Hussong

A SEISMIC STUDY OF THE CRUSTAL STRUCTURE OF THE ONTONG JAVA PLATEAU AND NAURU BASIN

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ABSTRACT

Seismic refraction results were obtained from thirty sonobuoys deployed along a line extending from the Ontong Java Plateau to the Nauru Basin in the southwest Pacific. The thick sedimentary layer on the Plateau was seen to thin with increasing water depth. Layer 2A was detected neither on the Plateau nor in the Basin. A ubiquitous layer 2B was observed on the Plateau with a very consistent seismic velocity, averaging 5.5 km/sec, and thickness averaging about 4.7 km over most of the Plateau. Layer 2B was also observed in the Basin, with seismic velocity averaging 5.6 km/sec, and thickness averaging 2.5 km. Layer 2C, where observed on the Plateau, had an average seismic velocity of 6.3 km/sec. Layer 3, where observed in the Basin had an average velocity of 6.6 km/sec.

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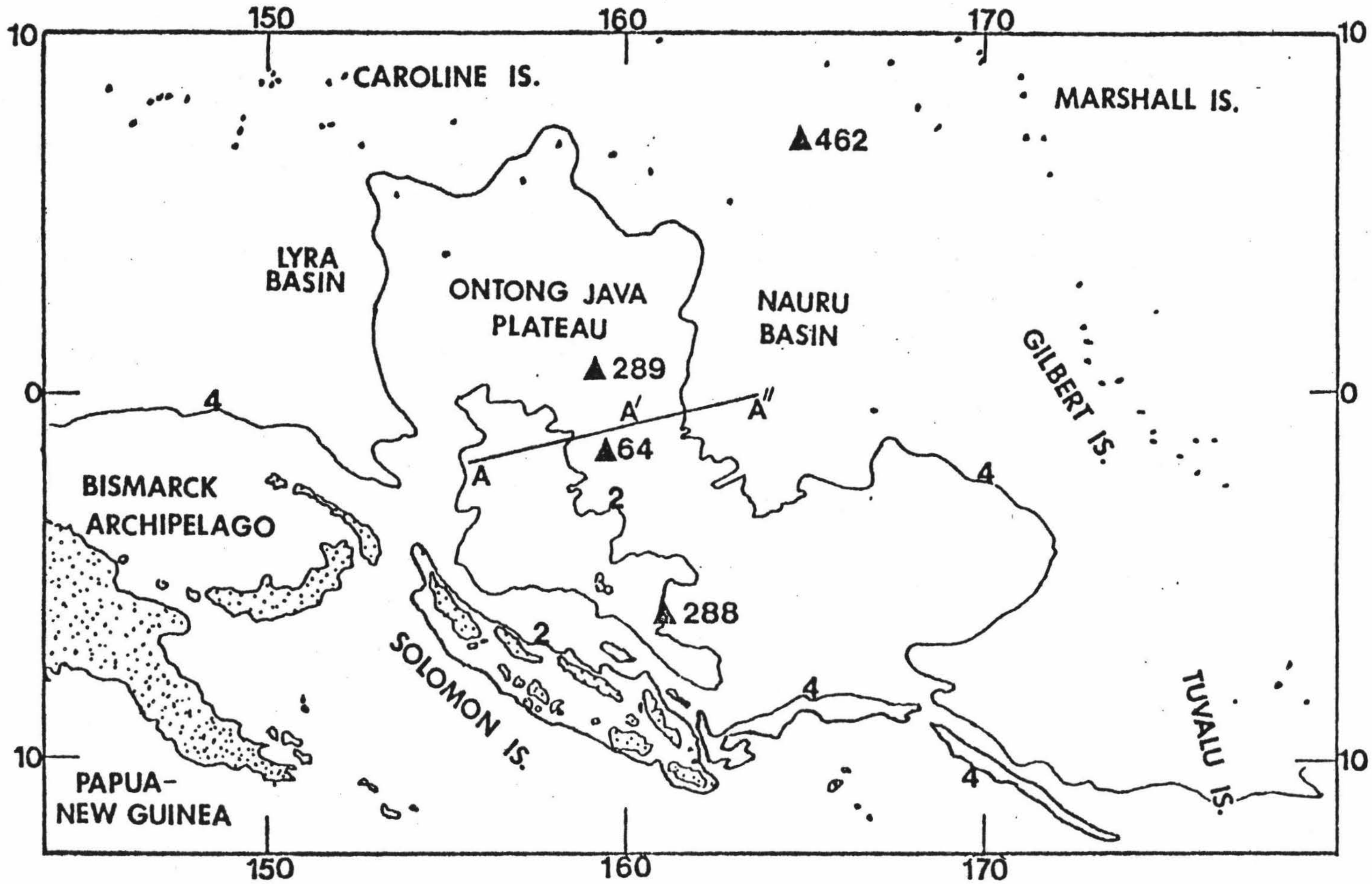
I. Introduction

In May, 1976 seismic refraction measurements were made across the northern Ontong Java Plateau and Nauru Basin by the R/V KANA KEOKI. Forty sonobuoys were deployed and data were obtained along a 930 km line (Fig. 1). The purpose of this study was to better define the seismic velocities of layers 2B and 2C, and to establish the thickness of layer 2B.

The Ontong Java Plateau and the Nauru Basin are two prominent features of the southwest Pacific (Fig. 1). The Plateau is about 1000 km wide and 2000 km long, covering approximately two million square km. The Nauru Basin is about 1200 km wide and 1000 km long. Water depth over the Plateau is less than 2 km, whereas the Nauru Basin is more than 4 km deep.

Recent studies on the Ontong Java Plateau include those by Furumoto et al. (1966, 1970), who, using seismic refraction techniques, found a very thick (40 km) crust in the northern part of the Plateau, and a less thick (25 km) crust in the southern part. A high seismic velocity (7.6 km/sec) basal crustal layer was also discovered in these studies. An upper crustal layer with a consistent 5.5-5.6 km/sec compressional velocity was reported by Hussong (1972), using ASPER and explosive seismic techniques.

Figure 1. Location of the Ontong Java Plateau and the Nauru Basin in the Southwest Pacific. Survey line shown by line AA'A". Selected contours in kilometers. DSDP (Deep-Sea Drilling Project) drilling sites represented by triangles. (map after Kroenke, 1972)


150
160
170
10
0
10
CAROLINE IS.
MARSHALL IS.
462
LYRA
BASIN
ONTONG JAVA
PLATEAU
NAURU
BASIN
GILBERT IS.
289
A
A′
A″
64
4
2
BISMARCK
ARCHIPELAGO
288
SOLOMON IS.
TUVALU IS.
PAPUA-
NEW GUINEA

Similar velocities had been earlier reported by Houtz *et al*. (1970) and were also later reported by Murauchi *et al*. (1973). Hussong *et al*. (in press) state that although no layer 2A is seen on the Plateau, the Ontong Java in other respects resembles Pacific Basin crust, excepting that each crustal layer appears to be proportionately thicker by approximately a factor of five.

In addition to the above mentioned works, sedimentary characteristics and velocities on the Plateau have been defined by reflection studies by Kroenke (1972), Johnson *et al*. (1974), Berger *et al* (1978), wide angle reflection studies by Maynard (1973), paleontological studies of cored samples by Valencia (1973), Resig *et al*. (1976), and physical property measurements by Johnson *et al*. (1977) and Milholland (1978).

Additional detailed information on the sedimentary layers was provided by drilling operations on the Plateau at DSDP (Deep Sea Drilling Project) sites 64, 288, and 289.

Gravity studies reported by Furumoto *et al*. (1970) indicate that the Plateau is essentially in isostatic equilibrium, with an average free air anomaly of only 15 mgl. Heat flow in the southern part of the Plateau is found to be about 35 mWm^{-2} (milliwatts/$meter^2$), lower than the Pacific average of about 63 mWm^{-2}, while the northern part has a normal value of 64 mWm^{-2} (Halunen and Von Herzen, 1968). Halunen and Von Herzen's data also indicate that the Nauru Basin's heat flow averages somewhat less than the Pacific average (about 49 mWm^{-2}).

II. Data Acquisition and Analysis

The seismic refraction data were collected along a line running approximately east-west from $156^{\circ}24'$E, $2^{\circ}01.5'$S to $163^{\circ}36.9'$E, $0^{\circ}03'$S (Fig. 1). Locations of individual sonobuoys are given in Table 1. The line was recorded in two segments: the first began at sonobuoy 1 and ended at sonobuoy 26; the second began at sonobuoy 27 and ended at sonobuoy 40. Shot sizes ranged from 1 to 600 pounds. All the sonobuoys were of U. S. Navy type SSQ41A with automatic gain control. Transmitted signals were received on board ship and recorded in analog mode in three frequency bands: 15-30 Hz, 30-60 Hz, and 500-1500 Hz. Shipboard recording was essentially the same as that described by Hussong (1972).

Thirty sonobuoy profiles were found to have sufficiently high signal-to-noise ratios to warrant analysis. Record sections were prepared for six of the profiles which typify regional characteristics or illustrate anomalous situations. Topographic, burn-time, and shot-depth corrections were applied to the traces, and a reducing velocity of 6.5 km/sec was used. Twenty-four other sonobuoy profiles were analyzed by the simpler and more rapid technique of constructing travel-time plots. Seismic arrivals were picked, burn-time and topographic corrections were applied, and the corresponding arrival

Table 1

Sonobuoy	Receiver Position Latitude (South)	Receiver Position Longitude (East)	Water Depth (km)	Velocity (km/sec) over Thickness (km) Sed	2A	2B	2C	3
3	0°48'	160°48'	2.65	(2.11)*	-	5.5	-	-
				1.2	-			
4	o°51'	160°37'	2.58	(2.11)	-	5.7		
				1.2				
7	0°58'	160°01'	2.38	(2.11)	-	5.3	6.2	-
				0.9	-	3.7	-	
8	1°00'	159°54'	2.50	(2.11)	-	5.4	6.1	-
				0.9	-	4.7	-	
9	1°05'	159°32'	2.15	(2.11)	-	5.5	6.3	-
				1.2	-	5.4	-	
10	1°06'	159°20'	2.10	(2.11)	-	5.6	-	-
				1.4	-			
11	1°11'	159°00'	2.10	(2.11)	-	5.5	6.2	-
				1.1	-	4.2	-	
12	1°13'	158°54'	2.00	(2.11)	-	5.5	6.4	-
				1.2	-	4.4	-	

*2.11 km/sec velocity assumed for thickness claculations.

