITES

Site	Priority	Location	Water Depth (m)	Distance From Nearest Land (n.mi.)	Jurisdiction	Penetration (m)	Objective
418A	1	25 02.10'N 68 03.44'W	5511	264	International	868	Obtain baseline suite of borehole geophysical data in old oceanic crust.
417D (Alternate to 418A)	2	25 06.69'N 68 02.81'W	5479	364	International	708	Same as at 418A.

TABLE 2

PROPOSED LEG 102 DRILLING/EXPERIMENT PROGRAM

Site	Location	Travel Time (days)	Drilling Time (days)	Departure Date (approximate)
	DEPART: Miami, Florida			19 March 1985
	Transit to Site 418	1.7		
418A	25 02.10'N 68 03.44'W			
	Site location and fishing		4.0	
	Downhole experiments: Logging (LDGO), 3 axis magnetometer (Germany) Magnetic Susceptibility (USGS) Multichannel sonic (LDGO) Televiewer (USGS/LDGO) VSP/oblique seismic (WHOI)[1] Large scale resistivity (SIO) Flowmeter and Packer (SIO) Heat flow in sediments			
	Pull out of hole		11.3	5 April 1985
	transit to port	3.7		
	Contingency[2]		1.3	
	ARRIVE: Norfolk, Virginia			10 April 1985
	Total:	5.4	16.6	22 days

1) Two-ship experiment with R/V Fred More
2) Transit to 417D and re-entry if fishing unsuccessful at 418A; drilling in 418A if fishing successful.

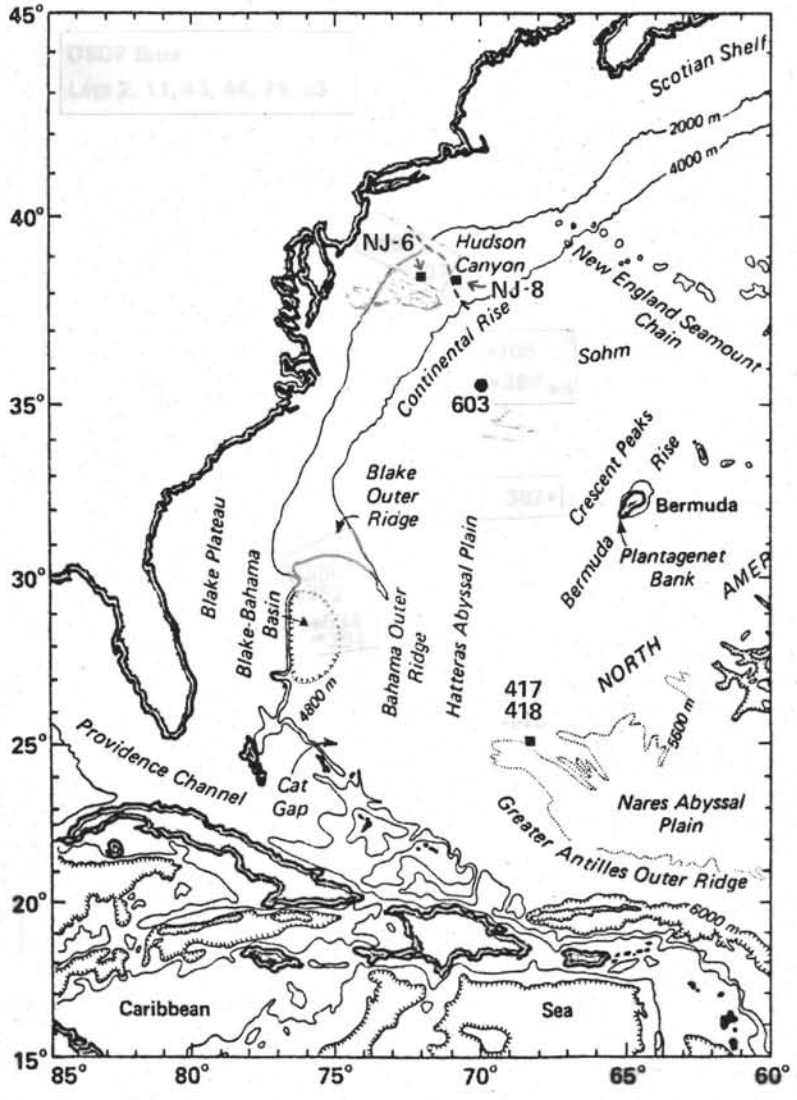

Figure 1. Location of sites to be drilled on Leg 102 and reference sites discussed in text.

