12. SITE SURVEY REPORT FOR SITE 142

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INTRODUCTION

In August of 1970, on a leg from Trinidad to the Ivory Coast, the R/V *Robert D. Conrad* completed a survey on the southern edge of the Ceara Rise (Figure 1) in preparation for drilling which took place the following November. The primary purposes of the survey were to locate the optimum site for drilling into the abyssal plain sediments and rise flank and to provide a regional geologic setting to aid in the interpretation of the drilling results. A tentative site had originally been chosen on the basis of data collected during the R/V *Vema* Cruise 25. These data are also included in this report.

REGIONAL SETTING

The Ceara Rise is a large topographic feature and has a known areal extent in excess of 5000 square miles. As shown in Figure 1, the rise lies to the northeast of the mouth of the Amazon River and is the physiographic division between the Ceara Abyssal Plain to the south and the Demerara Abyssal Plain to the north and northeast (Heezen and Laughton, 1963). The southern edge of the Ceara Rise lies about 100 miles due north of the North Brazilian Ridge described by Hayes and Ewing (1970).

We mapped the rise primarily on the basis of the characteristic sediment sequence observed on the reflection records. This sediment sequence has a subsurface extent which is somewhat larger than the topographic feature. For instance, the separation of the rise into two pieces (see Figure 1) may only be superficial; there is some indication that these two segments are connected beneath the Pleistocene abyssal plain sediments. Figure 2a illustrates the track line configuration of the detailed survey.

TOPOGRAPHY

Figure 2b is a topographic map of the detailed survey area. The southern edge of the rise in this area is outlined by the 2290-fm contour. The total relief in this area is about 600 fm. The main features of interest are (1) the northwest-southeast trend of the topography of the rise, (2) the steep southern flank of the rise particularly in the region from about 42° 50'W to 43° 20'W, (3) the subtle depressions in the abyssal plain which may mark the paths of sediment transport, (4) the topographic terrace developed between the 2000- and 2100-fm contours on the southwestern "corner" of the rise, and (5) the unusual microtopography found in selected areas.

GRAVITY AND MAGNETICS

Figures 2c and 2d show, respectively, the free-air gravity and the residual total intensity magnetic anomalies for the survey area. The gravity anomalies tend to coincide with the regional topography and the magnetic anomalies, which are a maximum of about 500 gammas peak to peak, are readily contoured subparallel to the topographic trend of the ridge. The basement cannot be followed from the plain onto the rise, thus making the interpretation of the gravity and magnetic observations more difficult. Strong indications of occasional reflections from the basement are observed on the seismic profiles, and the presence of relatively high-amplitude, lineated magnetic anomalies support the suggestion that magnetic basement is not deeply buried. The free-air gravity anomaly associated with the rise (20 mgal/km of rise) is significantly smaller (by about 20 mgal) than that expected either from an uncompensated sediment pile or from an uncompensated basement ridge covered with sediment. This observation implies some gravimetric compensation at depth, but further speculation regarding the details of the underlying crustal configuration is unwarranted without further knowledge of the basement trends.

SEISMIC REFLECTION RECORDS

Low-frequency air gun reflection records over the rise (Figures 3-5) typically show a pile of sediments which has a minimum thickness of 1 km. Basement (Layer 2) was recorded only intermittently in the survey area as illustrated at miles 2132 and 2237 (Figure 4). Figure 1 shows the locations of such possible basement highs throughout the rise, and they appear to trend roughly along the topographic high. In some places, such as mile 2073 in profile B-C (Figure 3), the steep scarp may be controlled by the basement relief. A large positive magnetic anomaly is also present along this scarp region as shown in Figure 2c.

Several sediment units which form the abyssal plain characteristically contain many closely-spaced reflectors, whereas, the rise sediment sequence is mostly acoustically homogeneous, containing only intermittent diffuse reflectors. However, seismic penetration of the rise sequence is less than that of the abyssal plain, indicating more energy attenuation by the rise sediment at this recording frequency.

Profiles A-B, B-C (Figure 3), and C-D (Figure 4) show the typical abyssal plain sequence in the area. There is an upper reflective zone, then a more transparent zone, then another reflective zone. This is followed by a transparent zone and finally a faint reflective zone which seems to lie close to basement. The top of the second reflective zone defines a prominent reflector which has been continuously mapped by Hayes and Ewing (1970) through all of the Ceara Abyssal plain except its extreme southwestern portion.