Table 1. (continued)

Sonobuoy	Receiver Position Latitude (South)	Longitude (East)	Water Depth (km)	Velocity (km/sec) over Thickness (km) Sed	2A	2B	2C	3
14	1°20'	158°12'	1.96	(2.11)	-	5.6	6.4	-
				1.2	-	5.0		
15	1°25'	157°49'	1.85	(2.11)	-	5.6	6.5	-
				1.1	-	5.2		
16	1°30'	157°30'	1.74	(2.11)	4.6(?)	5.7	-	-
				0.8	1.3			
17	1°35'	157°15'	1.67	(2.11)	-	5.3	-	-
				0.9	-			
18	1°40'	157°00'	1.66	(2.11)	-	5.4	-	-
				1.0	-			
19	1°42'	156°52'	1.67	(2.11)	-	5.4	-	-
				1.0	-			
20	1°45'	156°39	1.70	(2.11)	-	5.6	-	-
				1.1	-			
21	1°46'	156°31'	1.68	(2.11)	-	5.7	-	-
				1.1	-			
22	1°49'	156°22'	1.68	(2.11)	-	5.5	6.1	-
				1.1	-	3.9		

Table 1. (continued)

Sonobuoy	Receiver Position Latitude (South)	Receiver Position Longitude (East)	Water Depth (km)	Velocity (km/sec) over Thickness (km) Sed	2A	2B	2C	3
23	1°52'	156°09'	1.70	(2.11)	-	5.5	6.1	-
				1.0		3.0		
24	1°55'	155°57'	1.70	(2.11)	-	5.4	-	-
				1.0	-			
25	1°57'	155°48'	1.78	(2.11)	-	5.6	-	-
				1.1	-			
26	2°00'	155°33'	1.92	(2.11)	-	5.4	-	-
				1.1	-			
27	0°03'	163°37'	4.45	(2.11)	-	5.6	-	6.8
				0.5	-	2.2		
30	0°09'	163°02'	4.45	(2.11)	-	5.7	-	-
				0.5	-			
31	0°52'	162°52'	4.45	(2.11)	-	5.7	-	6.6
				0.7	-	2.8		
32	0°18'	162°42'	4.44	(2.11)	-	5.6	-	6.4
				0.8	-	2.5		
33	0°22'	162°31'	4.40	(2.11)	-	5.4	-	-
				0.8	-			

Table 1. (continued)

Sonobuoy	Receiver Position		Water	Velocity (km/sec) over Thickness (km)				
	Latitude (South)	Longitude (East)	Depth (km)	Sed	2A	2B	2C	3
36	$0^o31'$	$161^o58'$	3.85	(2.11)	-	5.3	-	-
				0.6	-			
37	$0^o33'$	$161^o47'$	3.40	(2.11)	-	5.5	-	-
				0.9	-			
38	$0^o36'$	$161^o35'$	3.30	(2.11)	-	5.5	6.0	-
				0.9	-	3.1		

times were plotted against distance from the receiver. The apparent layer velocities were determined from the slopes of alligned points. In both methods of analysis, models of crustal structure were developed using the SERIT inversion program (Odegard, personal communication). Models derived from the record sections were further checked and verified by ray-tracing, utilizing the RAYTX program (Gettrust, personal communication).

In order to develop crustal structure models, a sediment column seismic velocity of 2.11 km/sec was assumed over the entire line, since no consistently satisfactory sediment refraction arrivals were detected. This assumed velocity was based on an average of sedimentary velocities found at DSDP site 289. Though this average may be slightly high for use in oceanic basins, it was also used in analyzing profiles recorded near the western edge of the Nauru Basin without apparent introduction of significant error. Sedimentary layer thicknesses were calculated using this assumed seismic velocity and the intercepts of the lines drawn through earliest basement refraction arrivals.

Layer velocities were considered to be reliably established when indicated by first arrivals on the record sections or travel-time plots. Second or later arrivals were only used for confirmation of the layer velocities.

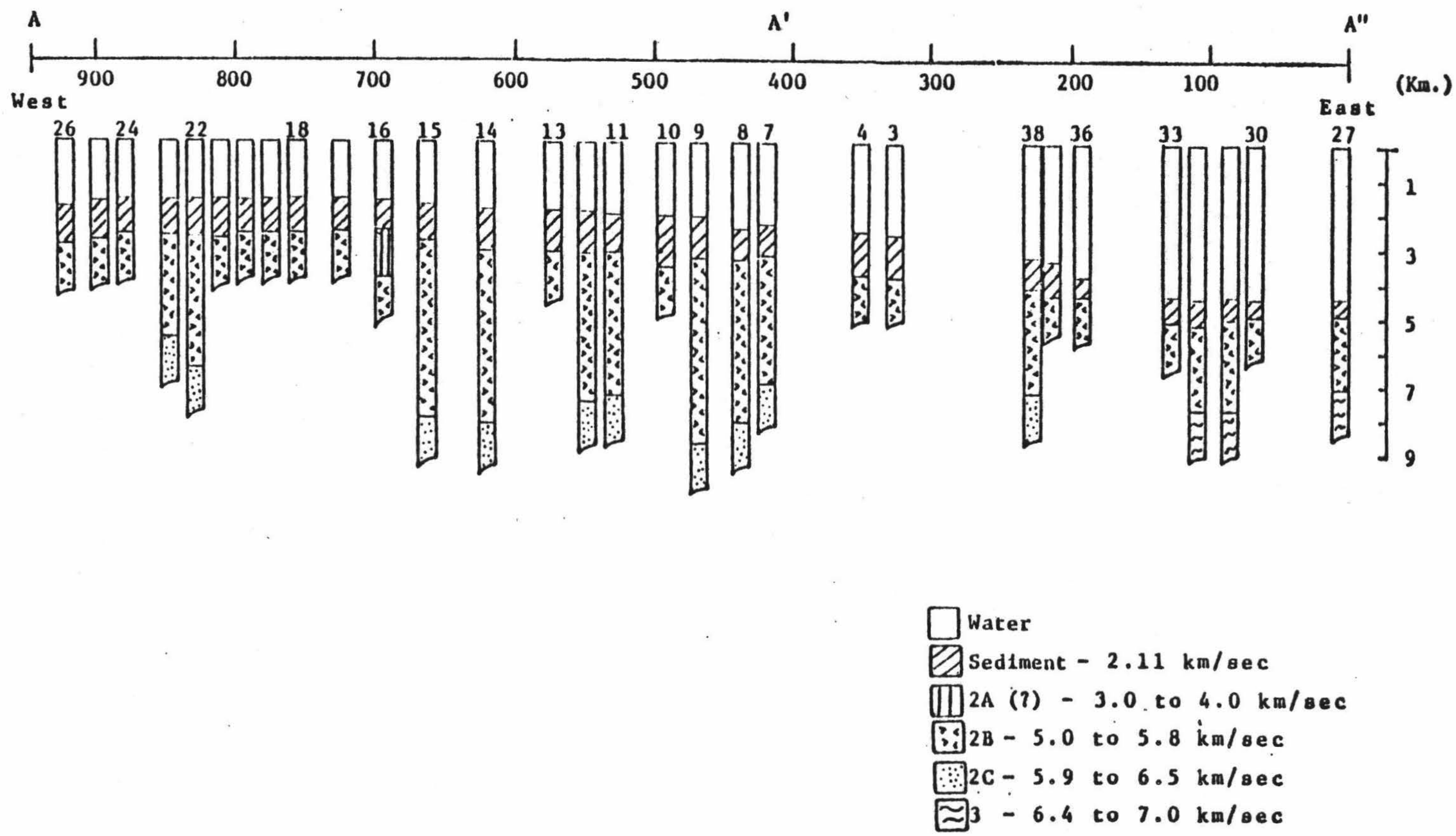
III. Results

The results of the thirty sonobuoys analyzed are shown in Figure 2 and Table 1. Bathymetric data were recorded on board ship with a 3.5 kHz echo sounder. The ocean floor on the Plateau appears relatively flat and devoid of relief. Water depth varies between about 1.6 and 2.5 km on the Plateau and between 3.8 and 4.5 km in the Basin. The sedimentary layer is seen to be smooth, flat-lying and conformable except in some areas on the flanks of the Plateau. Sedimentary thicknesses, calculated from refraction data using a 2.11 km/sec assumed velocity, as previously described, were found to be in reasonably good agreement with those calculated from reflection records obtained along a nearby parallel ship track, using the reflection time-thickness curve developed by Maynard (1973) and Kroenke (1972).

Crustal models with constant velocity layers were assumed. The observation of relatively well-defined wide-angle reflections indicating fairly sharp discontinuities, and the presence of regions of higher amplitude arrivals near critical points supports the validity of this approach.

Layers found to have seismic velocities between approximately 3 and 4 km/sec were classified as 2A. Layers with seismic velocities between about 5.0 and 5.8 km/sec were classified as 2B. Those with velocities ranging from

Figure 2. Survey results. 2.11 km/sec is assumed velocity for sediment. See map (Fig. 1) for orientation of line AA'A".