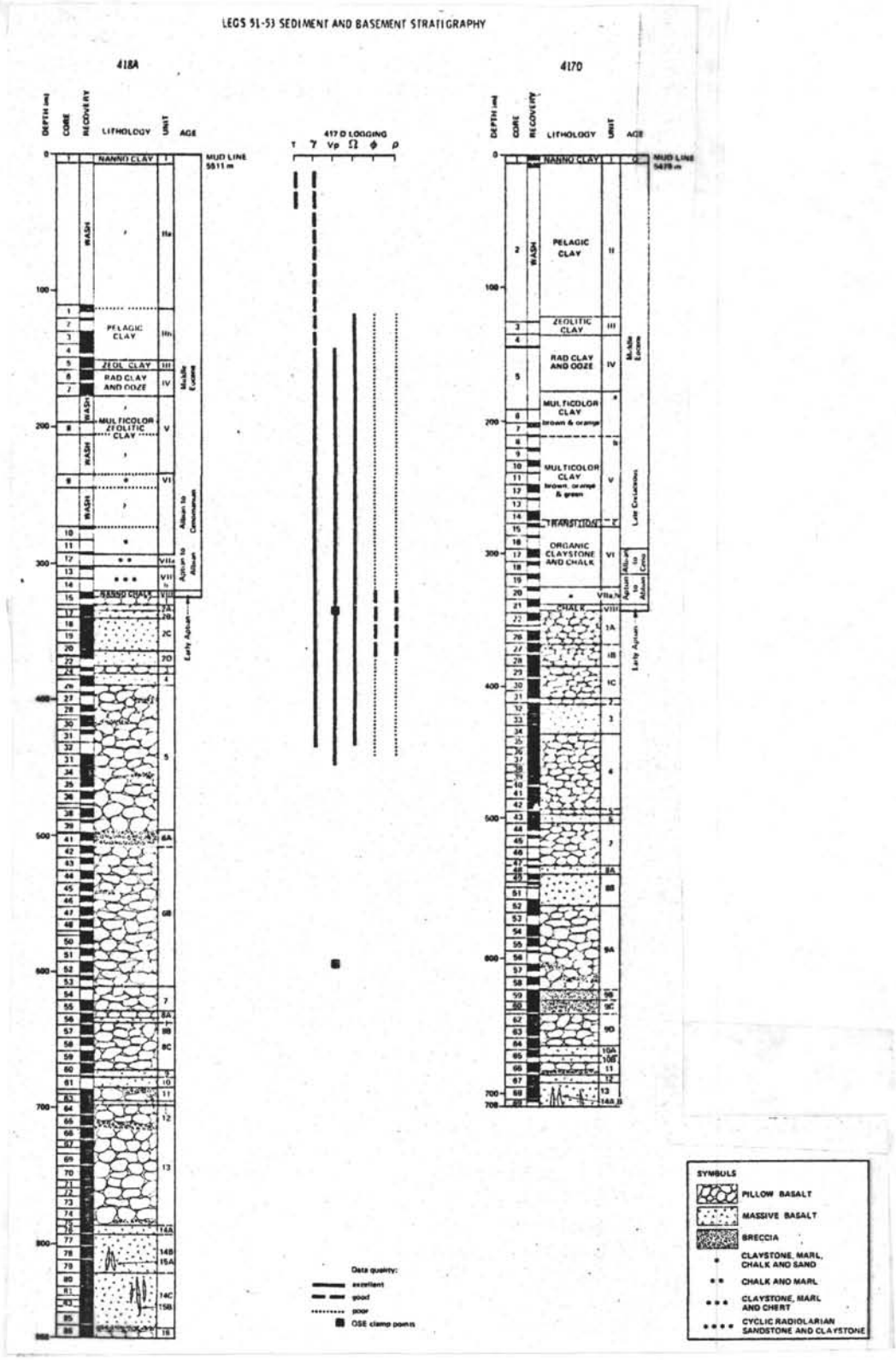

Figure 2. Lithology versis depth in Holes 417D and 418A. Also shown are the intervals logged in Hole 417D on Leg 51 and the positions of the geophone during the oblique seismic experiment on Leg 52. T, , Vp, Ω, ϕ, and ρ stand for the temperature, natural gamma ray, velocity, resistivity, porosity, and density logs, respectively.