[1]Contribution No. 1817

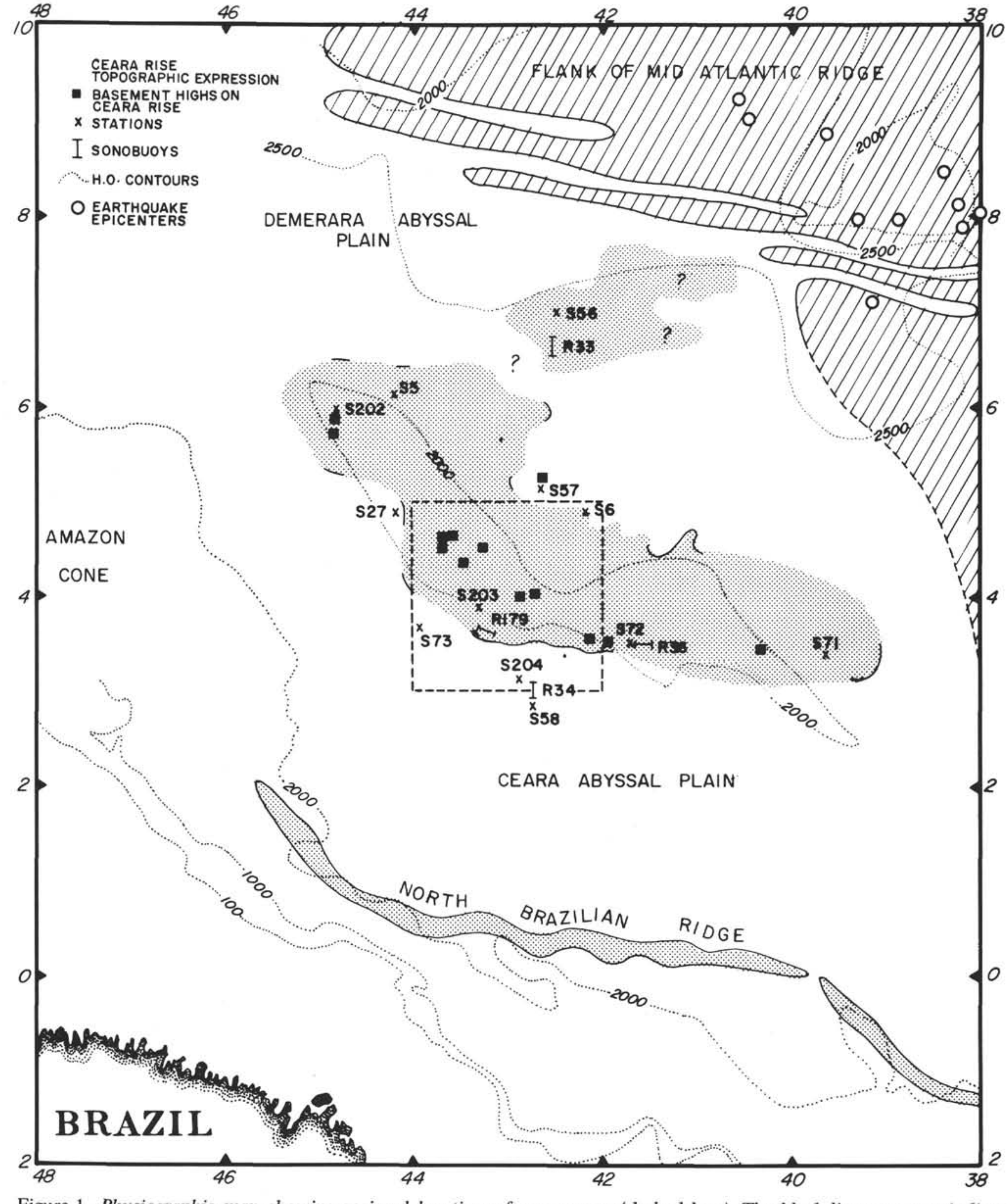


Figure 1. *Physiographic map showing regional location of survey area (dashed box). The black line segments indicate profiler crossings. The fracture zones to the north are after Fox (1972), and the epicenters are the courtesy of Lynn Sykes. Contours are from USNAVOCEANO map 15254-7 Misc. The structural outline of the North Brazilian Ridge is from Hayes and Ewing (1970).*

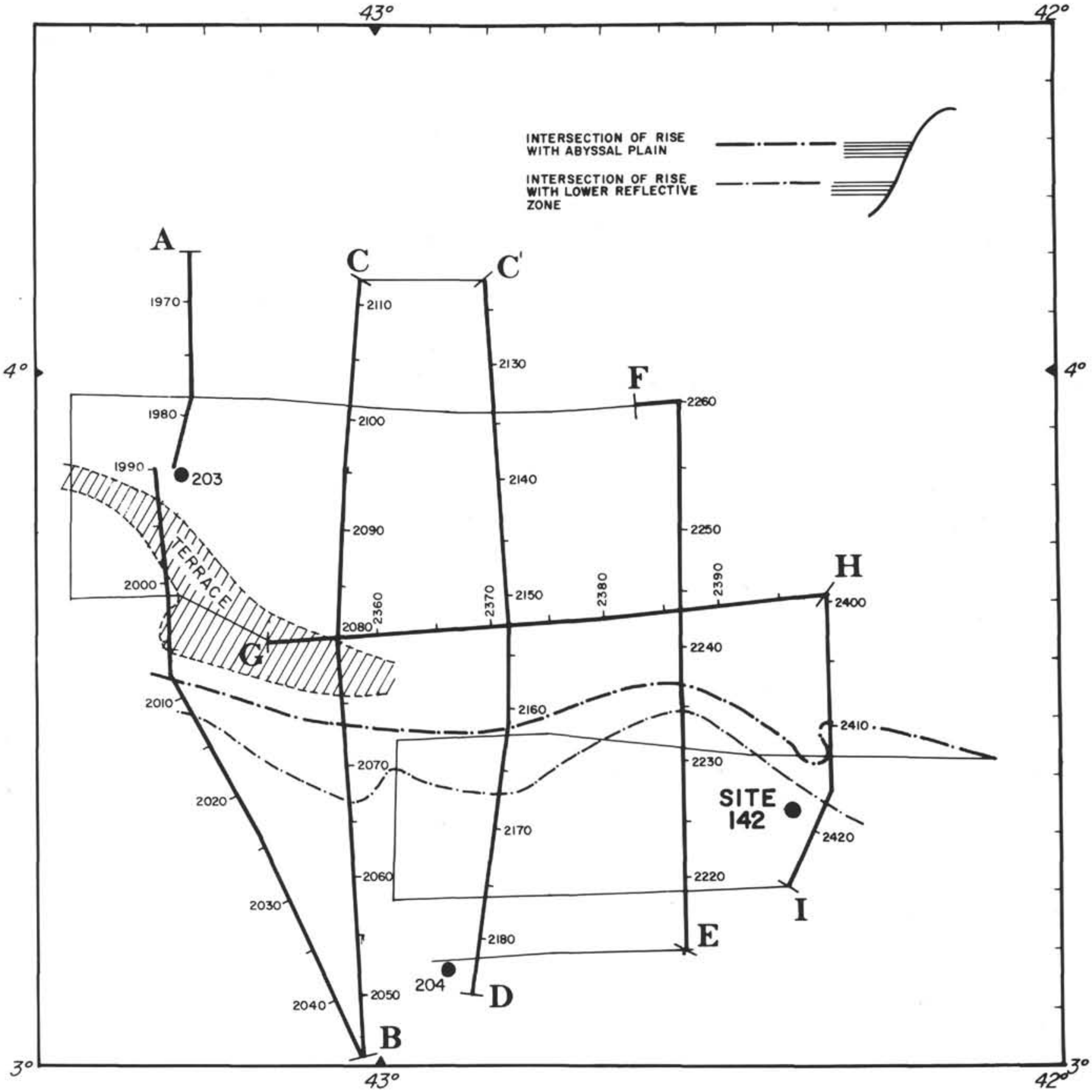


Figure 2a. *Physiographic and profiler location map for Site 142 survey area. Numbers beside track are miles along the track for that leg of the R. V.* Conrad *and concur with the mileage for Figures 3-6.*

As seen in all the profiles, but most clearly illustrated in E-F (Figure 4) and G-H-I (Figure 5), the upper reflective zone onlaps the rise sequence. The relationship of the upper transparent zone and intermediate reflective zone is not so clear. However, many profiles indicate a slight apparent shoaling of the top of the second reflective zone towards the rise, and profile E-F (Figure 4) strongly suggests continuity of these two acoustic intervals (not necessarily lithologic) from the plain onto the rise. Profile G-H-I (Figure 5) also illustrates this.