A
A'
A"
900
800
700
600
500
400
300
200
100
(Km.)
West
East
26 24 22 18 16 15 14 13 11 10 9 8 7 4 3 38 36 33 30 27
1
3
5
7
9
Water
Sediment - 2.11 km/sec
2A (?) - 3.0 to 4.0 km/sec
2B - 5.0 to 5.8 km/sec
2C - 5.9 to 6.5 km/sec
3 - 6.4 to 7.0 km/sec

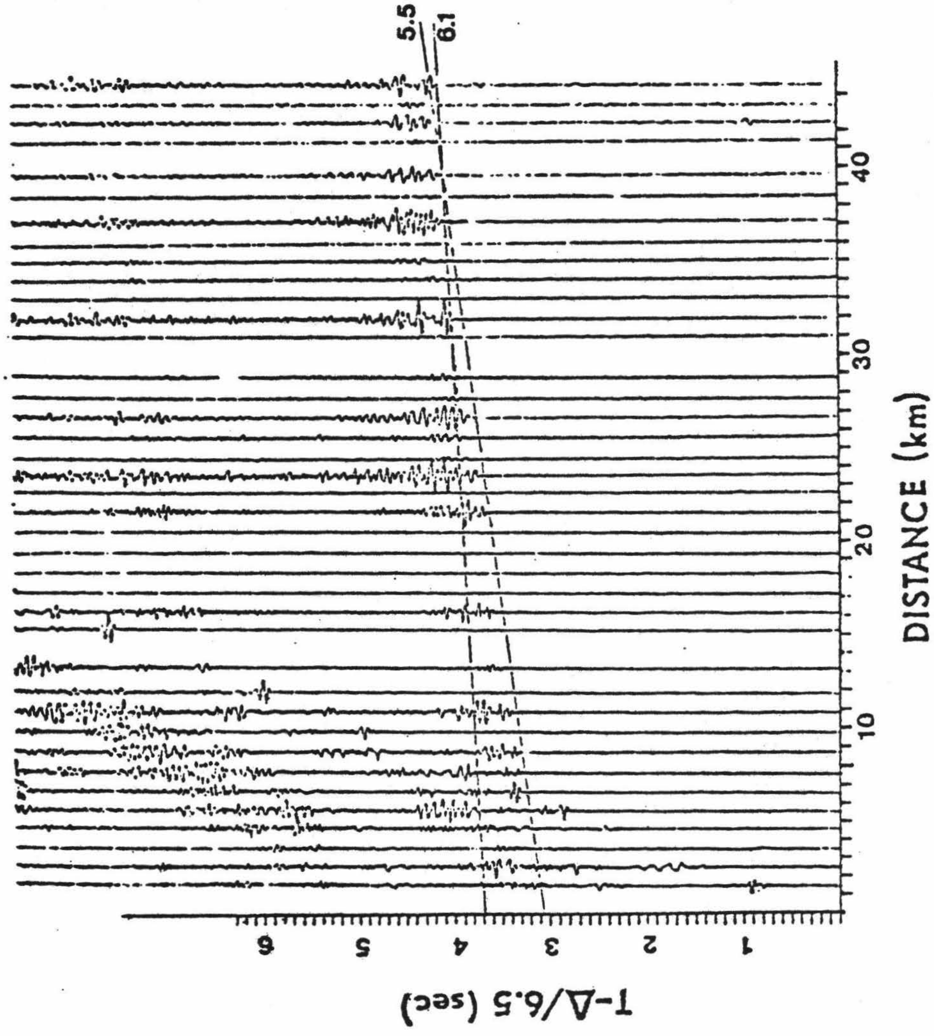
5.9 to 6.5 km/sec were classified as 2C, and layers with velocities between 6.4 and 7.0 km/sec were classified as 3. This classification system is patterned after those used by Houtz and Ewing (1976) and Raitt (1963).

Layer 2A appears to be absent both on the Ontong Java Plateau and near the western edge of the Nauru Basin, with the possible exception of one profile (No. 16). Layer 2B, however, was consistently detected both on the Plateau and in the Basin.

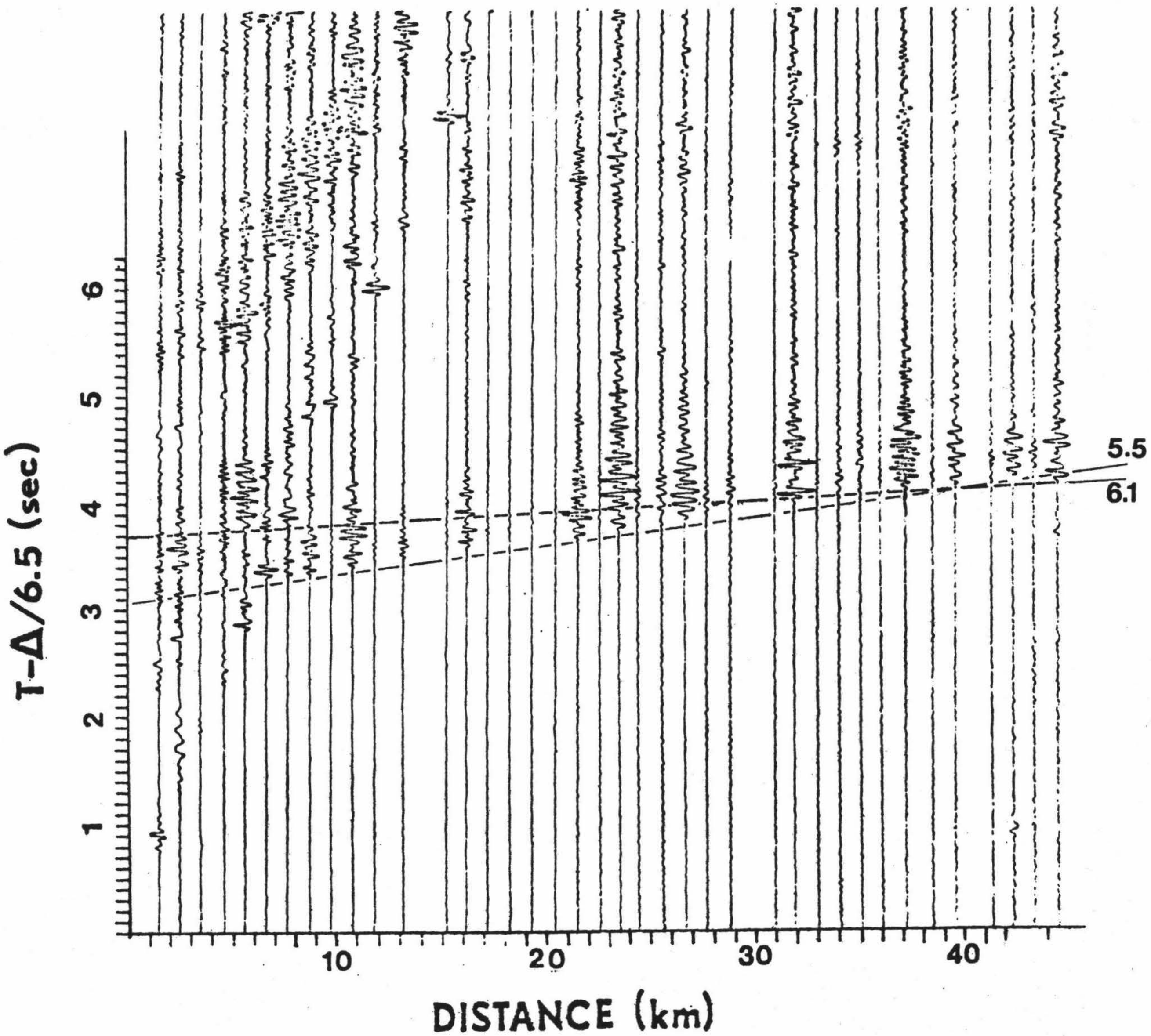
<u>Sonobuoys 18 to 26</u>: Located near the center of the Plateau, these profiles show well-defined 2B velocities. The record section shown in Figure 3 is typical of this area. The far western profiles in this group (No. 22 and 23) may also indicate a thinning of layer 2B. Data from the lower layer are less reliable, however, and thus the thinning cannot be reliably established.

<u>Sonobuoys 7 to 17</u>: These profiles, located east of those discussed above, but still on the main part of the Plateau, also show a well-defined layer 2B, with fairly consistent thickness and constant velocity (averaging 5.5 km/sec). This group of profiles is represented by the record sections shown in Figures 4 and 5. Profile 16 (Fig. 5) is somewhat unusual, however, in that it suggests the presence of an intermediate seismic velocity 4.6 km/sec between the sediments and layer 2B. This is the possible exception to the absence of a layer 2A mentioned above.

Figure 3. Record section of sonobuoy 22. Representative of westernmost sonobuoy group on main part of Plateau (sonobuoys 18 to 26). May indicate thinning of layer 2B.