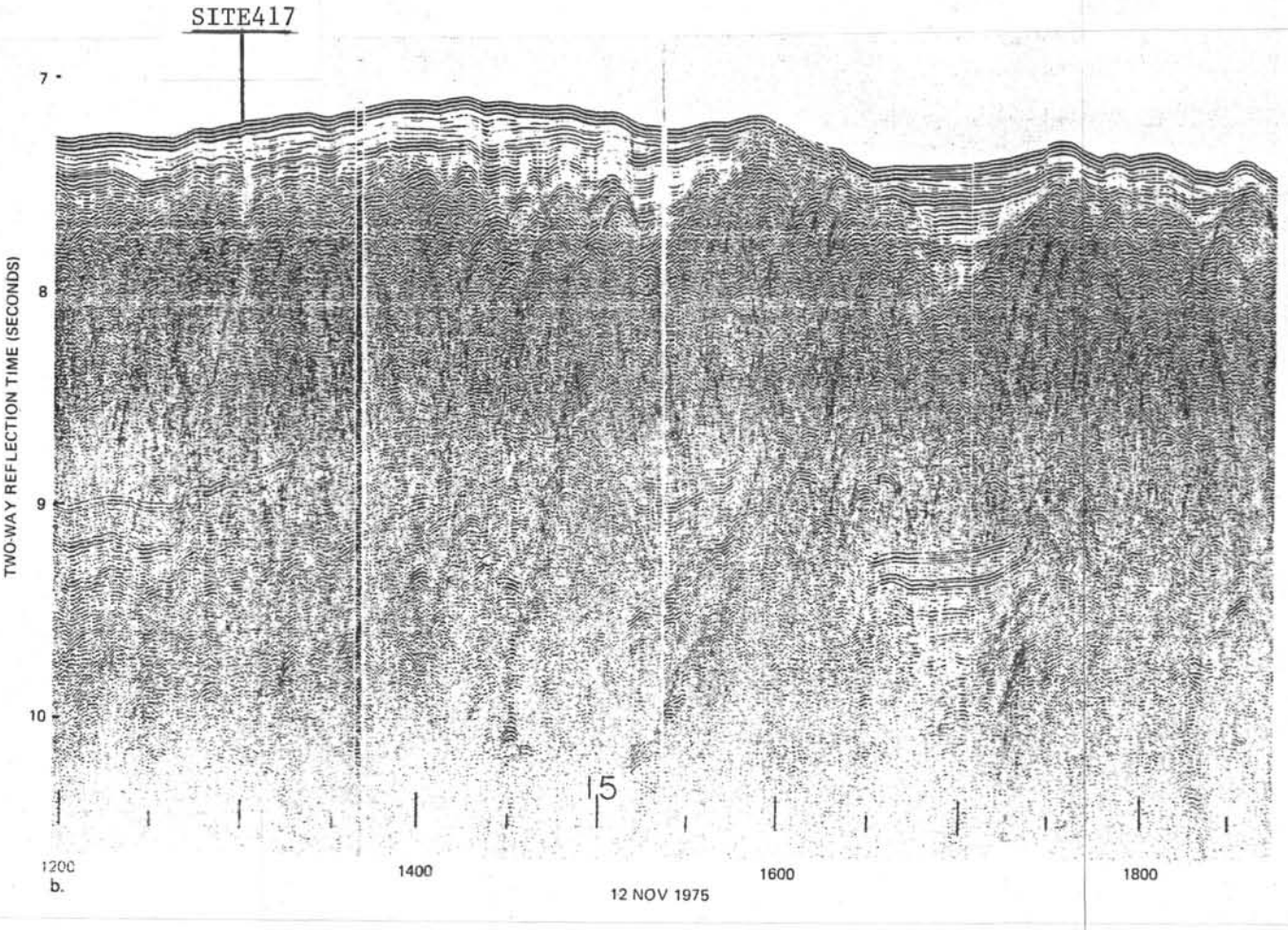

Figure 3. Seismic reflection profiler record collected aboard R/V Robert D. Conrad cruise 1903 with Site 417 location. Airgun sound source. Vertical scale in seconds of two way reflection time. Horizontal scale: one hour represents about 10 km.

SITE NUMBER: 418A (Bermuda Rise)

POSITION: 25 02.10'N 68 03.44W

SEDIMENT THICKNESS: 324 m

WATER DEPTH: 5511 m

PRIORITY: 1

PROPOSED DRILLING PROGRAM:

Re-enter and fish logging tool from hole; conduct logging, downhole experiments and two-ship seismic experiment with R/V Fred more; deepen hole if time available.

SEISMIC RECORD:

D/V Glomar Challenger Leg 52, 10 Feb 1977, 0943 hr.

OBJECTIVES:

1. Acquire baseline suite of borehole geophysical data in old oceanic crust.
2. re-open hole for eventual deepening.

HEAT FLOW: Yes

LOGGING: Yes

SEDIMENT TYPE:

0-868 m: Drilled on Legs 52 and 53 (see Fig. 2)
>868 m: Dike transition zone.

SITE NUMBER: 417D

POSITION: 25 06.69'N 68 02.81'W

SEDIMENT THICKNESS: 343 m

WATER DEPTH: 5479 m

PRIORITY: 2 (alternate to 418A)

PROPOSED DRILLING PROGRAM:

If logging tool cannot be fished from Hole 418A re-enter and clean to top of bottom hole assembly; conduct the same logging and experiment program as planned in Hole 418A.