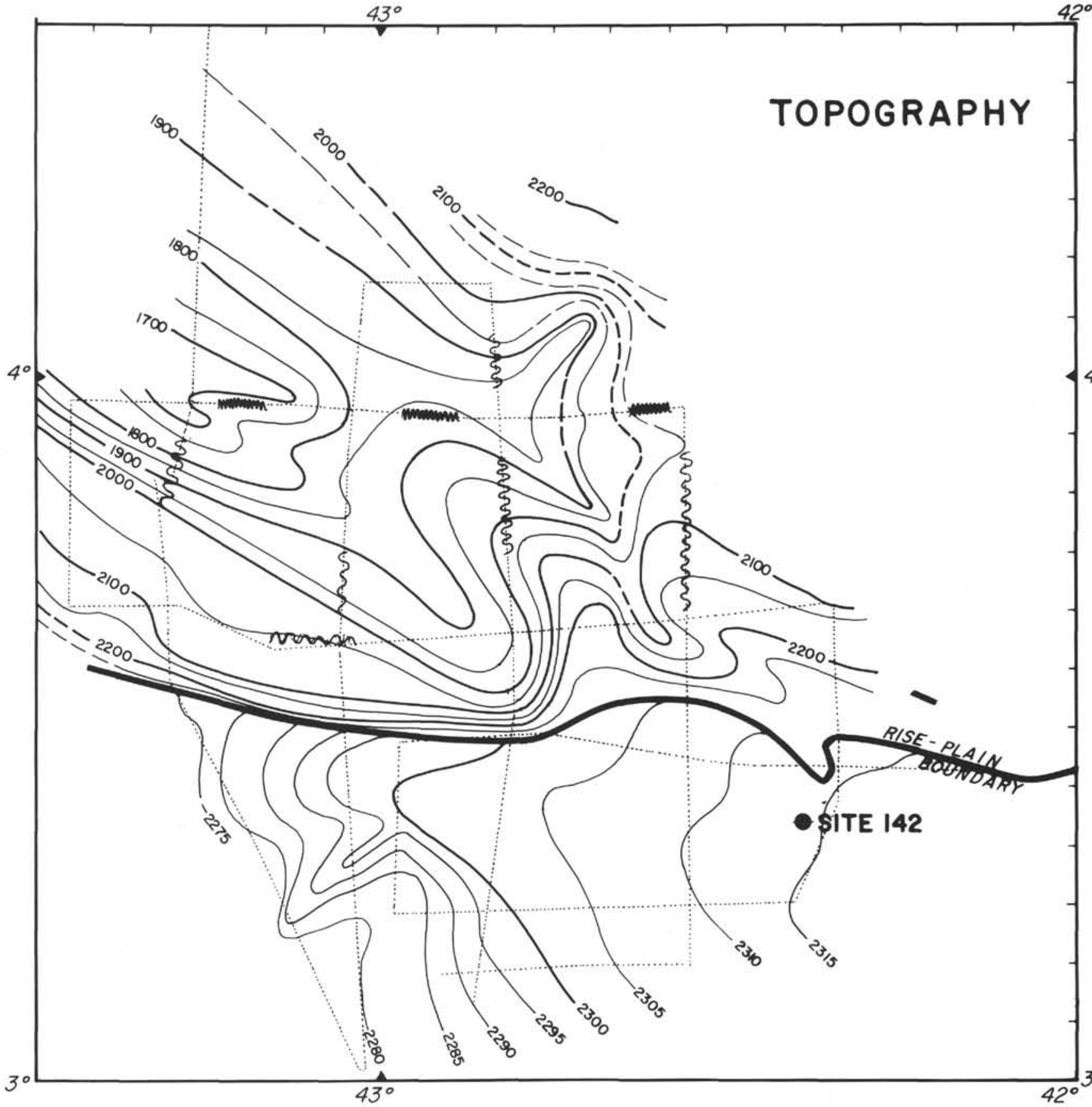


Figure 2b. *Bathymetric map for the survey area. The contour interval over the rise is 50 fm (uncorrected) and over the abyssal plain is 5 fm. The wiggly lines along the track indicate the presence of hyperbolated bottom which is discussed in the text and seen in Figures 3 and 6. The short wiggles indicate wave lengths on the order of 100 to 150 meters, and the long wiggles on the order of 200 to 300 meters.*

A sonobuoy (RC13-179, Table 1) shot on the terrace-like feature, recorded a sequence of low-velocity sediments overlying material with a refraction velocity of about 4.5 km/sec, which is high enough to be layer 2 (oceanic basalt). The depth of the 4.5 km/sec layer was close to that of the deepest reflector observed over the rise, which is best seen between miles 2387 and 2412 in profile G-H-I. This reflector may represent a unit which directly overlies and conforms to basement. Results of other sonobuoys in the area are shown in Table 1, and sonobuoy station R36 also indicates more than 0.9 km of low-velocity sediments are present on the rise.

The 3.5 kHz records taken over the rise intermittently record an interesting hyperbolated bottom. The wavelength of the hyperbolae (Figures 2b and 6) is distinctly longer for north-south tracks (200-300 m) than for those on an east-west heading (100-150 m), and on some of the later traverses their spacing is very regular. The slope directly to