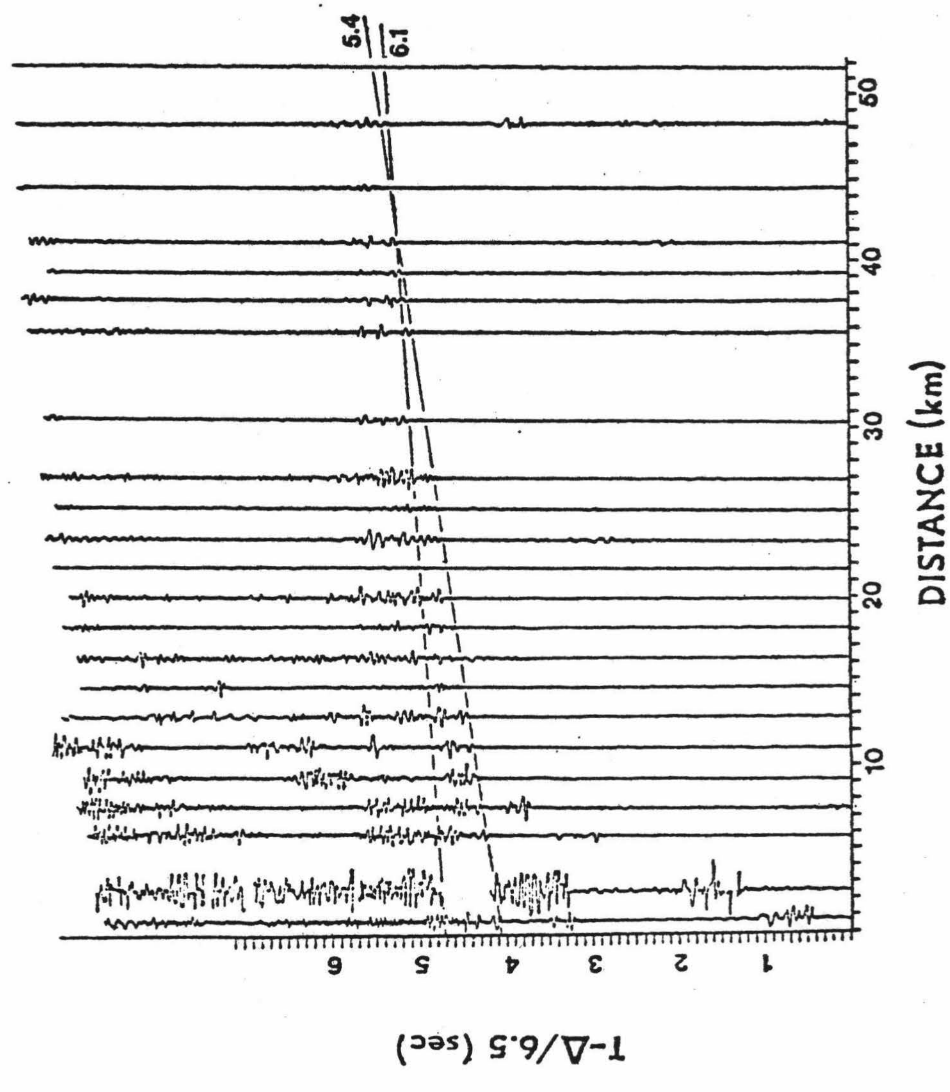


SONOBUOY 22

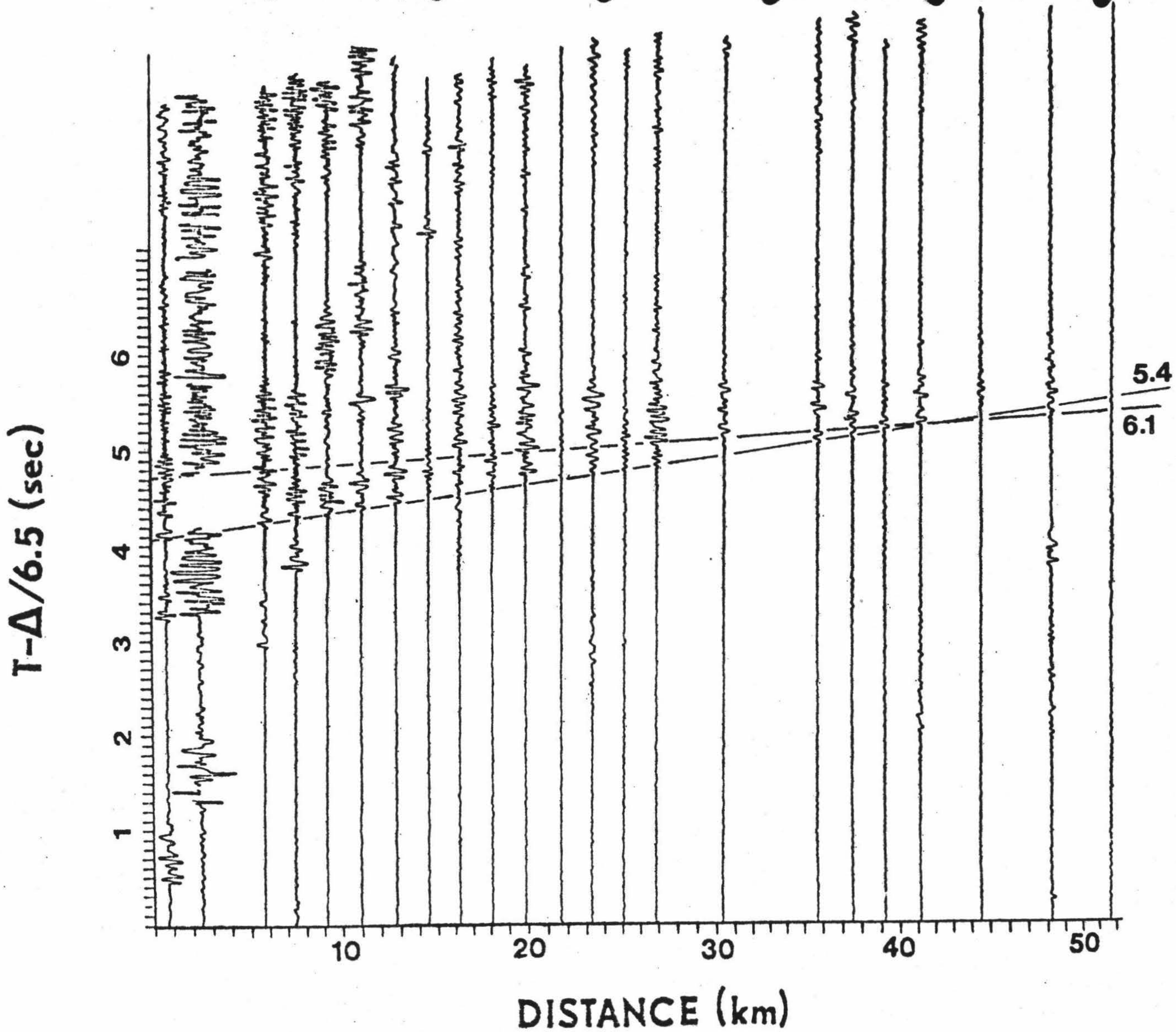


SONOBUOY 22

Figure 4. Record section of sonobuoy 8. Located on main part of Plateau. Representative of sonobuoy group 7 to 17.