SEISMIC RECORD:

D/V Glomar Challenger Leg 51, 2 December, 1976, 1810 hr.

OBJECTIVES:

1. Acquire baseline suite of borehole geophysical data in old oceanic crust.

HEAT FLOW: Yes

LOGGING: Yes

SEDIMENT TYPE:

0-708 m: Drilled on Legs 51 and 52 (see Fig. 2)

SITE NUMBER: 603 (North American Basin)

POSITION: 35 30'N, 70 02'W SEDIMENT THICKNESS: 1815 m

WATER DEPTH: 4616 m PRIORITY: 2

PROPOSED DRILLING PROGRAM:

Wash and drill single bit hole to 1500 m; conduct logging and vertical seismic profiling.

SEISMIC RECORD:

R/V Conrad 21, Leg 1, MCS line 77, 23 September 1977, 1731 hr.

R/V Knorr 80, MCS regional survey.

R/V Fay regional surveys.

OBJECTIVES:

Wash and drill single bit hole to 1500 m; conduct logging and vertical seismic profiling.

SEISMIC RECORD:

R/V Conrad 21, Leg 1, MCS line 77, 23 September 1977, 1731 hr.

R/V Knorr 80, MCS regional survey.

R/V Fay regional surveys.

OBJECTIVES:

1. Correlate logging and VSP results with results of detailed seismic stratigraphy experiments conducted in the vicinity of the site after Leg 93.

HEAT FLOW: Yes

LOGGING: Yes

SEDIMENT TYPE:

0-1585 m: Drilled on Legs 93 and 95 (see Fig. 6).
>1814 m: Jurassic (Callovian?) basalt.