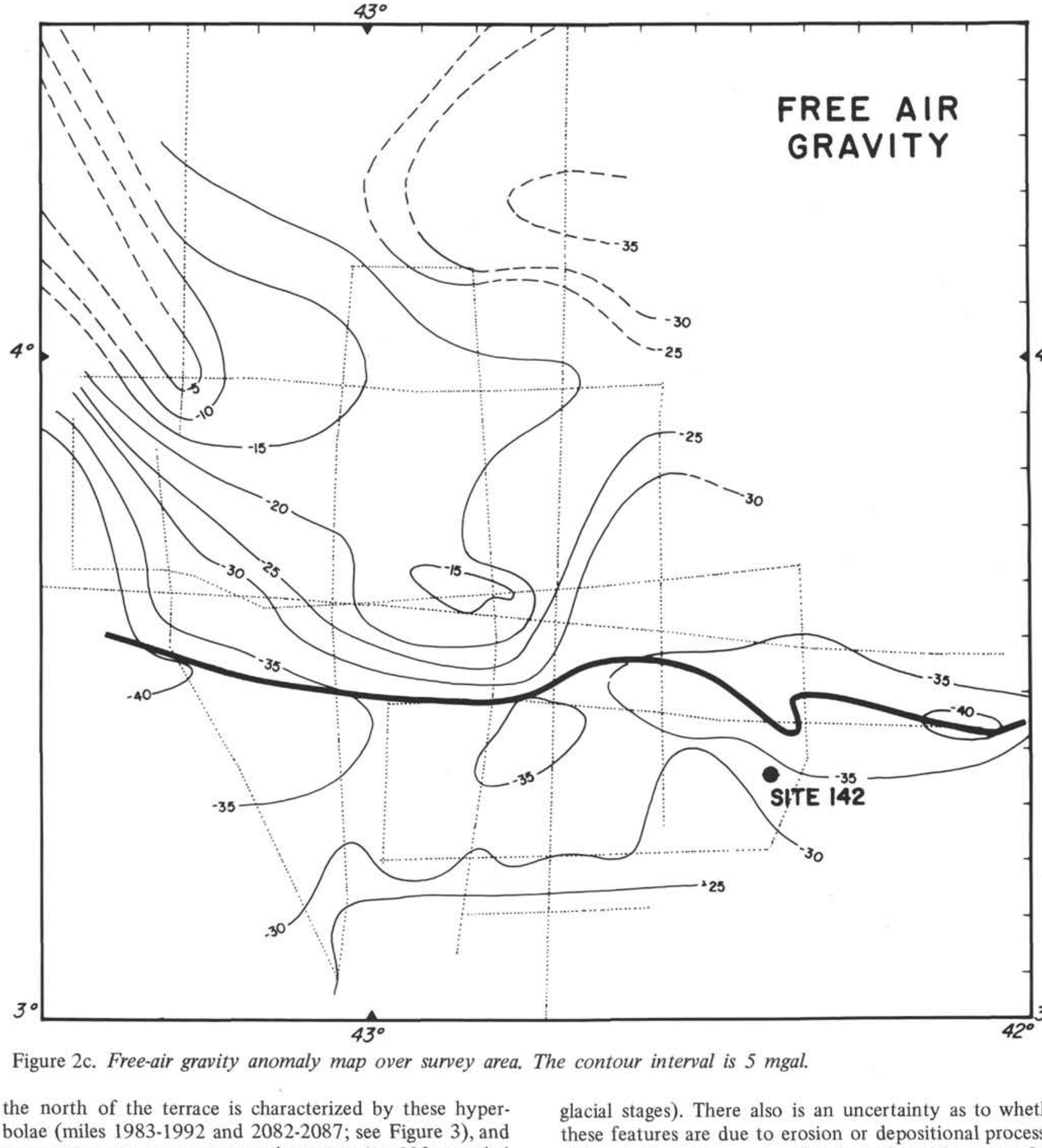


Figure 2c. *Free-air gravity anomaly map over survey area. The contour interval is 5 mgal.*

the north of the terrace is characterized by these hyperbolae (miles 1983-1992 and 2082-2087; see Figure 3), and a current meter measurement taken at station 203 recorded a southwesterly bottom current of 11 cm/sec. The origin of this bottom type is undoubtedly related to bottom currents (North Atlantic Deep Water), but the details of the process of formation of the micro-relief are more elusive. The current measurement suggests a contemporaneous formation; bottom photographs taken in the same locality show no convincing evidence for strong currents. However, the tangency of the hyperbolae to the present sea floor (in all but one case) implies an age probably no older than Pleistocene (the currents may have been stronger in the glacial stages). There also is an uncertainty as to whether these features are due to erosion or depositional processes, although the latter explanation is preferred because of the inferred periodicity of the features. The evidence for large-scale outcropping of older material on the southern edge of the rise (for example, Miocene age of piston core V25-62 and profile C-D, Figure 4) suggests erosional and/or tectonic processes for this section.

PISTON CORES

Locations of coring stations in the area are shown in Figure 1 and listed in Table 2. Cores taken in the surrounding abyssal plains typically show a series of latest Pleistocene