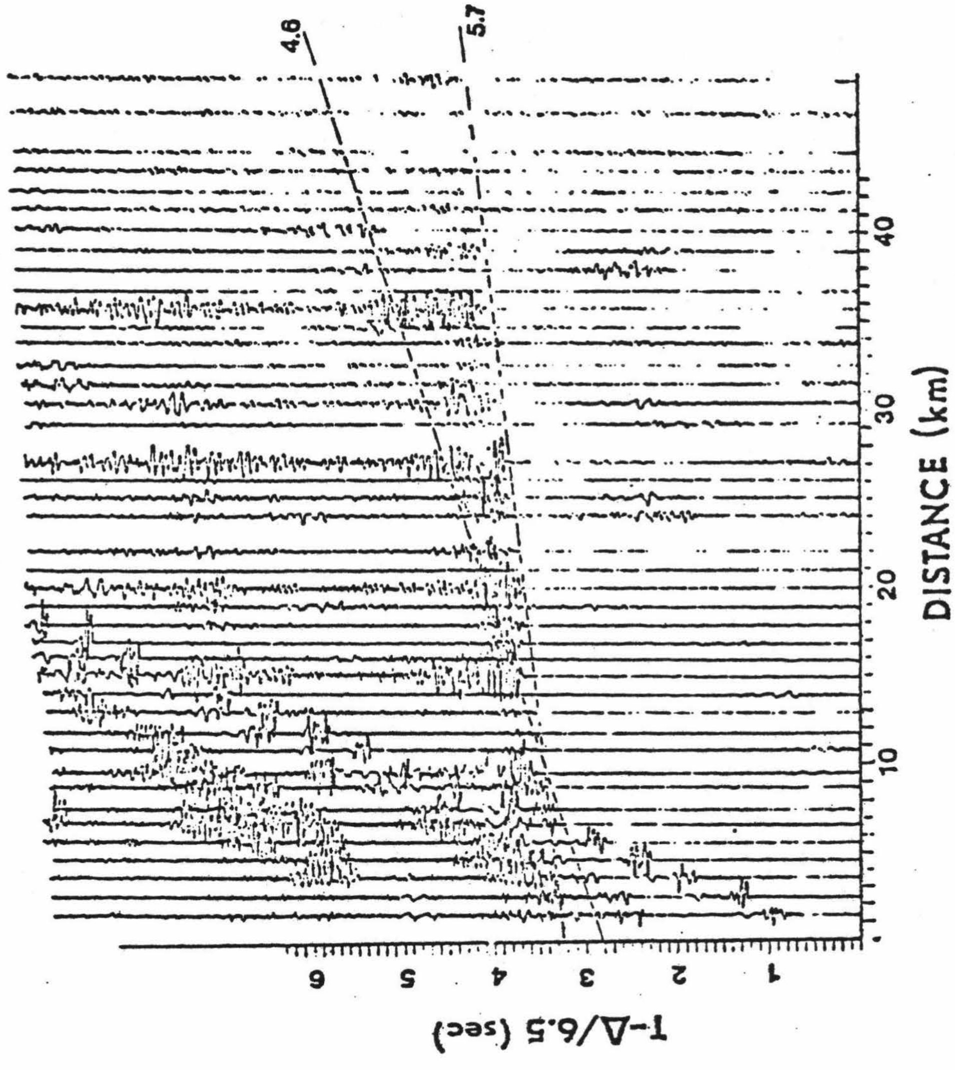


SONOBUOY 8

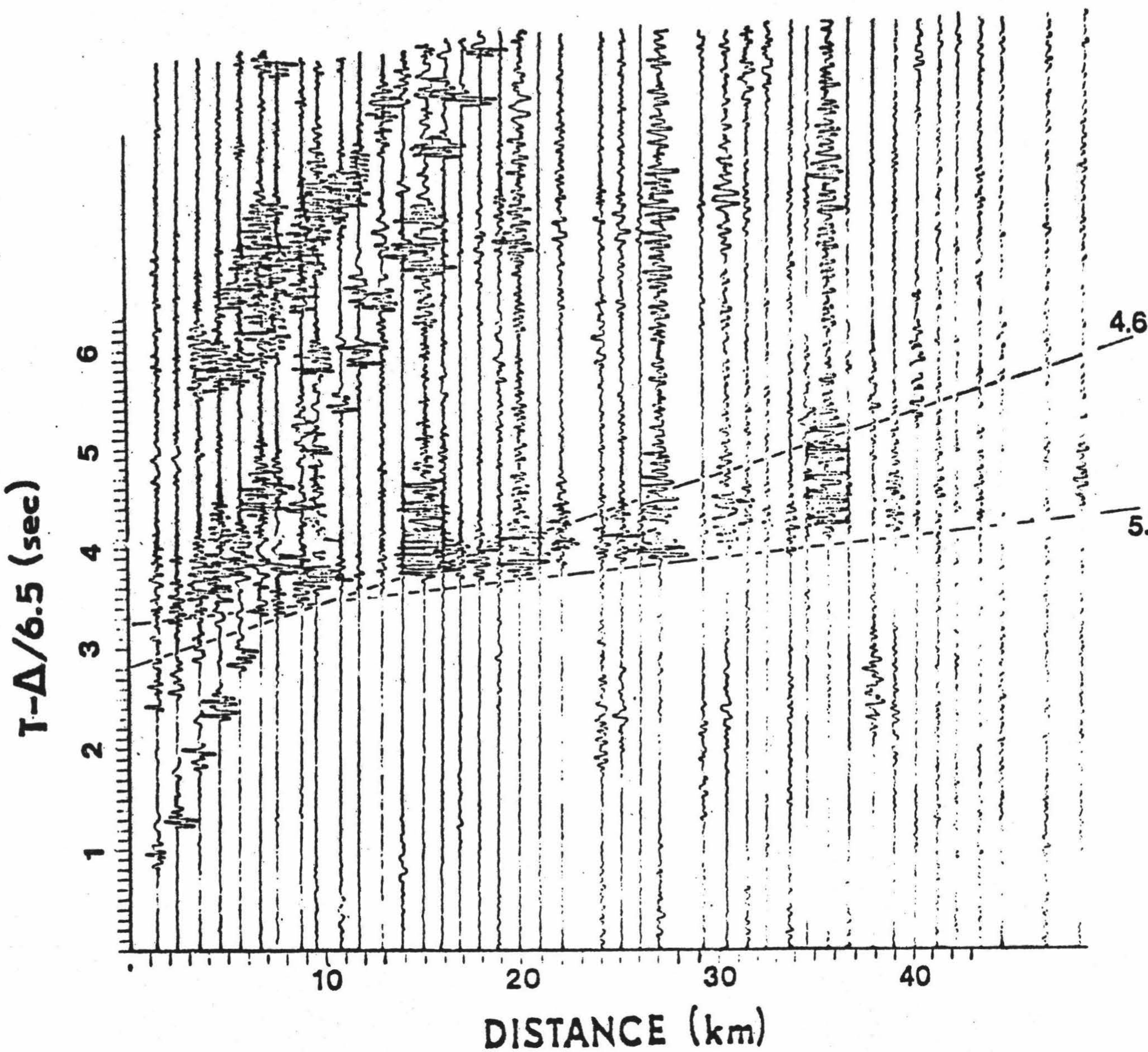


SONOBUOY 8

Figure 5. Record section of sonobuoy 16. Located on main part of Plateau. May indicate existence of intermediate velocity layer between sediment and basaltic layer.



SONOBUOY 16



SONOBUOY 16

Three interpretations of the 4.6 km/sec layer are possible. In the first case, it may exist as part of the basaltic layer, representing layer 2A, though with a slightly higher seismic velocity than found elsewhere in the world. In this case, however, the refraction data indicate only about 0.8 km of sediment overlying layer 2A, using an assumed sediment seismic velocity of 2.11 km/sec. This is inconsistent with nearby reflection data which indicate about 1.2 km of sediment in the area. In the second case, the 4.6 km/sec layer may exist in the sedimentary column overlying basaltic basement. In this case, an exceptionally large sediment thickness would be indicated in the vicinity. If one considers the remarkable continuity of sedimentary reflectors seen on the upper part of the Plateau, however, and the absence of a thick high-velocity sedimentary layer at DSDP site 289, this conclusion would appear to be unlikely. In the third case, the apparent 4.6 km/sec refractor may not have geologic significance. The velocity determination is based on only three first arrivals, which may have been produced by local structure or lateral inhomogeneities. If this layer determination is assumed to be in error, reanalysis of the refraction data, again using the assumed sedimentary velocity of 2.11 km/sec, indicates about 1.1 km of sediment overlying a 5.6 km/sec layer 2B. This assumption would put profile 16 back in good agreement with the reflection data and with models developed from adjacent refraction profiles.

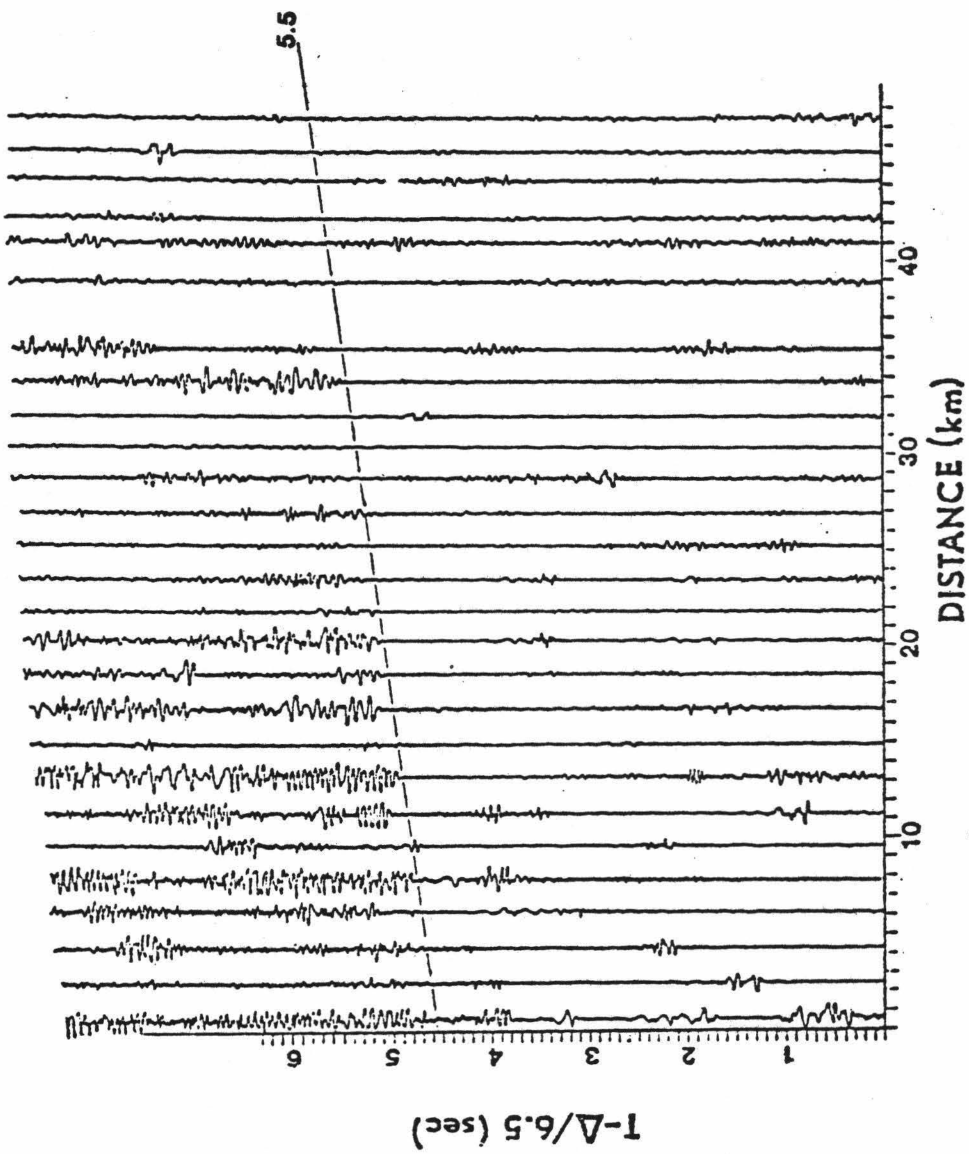
Beneath layer 2B another layer is observed on most of the profiles in this group. Seismic velocities of this layer, labeled 2C in Table 1, vary between 6.1 and 6.5 km/sec. Limited sonobuoy transmission range prevented determination of the thickness of layer 2C.

At this point it should be noted that the velocities of the apparently ubiquitous layer 2B are extremely consistent across the Plateau, ranging from 5.3 to 5.7 km/sec. The average 2B velocity on the main part of the Plateau (sonobuoys 7 to 26) is calculated to be 5.5 km/sec with a standard deviation of slightly more than 0.1. Thickness of layer 2B averages about 4.7 km over the central part of the Plateau from sonobuoys 7 to 15, but the average decreases to 4.4 km if values from sonobuoys 22 and 23, which appear to indicate a thinning of the layer, are included. Below layer 2B, the seismic velocity of layer 2C, where detected on the main part of the Plateau, was found to average 6.3 km/sec with a standard deviation of slightly greater than 0.1. This average and standard deviation do not significantly change if results from sonobuoys 22 and 23 are included.

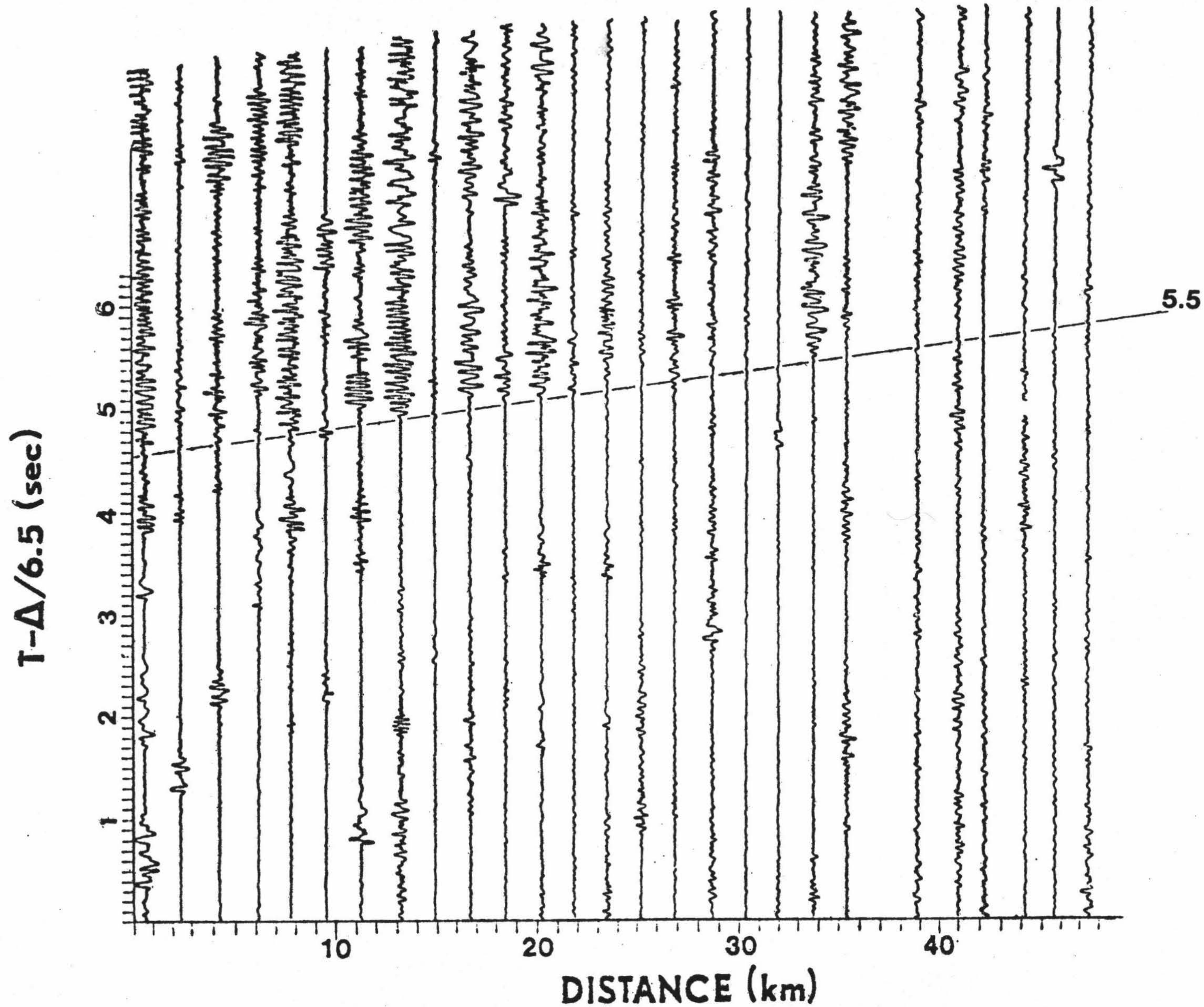
Sonobuoys 1 to 6 and 37, 38: Profiles 1 to 6 were recorded on the flanks of the Plateau, east of those described above. Although fairly poor signal-to-noise ratios characterize these profiles, profiles 3 and 4 indicate 2B velocities similar to those seen farther west on the Plateau. Figure 6 depicts one of the best record sections of this group. Farther east, water depth increases and layer thicknesses decrease (profiles 37-38) signalling transition from the Ontong Java Plateau to the Nauru Basin physiographic province. The actual border of the Plateau is thought to be in the vicinity of sonobuoy 37. The record section in Figure 7 is from this area.