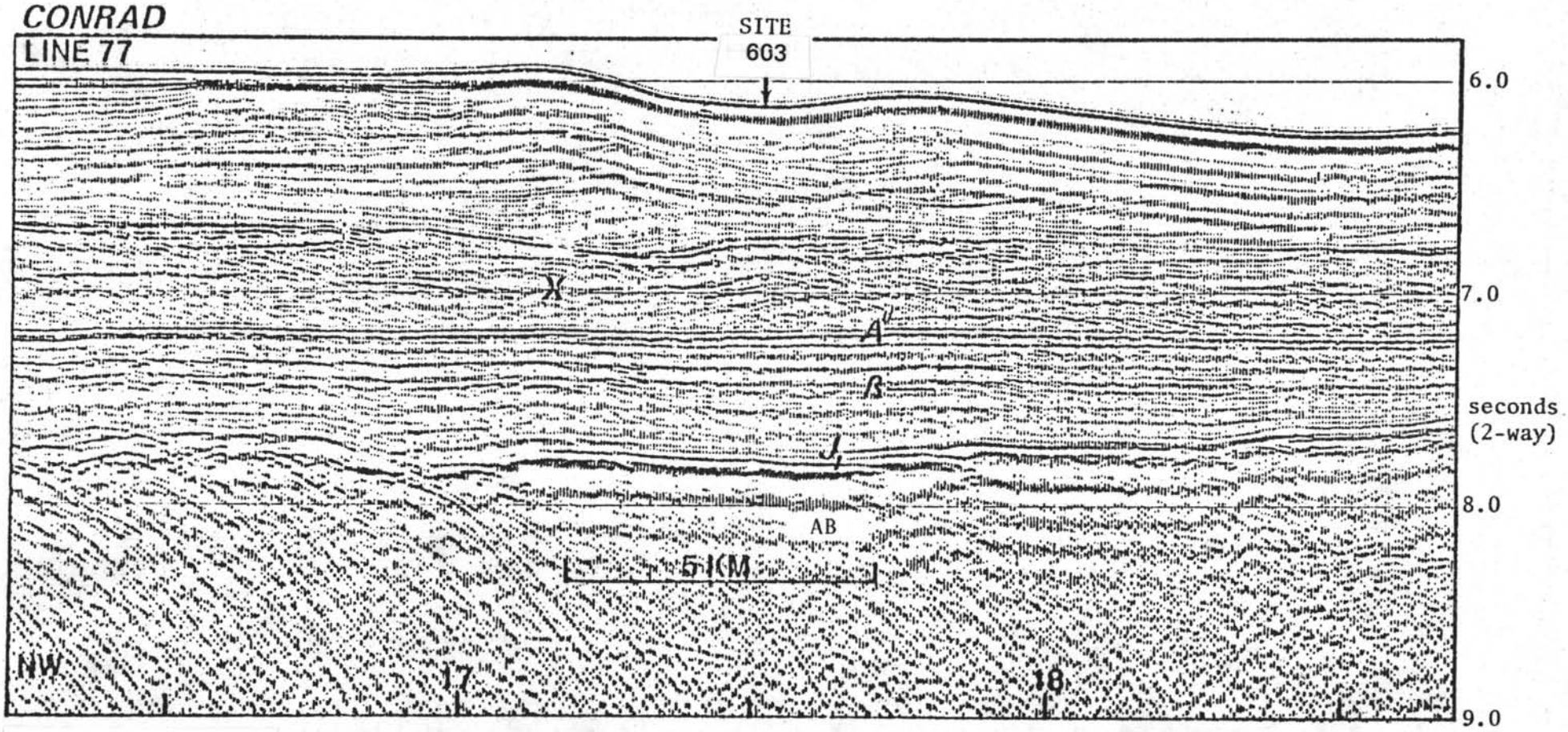

Figure 4. Multichannel seismic reflection profile showing location of Site 603 R/V *Conrad* 21, Leg 1, MCS line 77, 23 September 1977, 1731 hr. X, A^u, β and J, represent prominent reflectors. AB represents acoustic basement.

SITE NUMBER: NJ-8 (Hudson Canyon)

POSITION: 38 42'N, 71 02'W SEDIMENT THICKNESS: 750 m

WATER DEPTH: 3000 m PRIORITY: 2

PROPOSED DRILLING PROGRAM:

Core and log continuously into basement

SEISMIC RECORD:

R/V Knorr 80, 16 August 1980, 0210 hr.

R/V Gyre 81-13, line 1B, 25 August 1981, 2315 hr.

R/V Conrad 21-01, 19 September 1977, 2000-2200 hr.

OBJECTIVES:

1. Sample basement of buried seamount in jurassic inner magnetic quiet zone to determine origin of low amplitude Jurassic anomalies.
2. Determine the spreading rate and subsidence history of the quiet zone from the age and nature of the sediments overlying the seamount.

HEAT FLOW: Yes

LOGGING: Yes

SEDIMENT TYPE:

0-750 m: Neogene pelagics overlying a thin cap of possible shallow water limestones of Cretaceous-Jurassic age.
>750 m: Basalt or granite.