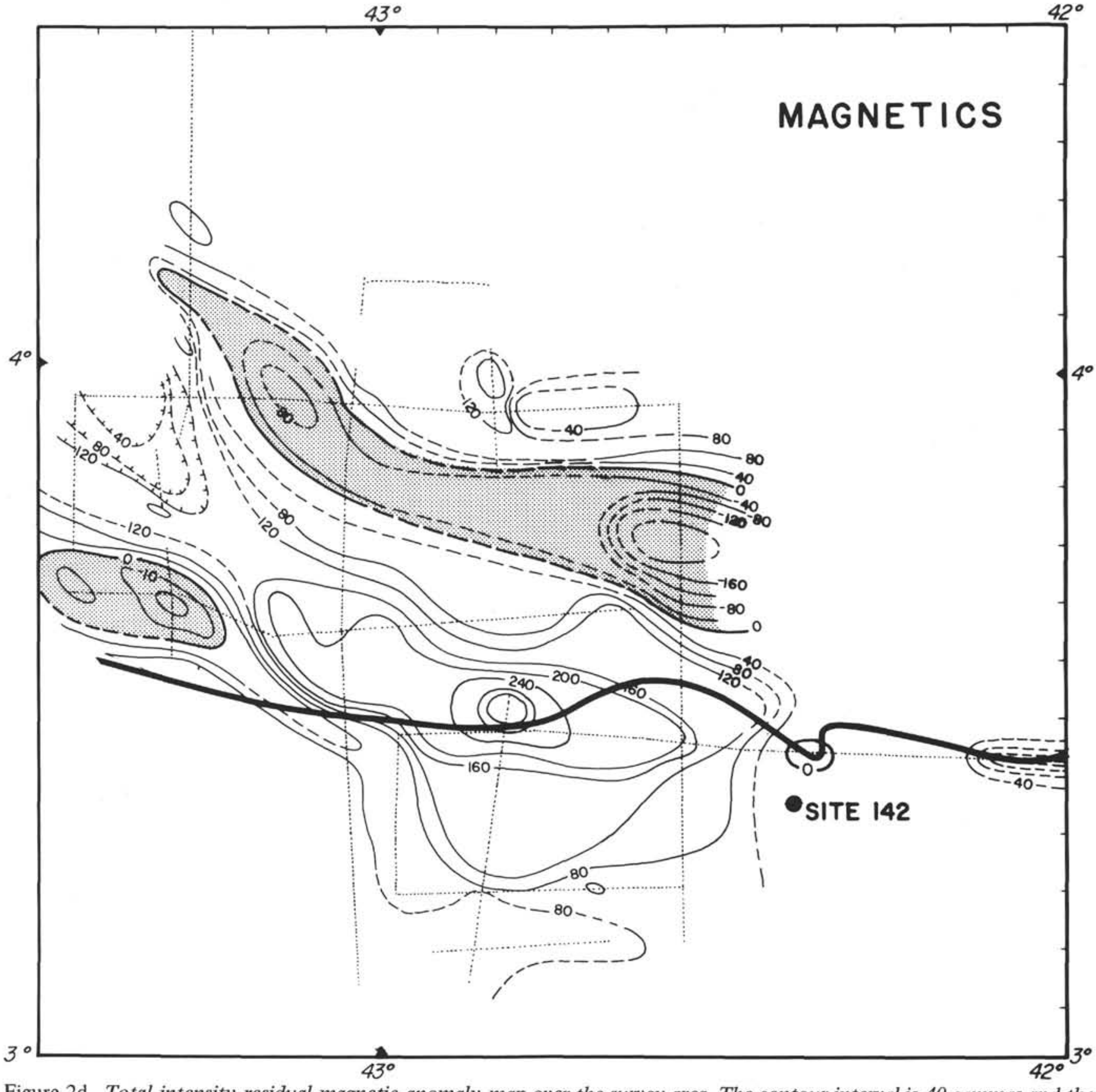
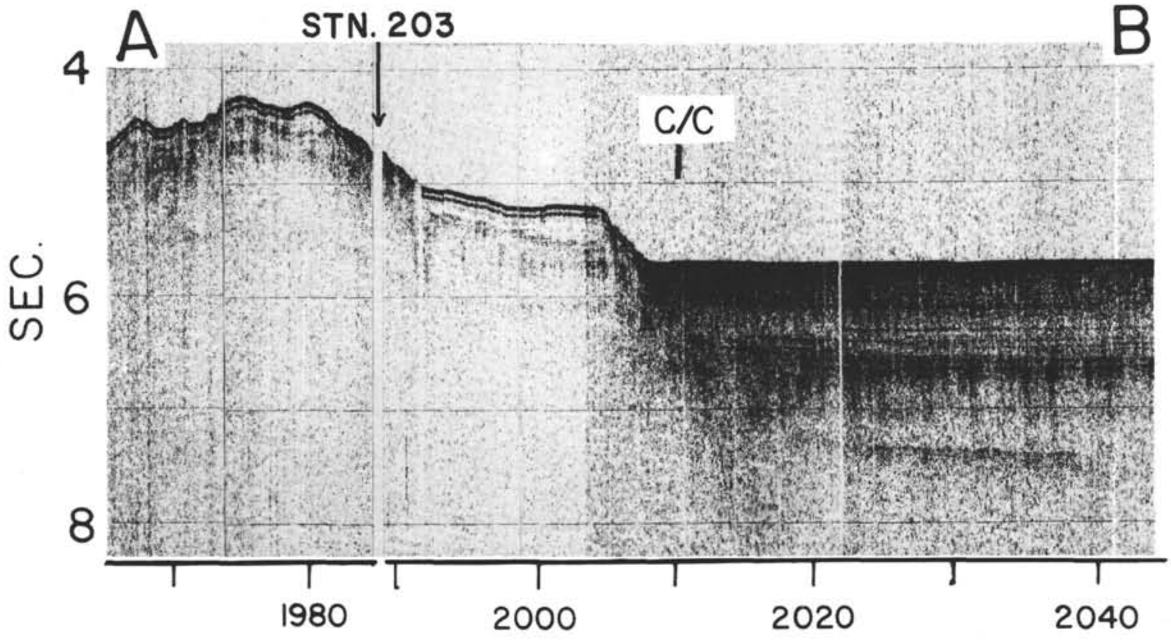


Figure 2d. *Total intensity residual magnetic anomaly map over the survey area. The contour interval is 40 gammas and the negative areas are indicated by stippling. The control here is less than for the gravity and topography because of instrumental problems.*

turbidites interlayered with gray hemipelagic clays overlain by 20 to 70 cm of brownish Holocene foraminiferal marl. In most cases there is a characteristic "rusty" zone at the Holocene-Pleistocene boundary (Damuth and Fairbridge, 1970). Cores taken on the southern part of the rise, in and near the survey area, are typically Holocene and late Pleistocene calcareous pelagic sediments (for example, cores V25-63, RC13-184). V25-62 contains latest Lower Miocene foraminiferal ooze that may be contemporaneous with some of the drilled section. (See Chapter 9, this volume.)

Cores taken on the northwestern flanks of the rise (RC8-5, RC13-183 and V25-47) at depths slightly shallower than the Demerara Plain to the north, contain terrigenous components. For example, RC8-5 has a 10-cm graded turbidite plus several thin sand-silt laminae consisting of quartz and feldspars (Damuth and Fairbridge, 1970). The material in these cores probably originated from the mouth of the Amazon River and reached this area by flow interaction between turbidity currents and bottom currents.