Sonobuoys 27 to 36: These profiles were recorded in the Nauru Basin, near its western edge. Despite fairly poor signal-to-noise ratios, these profiles again give reasonably dependable seismic velocity values. Layer 2B velocity values were found to be fairly consistent and similar to those seen on the Plateau. In contrast to observations on the Plateau, the layer seen beneath layer 2B in the Basin had a slightly higher average seismic velocity, best corresponding to values characteristic of layer 3. The record section shown in Figure 8 was recorded in this area, but is somewhat anomalous, exhibiting an interval of unusually low amplitude arrivals. Although such an effect might be considered indicative of a low-velocity zone, comparison of this record section with surrounding sonobuoy profiles leads to the conclusion that

Figure 6. Record section of sonobuoy 3. Located in western part of transition zone from Ontong Java Plateau to Nauru Basin.

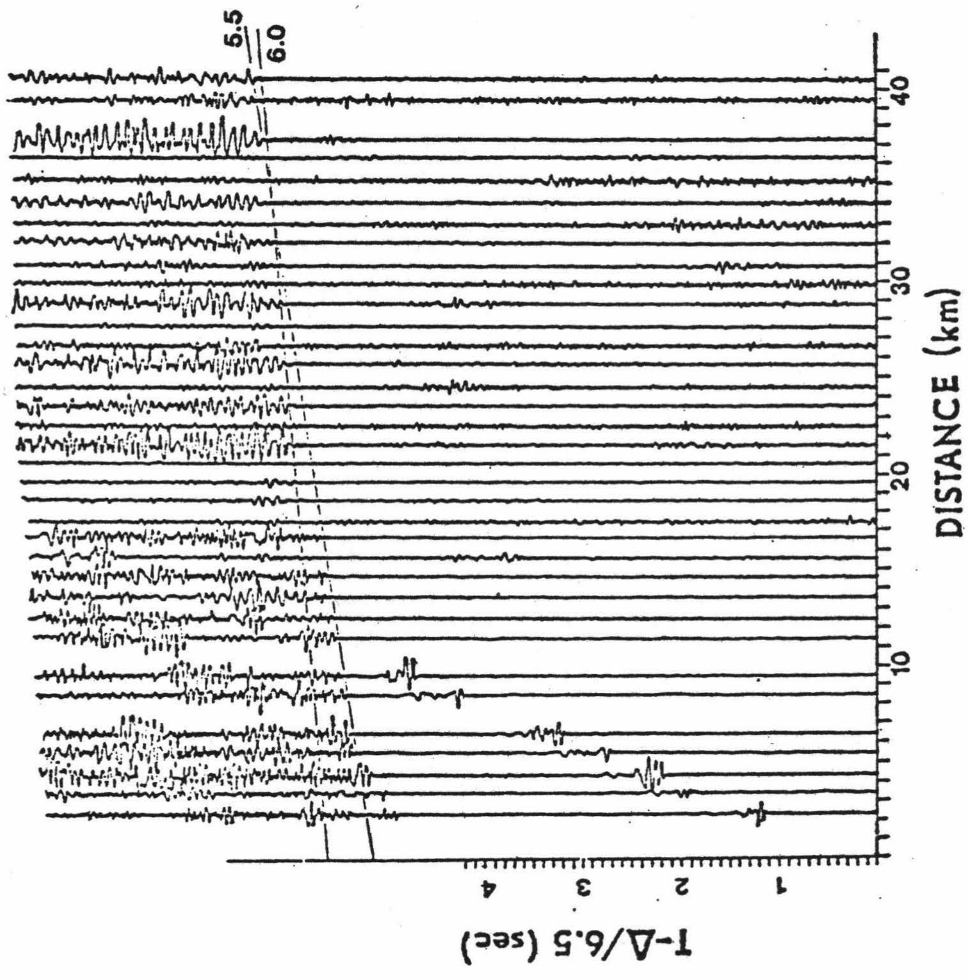


SONOBUOY 3

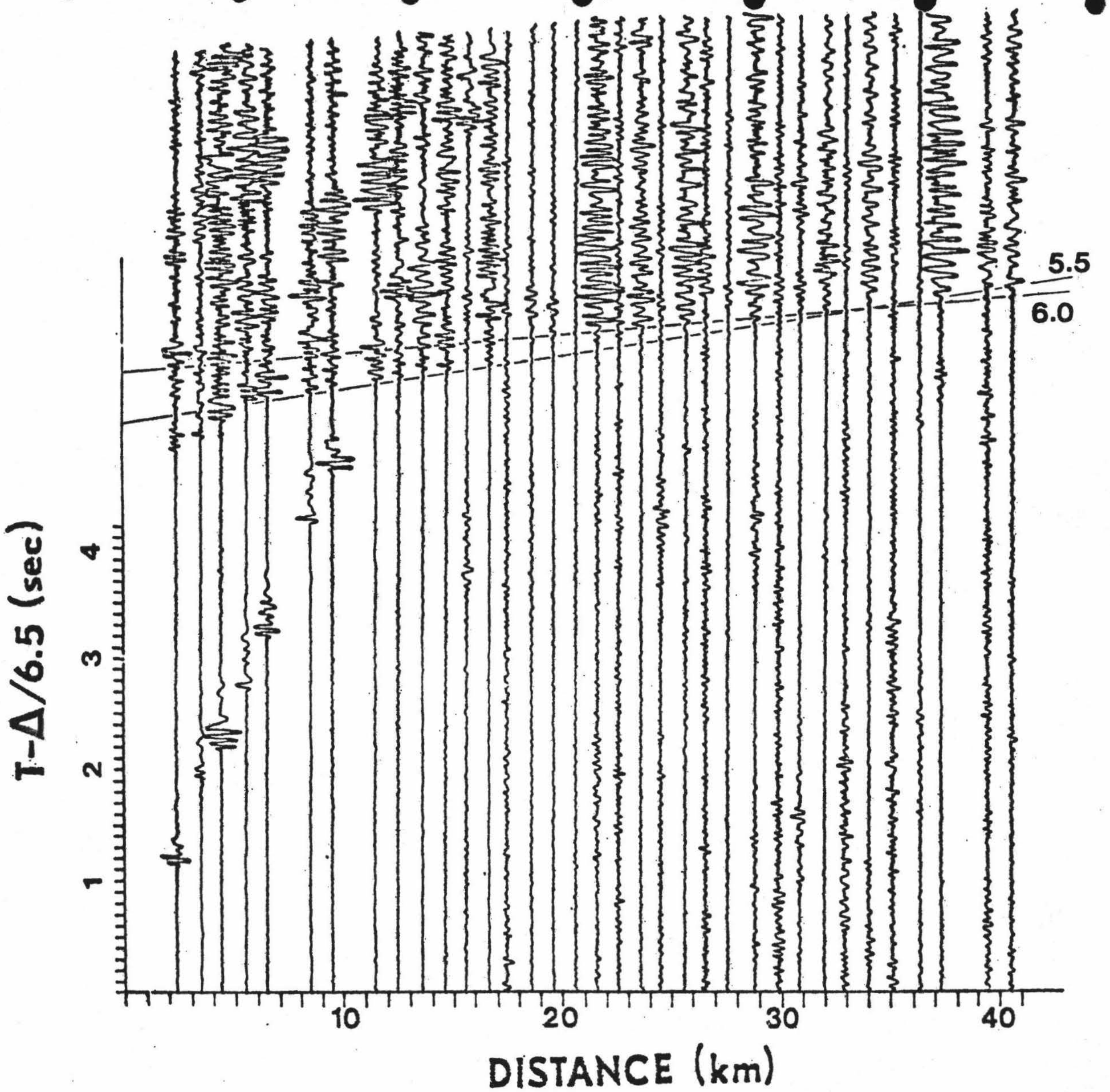


SONOBUOY 3

Figure 7. Record section of sonobuoy 38. Located at eastern end of transition zone from Ontong Java Plateau to Nauru Basin.