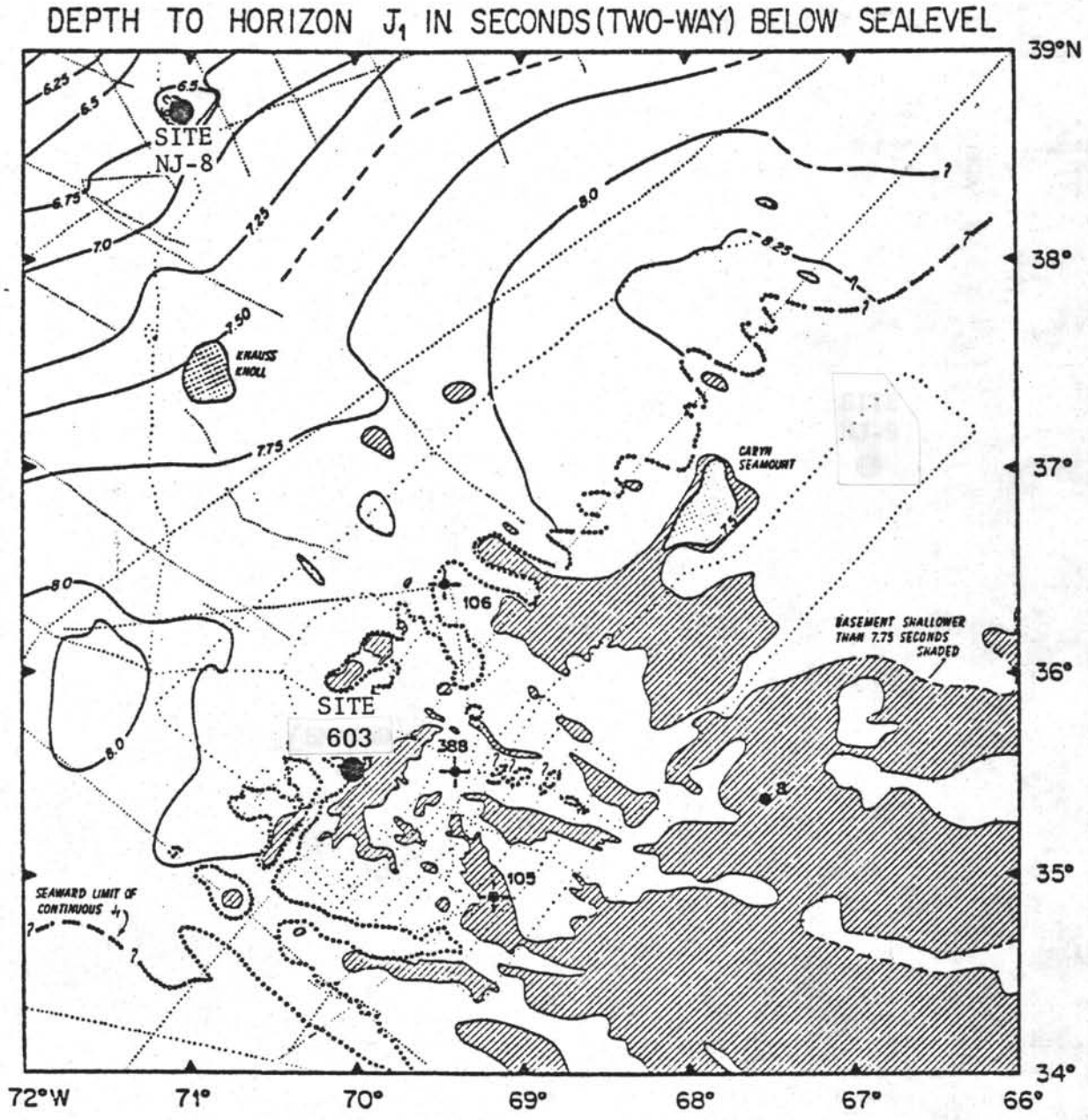

Figure 5. Location of Site 603 and alternate Site NJ-8 with respect to basement high (hashured) and seaward limit of J_1 reflector.

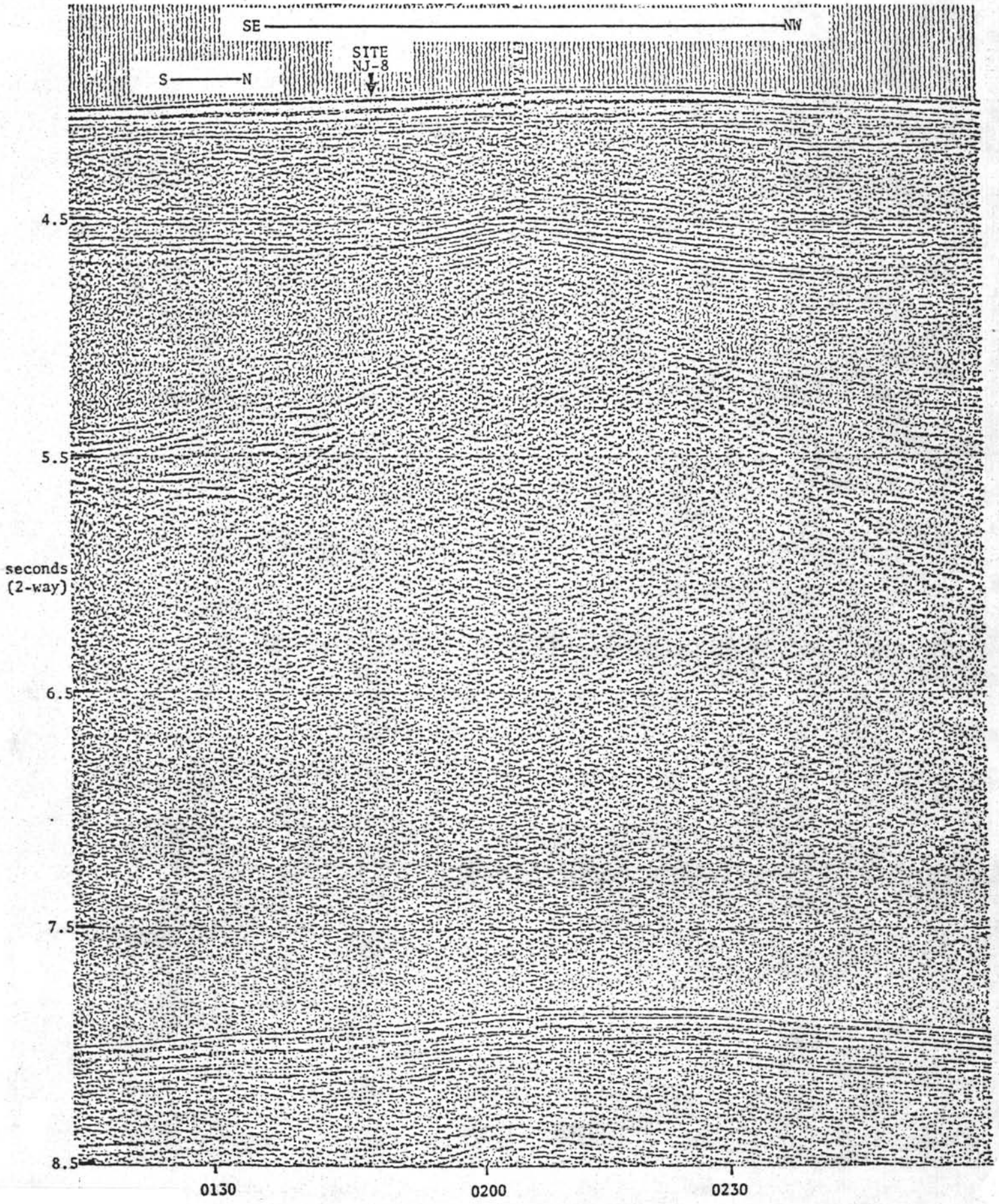

Figure 6. Multichannel seismic reflection profile showing location of alternate Site NJ-8. R/V *Knorr* 80, 16 August 1980.