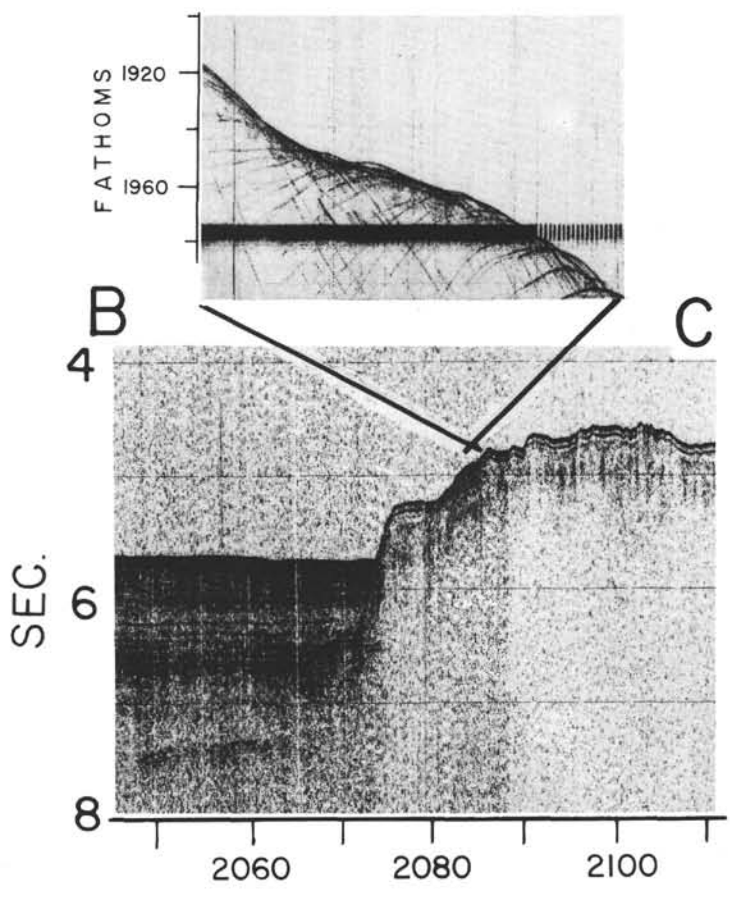


Figure 3. *Profiles A-B and B-C. See Figure 2a for location. The offset on profile B-C is a section of 3.5 kHz record showing the hyperbolated bottom. The vertical scale for the profiles is two-way travel time. c/c indicates a course change.*