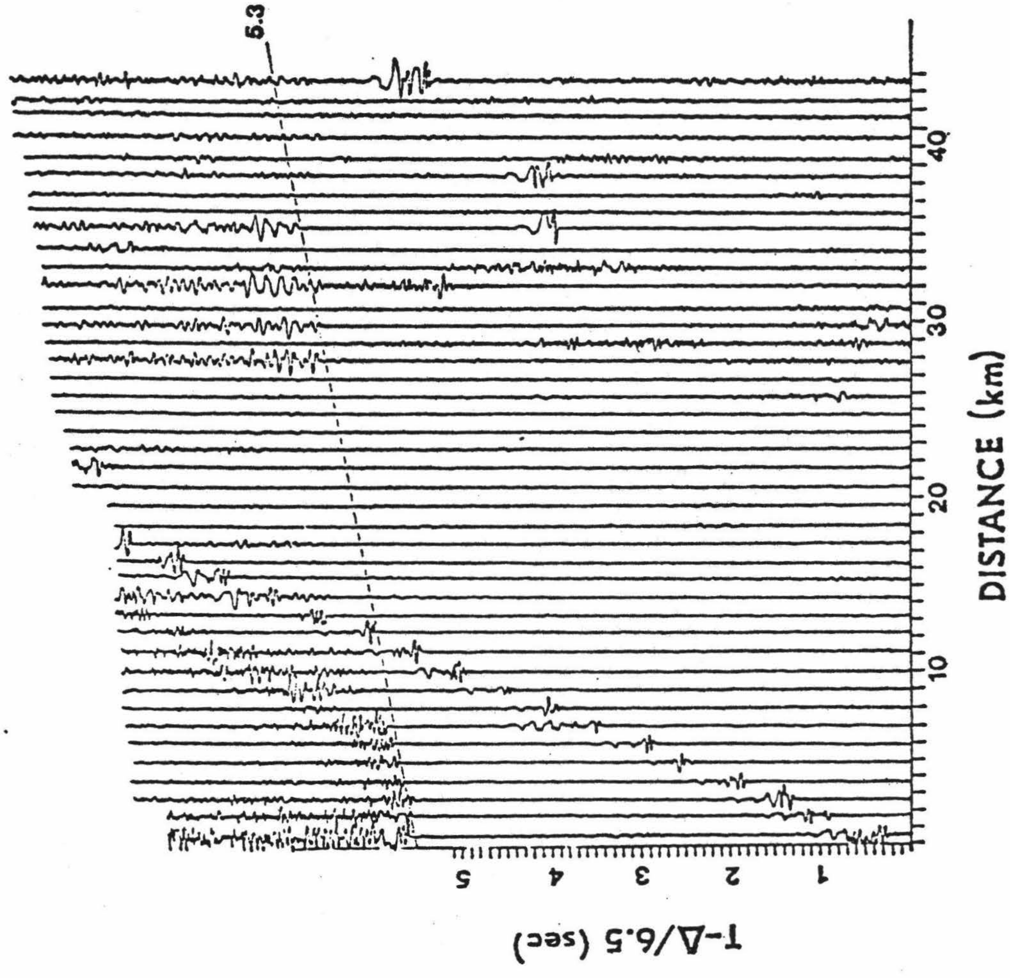


SONOBUOY 38

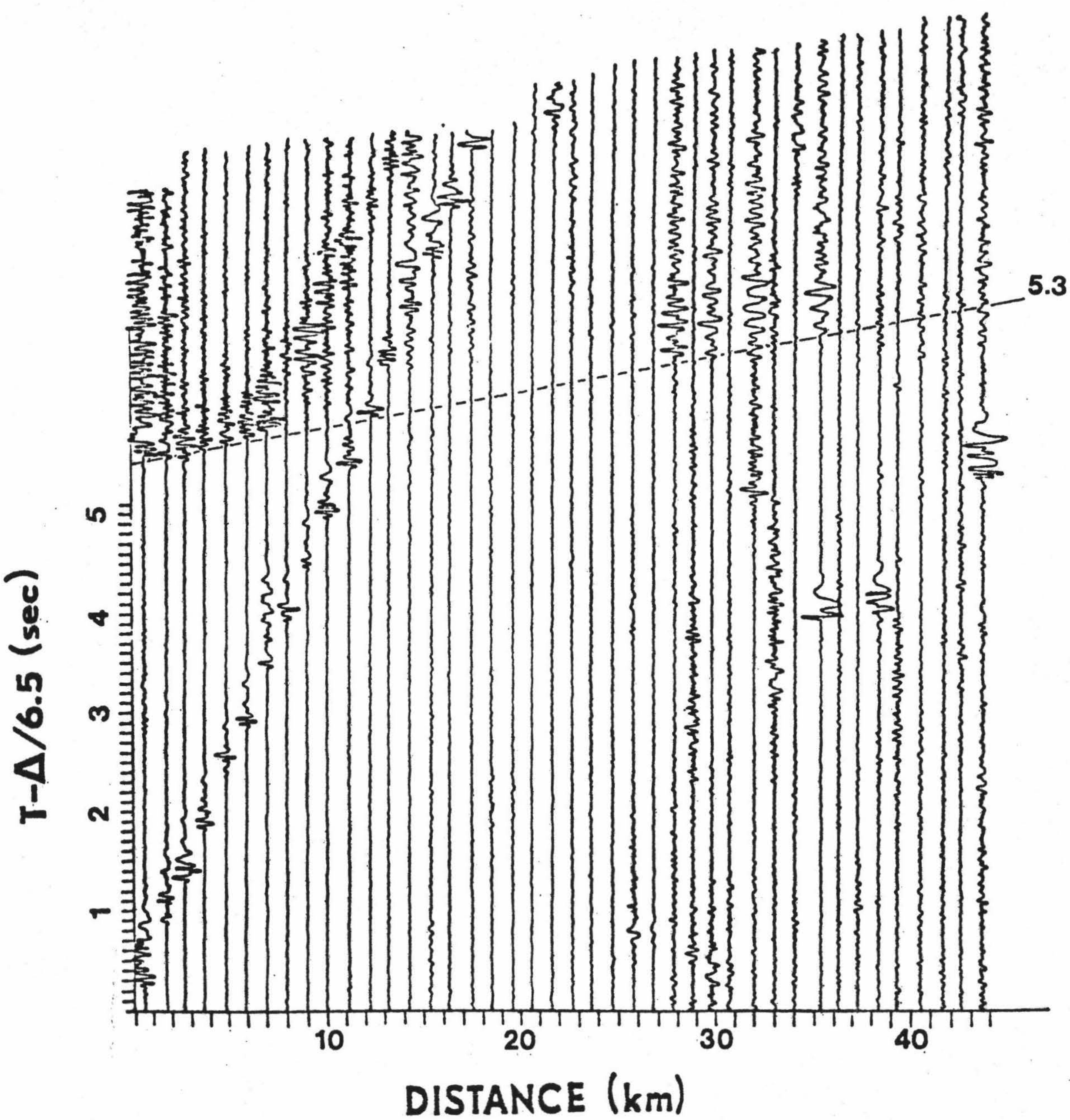


SONOBUOY 38

Figure 8. Record section of sonobuoy 36. Located near western edge of Nauru Basin. Region of low-amplitude arrivals probably indicative of local anomaly.



SONOBUOY 36



SONOBUOY 36

the effect is due to a local anomaly, rather than a widespread low-velocity zone.

The average 2B velocity near the western edge of the Nauru Basin is found to be 5.6 km/sec, with a standard deviation of slightly less than 0.2. Layer 2B is found to be about 2.5 km thick in this part of the Basin. Layer 3 averages 6.6 km/sec, with a standard deviation of 0.2.

Profiles 1 to 6 and 37, 38 were recorded in the transition zone from the Ontong Java Plateau to the Nauru Basin, and so have not been included in the averages presented above.

IV. Discussion of Results

As mentioned earlier and seen in Figure 2, the sedimentary thickness, calculated from the 2B refraction intercepts, is greater on the shallower Plateau than in the deeper Basin. This sedimentary thinning with depth has been observed by previous investigators, including Kroenke (1972), Resig *et al*. (1976), and Berger (1976). It is best explained by noting that chemical dissolution will limit carbonate sediment accumulation as the sea floor approaches the carbonate compensation depth. Some evidence of disruption of reflectors in the sedimentary layers on the flanks of the Plateau, probably a result of erosion and/or slumping, is apparent in the reflection profiles. Acoustic basement, corresponding to the basaltic layer (Kroenke, 1972) appears relatively smooth, however.

As was also previously mentioned, no reliable evidence of a widespread layer 2A was observed in this survey. This observation also agrees with results reported by previous investigators, including Hussong (1972). Moreover, Hussong *et al*. (in press) state that the lack of a 2A layer on the Plateau may be a consequence of "water depth at the time of formation, mode of volcanism, and time between eruptions."

Velocities of layer 2B on the Plateau, with values ranging from 5.3 to 5.7 km/sec, average 5.5 km/sec. Layer 2B seismic velocities ranging from 5.4 to 5.6 km/sec and one value of 4.8 km/sec (from a double-ended line) were reported by Hussong (1972). Values of 5.6 and 5.7 km/sec were found by Murauchi et al. (1973). Murauchi observed a 5.2 km/sec layer overlying a 5.7 km/sec layer on one profile, but this cannot be considered as evidence for a widespread layer 2A. Seismic velocities reported by Furumoto et al. (1970) range from 5.0 to 5.5 km/sec for three double-ended lines, and from 4.4 to 4.6 km/sec for one double-ended and one single-ended line. Thus results herein agree reasonably well with those from other surveys.