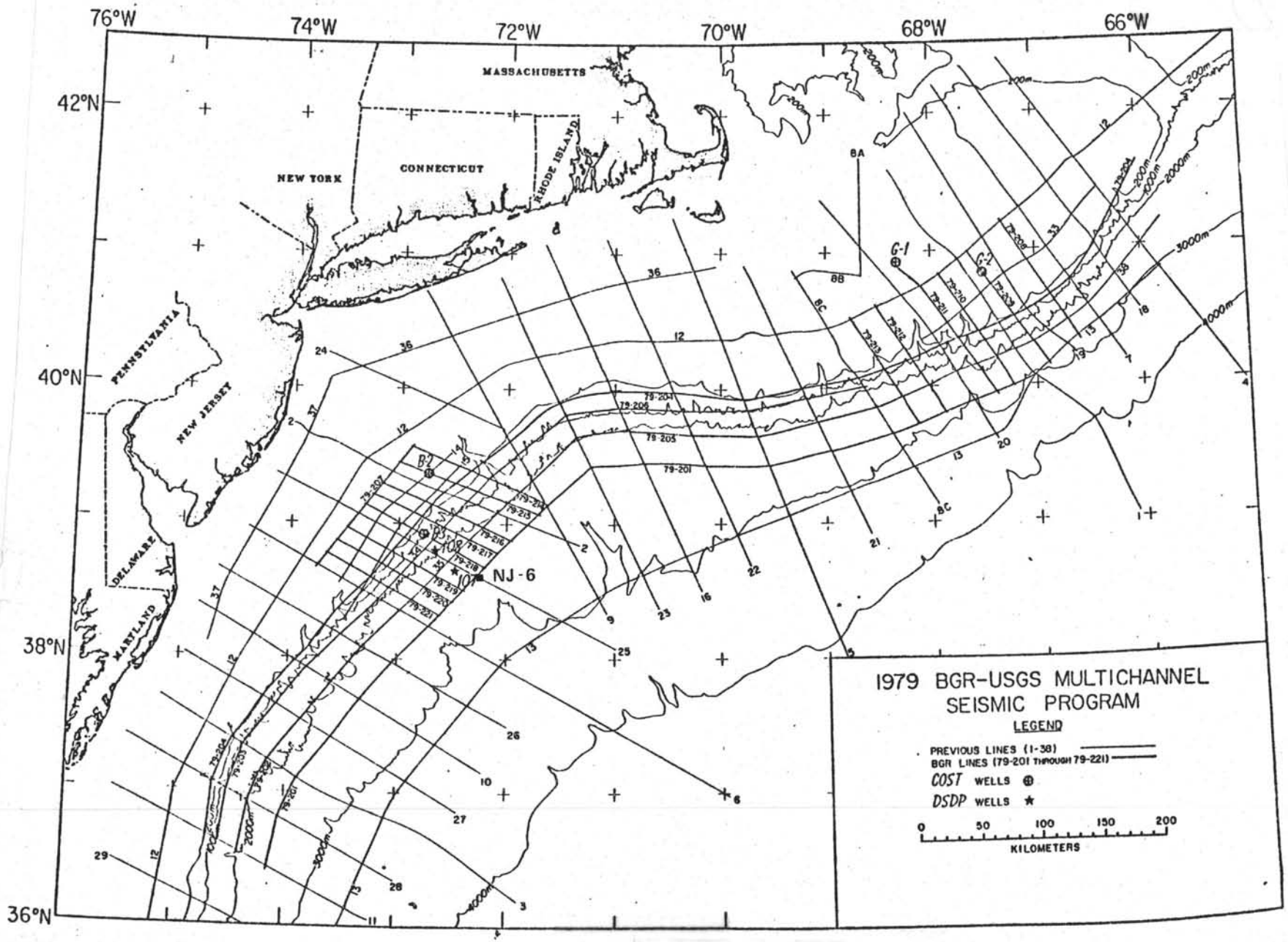

Figure 7. Location of Site NJ-6.