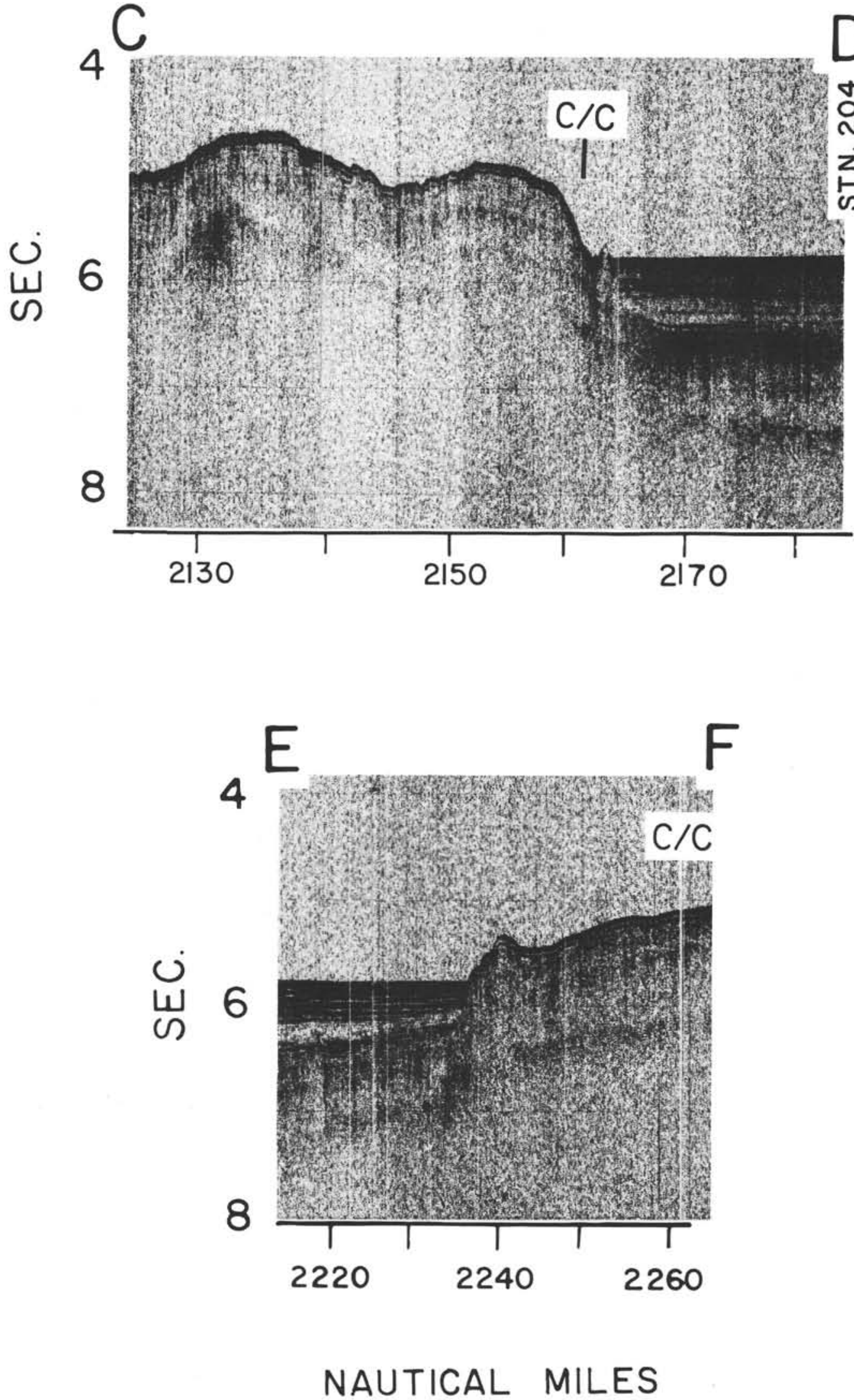


Figure 4. *Profiles C-D and E-F. See Figure 2a for their location.*

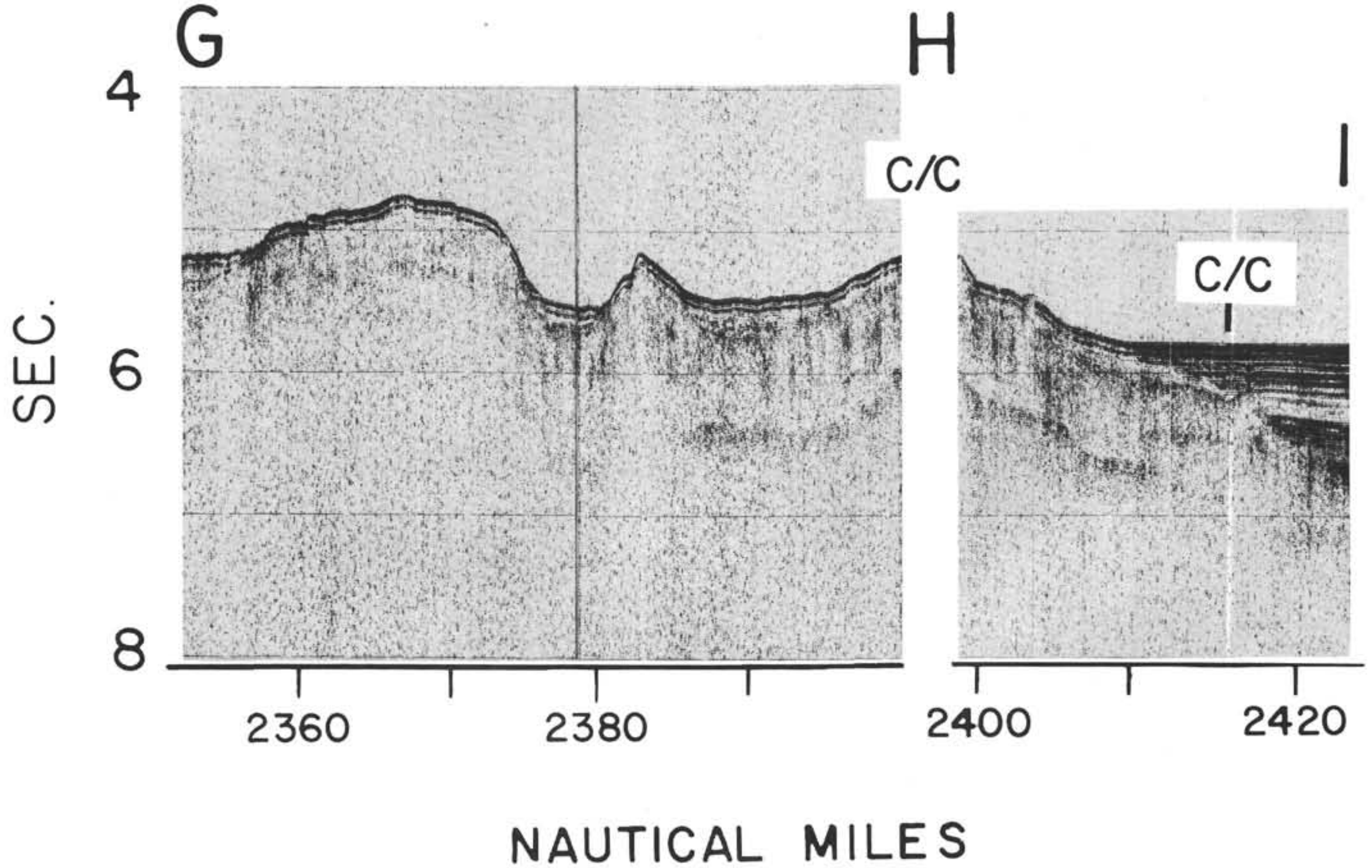


Figure 5. *Profile G-H-I. See Figure 2a for location.*

TABLE 1
Sonobuoys in the Vicinity of the Ceara Rise

Cruise	Buoy No.	Interval (sec)	Interval Velocity (km/sec)	Thickness (sec)
V25	R33	6.00-6.75	2.70	0.75
		6.77 Refraction	4.79	
V25	R34	5.73-6.20	1.66	0.47
		6.20-6.55	1.97	0.35
		6.55-7.10	2.20	0.55
V25	R36	4.54-5.06	1.70	0.50
		5.06-5.47	2.49	0.41
RC13	R179	5.202-5.934	1.955	0.73
		5.934-6.216	2.042	0.29
		6.216-6.431	2.841	0.21
		6.431-Refraction	4.50	

Core RC13-186 (Station 204, profile C-D) was taken on the Ceara Abyssal Plain within the survey area. The left side of Figure 7 shows the approximate acoustic sequence in which it was taken. The subbottom reflectors in this area are directly correlatable with sand layers sampled in the cores.

ACKNOWLEDGMENTS

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TABLE 2
Cores in the Vicinity of the Ceara Rise

Cruise	Station Number	Core Number	Length	Depth (fm)	Basal Age	Lithology[a]
V25	56	47	919	2420	Late Pleistocene	Foram marls with a few terrigenous silt and sand laminae (<5 cm).
V25	57	48	971	2500	Late Pleistocene	Brown foram marl with rusty zone at base (63-70 cm) overlying hempelagic clay with several terrigenous turbidites which are largely gray homogeneous clay with several silt-sand beds at bases.
V25	58	49	822	2292	Late Pleistocene	Brown foram marl with rusty zone at base (60 cm) overlying hemipelagic gray clay with interbedded graded sand/silt beds.
V25	71	62	345	2300	Miocene	Yellowish gray foram ooze. Semi-indurated
V25	72	63	780	1715	Late Pleistocene	Foram marls–no terrigenous components
V25	73	64	368	2255	Late Pleistocene	Brown foram marl with basal rusty zone (58 cm) over gray hemipelagic clay with several thin (< 5 cm) sand-silt beds.
V18	27	22	570	2207	Late Pleistocene	Brown foram marl with rusty zone (58 cm) over gray hemipelagic clay with several sand-silt beds, some graded, 5-130 cm.
RC8	5	5	803	2410	Late Pleistocene	Brown foram marl with basal rusty zone (45 cm) over gray hemipelagic clay with numerous thin sand-silt laminae, generally < 1 cm thick.
RC8	6	6	592	2422	Late Pleistocene	Brown foram marl with rusty zone (69 cm). Gray hemipelagic clay with a few sand silt lenses (< 1 cm thick).
RC13	202	183	1027	1990	Late Pleistocene	Brown foram marl with basal rusty zone (65 cm), overlying gray hemipelagic clay.
RC13	203	184	811	1840	Late Pleistocene	Light brown foram marls
RC13	204	185	896	2289	Late Pleistocene	Brown foram marl with rusty zone (48 cm) over gray hemipelagic clays with several sand-silt beds, many graded 5-170 cm thick.
RC13		186	630			Similar to 185

[a]All silt-sand layers mentioned are terrigenous.