The seismic velocities shown in Table 1 also fall well within the range of velocities for basalt as reported by Rosendahl (1976). As can be seen in Figure 9, the 5.5 km/sec compressional velocity found for layer 2B on the Plateau would indicate an unaltered massive basalt. Indeed, basalt samples obtained at DSDP site 289, about 90 km to the north of the survey line, at approximately the same depth as the layer indicated by this survey's refraction data, were fairly massive and fresh, with vesicles smaller than 2 mm and composing less than 1% of core volume. The average seismic velocity of the DSDP 289 basalt cores was about 5.76 km/sec, with a standard deviation of 0.26 (Milholland, 1978). The velocity structure of these basalt cores is shown in Figure 10, and values are seen to cluster around 5.5 km/sec, agreeing well with the results of this survey. The horizontal homogeneity is clearly

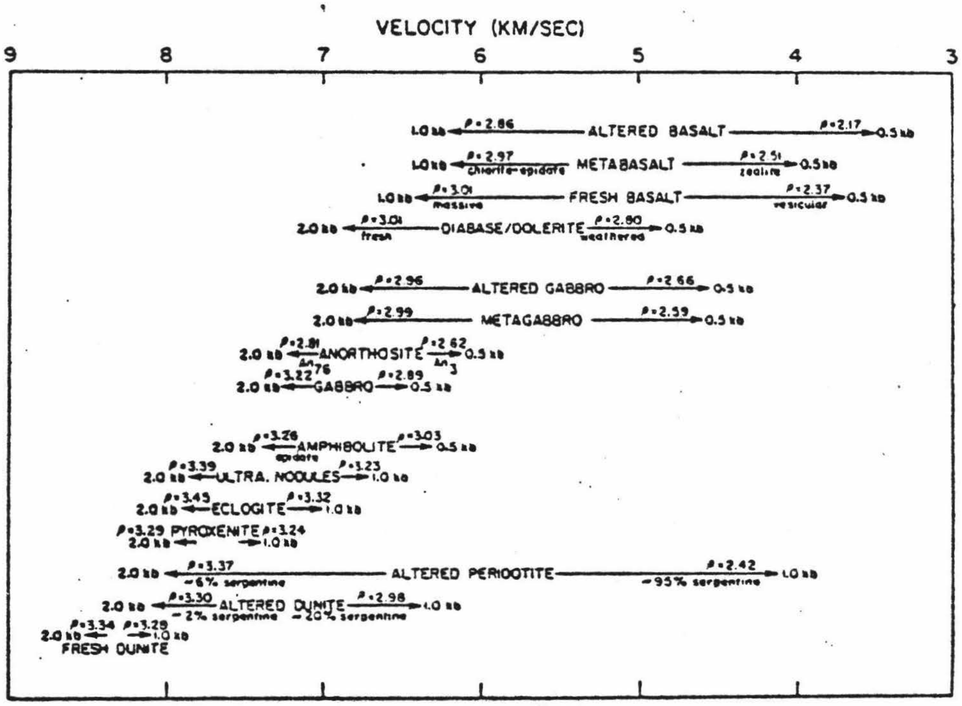


Figure 9. Compressional velocities found for materials found in the oceanic crust (from Rosendahl, 1976).

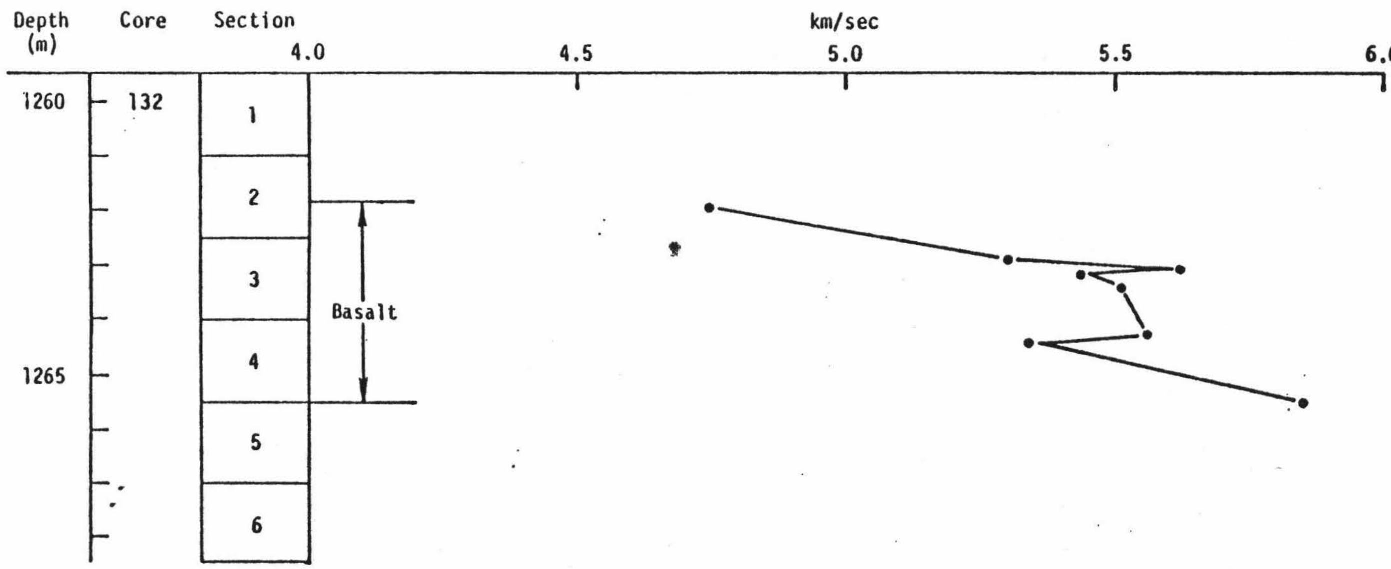


Figure 10. Acoustic velocities measured in basalt cored at DSDP site 289 (after Andrews and Packham _et al_., 1975).

demonstrated by the extremely small amount of scatter in the seismic velocities obtained by the various sonobuoys. As previously mentioned, this layer on the Plateau is seen to average about 4.7 km thick (or 4.4 km, if one includes the westernmost profiles in the average).

The next lower layer (2C in Table 1) has velocities ranging from 6.1 to 6.5 km/sec on the main part of the Plateau. Uppermost sub-2B seismic velocities found in previous investigations include those found by Hussong (1972), ranging from 5.9 to 6.7 km/sec, those found by Murauchi (1973), about 6.1 km/sec, and those found by Furumoto (1970), ranging from 5.8 to 6.5 km/sec. Hussong et al. (in press) state that this deeper layer, with an average velocity of 6.5 km/sec, is sometimes seen to consist of an upper 6.1 km/sec layer and a lower 6.8 km/sec layer. The averaging of these layers may be the cause of some of the variability of apparent velocities calculated from deep refractions. The layer observed by this survey corresponds best to the uppermost of the two layers, and may consist of dolerite. This interpretation is supported by Rosendahl's diagram and by ophiolite evidence, the latter to be considered later.

Sonobuoy profiles in the Nauru Basin, like those on the Plateau, show no clear indication of a layer 2A. Because low signal-to-noise ratio may be responsible for this apparent absence, additional data must be collected to definitely confirm the presence or absence of the layer. In contrast to observations on the Plateau, layer 2B seismic velocities found in the Basin are slightly higher. This observation may be the result of a real, yet subtle change in velocity, since no significant dip is apparent from the bathymetry or reflection data. Layer 2B near the western edge of the Basin is found to be about 2.5 km thick. The next lower layer observed is found to have velocities ranging from 6.4 to 6.8 km/sec averaging 6.6 km/sec. Since velocities are also somewhat higher than those found on the Plateau, this layer is best classified as layer 3. No refractor was observed in the Basin with velocities typical of layer 2C, but shot spacing and poor signal-to-noise ratio prevent confirmation of a thin layer 2C's absence.

In order to more accurately interpret the geophysical data obtained in this survey in terms of geologic structure, it is useful to examine the ophiolite sequences found in the Solomon Islands, particularly those found on Malaita and Santa Isabel. Malaita, one of the islands in the Pacific province of the Solomon Islands (Coleman, 1970) has been proposed to consist of a deformed section of southwest Plateau margin (Kroenke, 1972). Two distinct basalt groups are found on Malaita. The older basalts are classified by Hughes and Turner (1977) as oceanic tholeiites, whereas the younger basalts are reported to be alkalic. Hughes and

Turner also state that the older basalts are extremely similar to those cored at DSDP site 289. Santa Isabel, lying on the boundary between the Pacific and Central provinces of the Solomon Islands, displays a similar ophiolite sequence. According to Stanton and Ramsey (1975), the uppermost igneous material in the sequence consists of the Sigana Volcanics, a fairly massive basalt layer composed of flows and pillow lavas of about the same age as the older basalts on Malaita. It is likely therefore, that both the Sigana Volcanics and the older Malaita basalts are equivalent to the basalts composing layer 2B on the Plateau.

The Sigana Volcanics, moreover, on Santa Isabel are known to overlie the Vitora Microgabbros (dolerites) (Stanton and Ramsey, 1975). Dolerite sills are also evident on Malaita, but their relation to the older basalts is not as clear-cut as on Santa Isabel. Thus, the Santa Isabel ophiolite sequence, at least, supports the hypothesis that the 2C layer on the Plateau consists of dolerite. No similar sub-aerial exposures of Nauru Basin crust exist, but postulating that layer 3 in the Basin consists of either dolerite or gabbro would not contradict available evidence.

Scatter in volocity values found on the Plateau may be indicative of actual geologic variation, but, in view of the uniformity of the upper basalt layer, it is probably better explained by experimental uncertainty resulting from small shot size and the extreme range needed to detect deep layers. Velocity scatter in the Nauru Basin may be explained by the complex fine structure of the Basin, as seen at DSDP site 462, about 700 km north of this line (Joides, in press). This same complex structure, consisting of a shallow and extremely thick intrusive complex may also be responsible for the apparent great thickness of the 2B layer in the Basin: refractions from the top of a fairly shallow sill may be interpreted as arrivals from a thick basalt layer. Alternatively, however, the layer may indeed be as thick as indicated, a consequence of gradational thinning of the 2B layer on the Plateau into the Basin.

V. Conclusions

In summary, this survey has attempted to further refine the crustal model developed for the Ontong Java Plateau and western Nauru Basin using seismic refraction techniques. Sediment thickness was found to decrease with increasing water depth from the Ontong Java Plateau into the Nauru Basin. No evidence was found which would indicate the presence of an extensive layer 2A on the Plateau or in the adjacent part of the Basin. A remarkably consistent layer 2B, with velocities averaging about 5.5 km/sec on the Plateau and 5.6 km/sec in the Basin was observed. Layer 2B averages about 4.7 km thick over most of the Plateau. A much thinner layer 2B, averaging about 2.5 km thick, is found near the western edge of the Basin. Seismic velocities found for this layer agree well with data from previous seismic and DSDP studies in the area, and with laboratory velocities found for basaltic rocks. Layer 2C has an average velocity of about 6.3 km/sec on the Plateau, and may consist of dolerite. Layer 3 in the Nauru Basin has an average seismic velocity of 6.6 km/sec.

Additional work in the area is needed to better define the deeper layers and to more closely examine the border between the Plateau and the Nauru Basin.

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