SITE NUMBER: NJ-6

POSITION: 38 37'N 72 17.3'W

SEDIMENT THICKNESS: 8-9 km

WATER DEPTH: 2387 m

PRIORITY: 2

PROPOSED DRILLING PROGRAM:

Core and log continuously to 1000 m

SEISMIC RECORD:

USGS line 25 (shotpoint 4000)

BGR line 201 (shotpoint 10880)

OBJECTIVES:

1. Determine Oligocene to recent sedimentation history of upper continental rise off New Jersey.
2. Correlate recovered lithology with seismic stratigraphy

HEAT FLOW: Yes

LOGGING: Yes

SEDIMENT TYPE:

0-320 m: Sand and silty clay of Pliocene-Quaternary age.
320-800 m: Sand, conglomerate and silty clay of late(?) and early(?) Oligocene-late Miocene age.
800-1000 m: Late (?) Eocene biosiliceous nannofossil chalk and limestone.

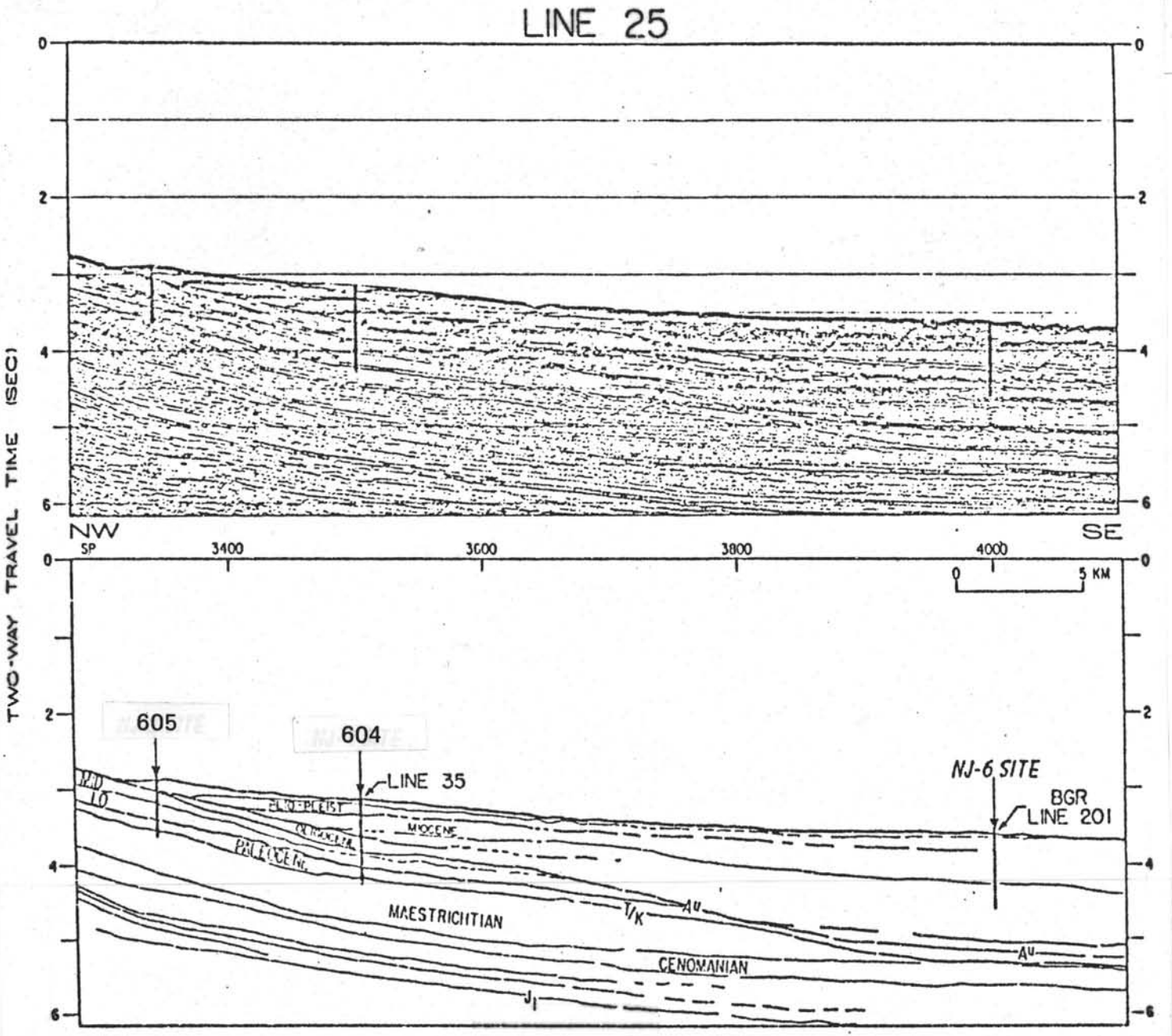

Figure 8. Location of Site NJ-6 and DSDP Sit4s 604 and 605 on USGS line 25.

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