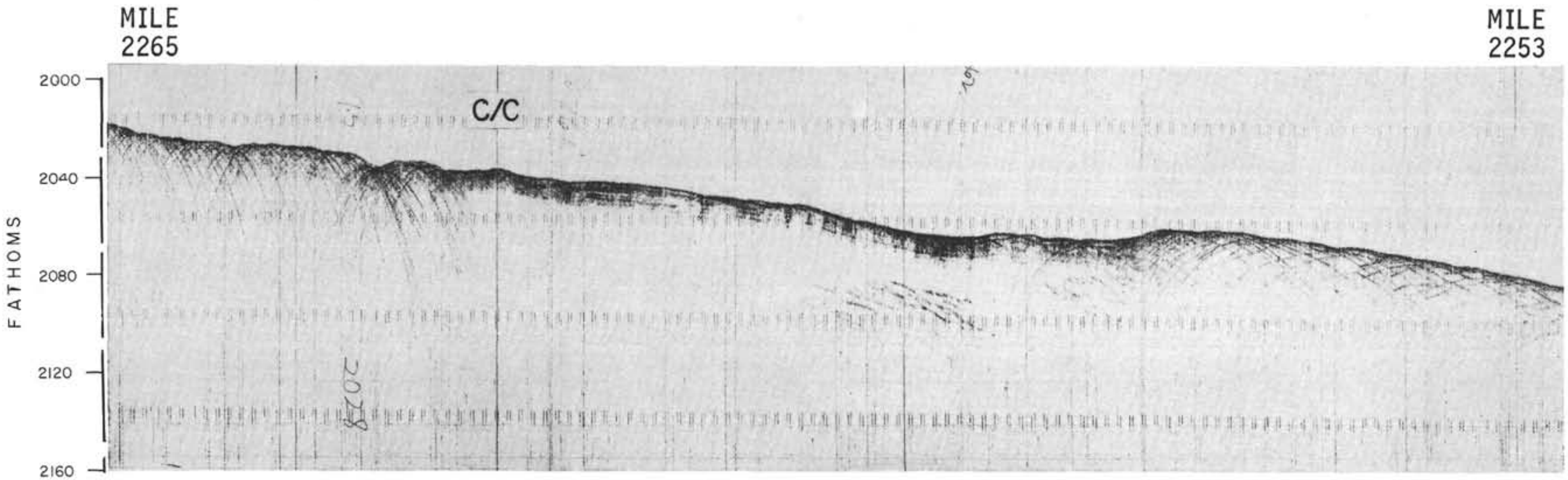

Figure 6. *3.5 kHz record on top of rise. See Figure 2a for location. Note the distinct shortening in wavelength after the course change.*

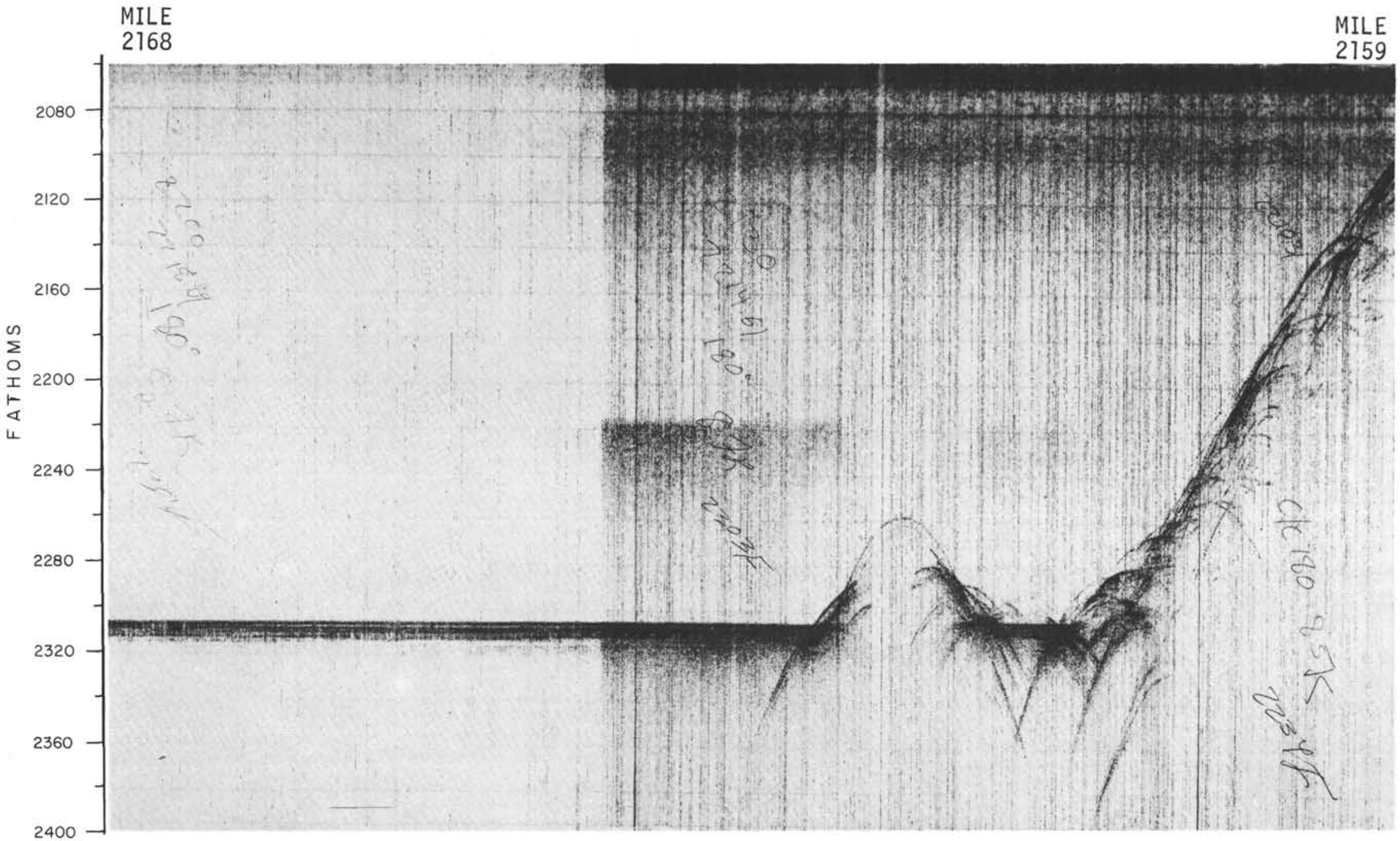

Figure 7. *3.5 kHz record of Ceara Abyssal Plain and adjacent southern flank of the Ceara Rise. See Figure 2a for location of profile.*