III. Seismic Studies on the Continental Shelf and Slope

Records from only two buoys could be utilized in the interpretation of profiles 14 and 20. In both cases the records from the third buoy were too poor to provide useful information.

A. Profile 20

Station 20 was profiled in a southwest-northeast direction close to the city of Port Elizabeth. The two buoys were 11.3 km apart and during the entire profile the maximum buoy drift was 6.5 km in 8 hours, the drift being in a southwesterly direction.

The travel time data (figure (9)) and the record sections (figures (10-11)) are shown for both buoys 2 and 3. For convenience in plotting, the arrivals from shots outside the buoys have been transposed to the corresponding positions between the buoys and the arrival is marked by a sloping bar. The apparent velocities, intercept times, dips and thicknesses of each layer beneath the buoys are listed in table 1.

The refractions from the unconsolidated sedimentary layer, 1.98 km/sec, which appear at the closest ranges as first arrivals are clearly distinguishable to more than 15 km as later arrivals. The 2.7, 3.5 and 4.4 km/sec arrivals from the semi and consolidated sedimentary layers are well determined from first arrivals for both the profiles. The dipping layer solution for the apparent velocities indicates that the 3.5 and 4.4 km/sec layers dip gently to the southwest and northeast respectively. The refraction with the apparent velocity of 6.3 km/sec is fairly well determined by four first arrivals on the southwest profile but was absent on the northeast profile. The thickness of layer 5 was thus calculated using the unreversed velocity 6.31 km/sec and the intercept time of 2.14 secs. The interpretation yields a total thickness difference beneath

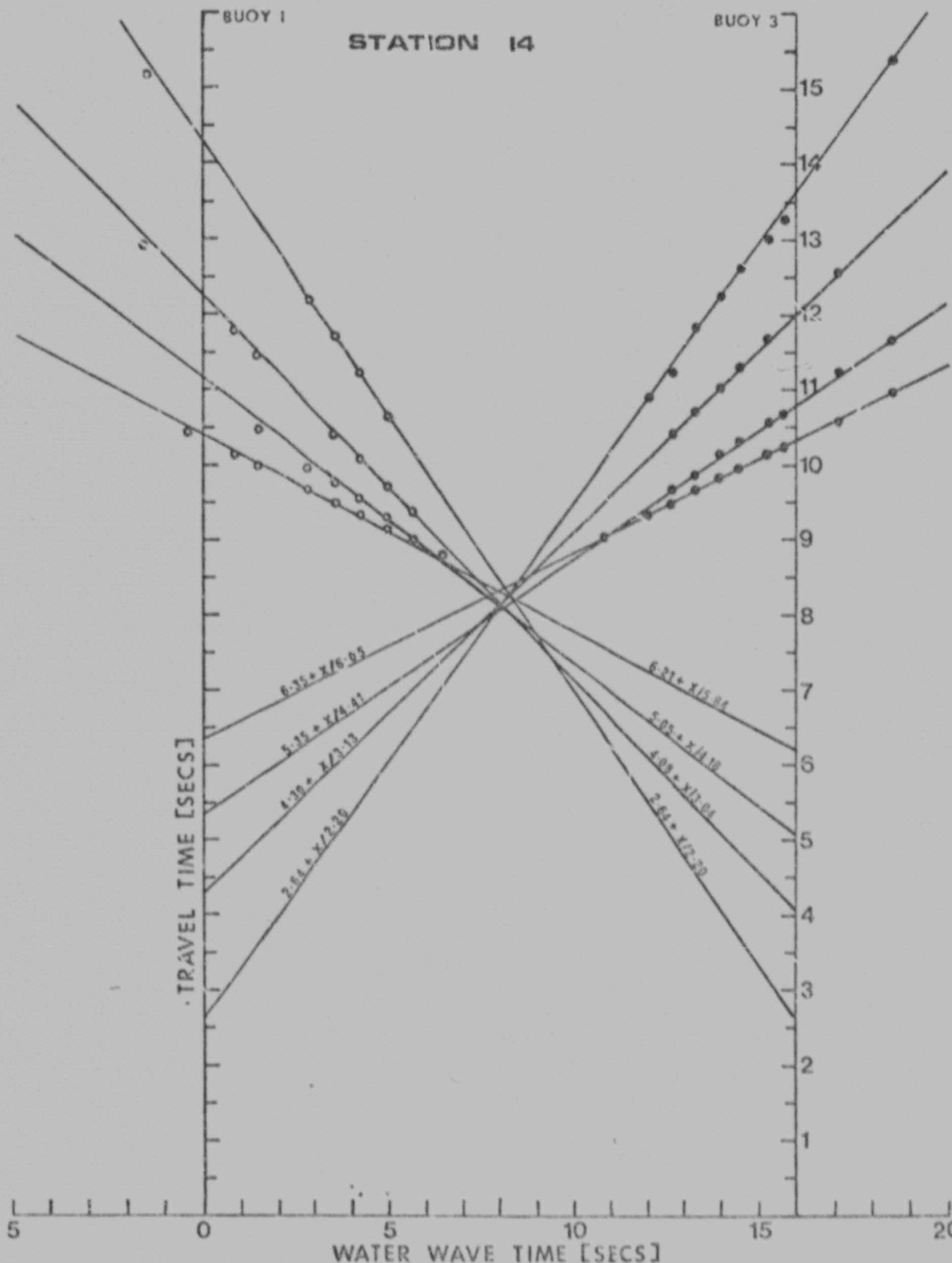

FIGURE 12. Travel-time plot for profile 14.

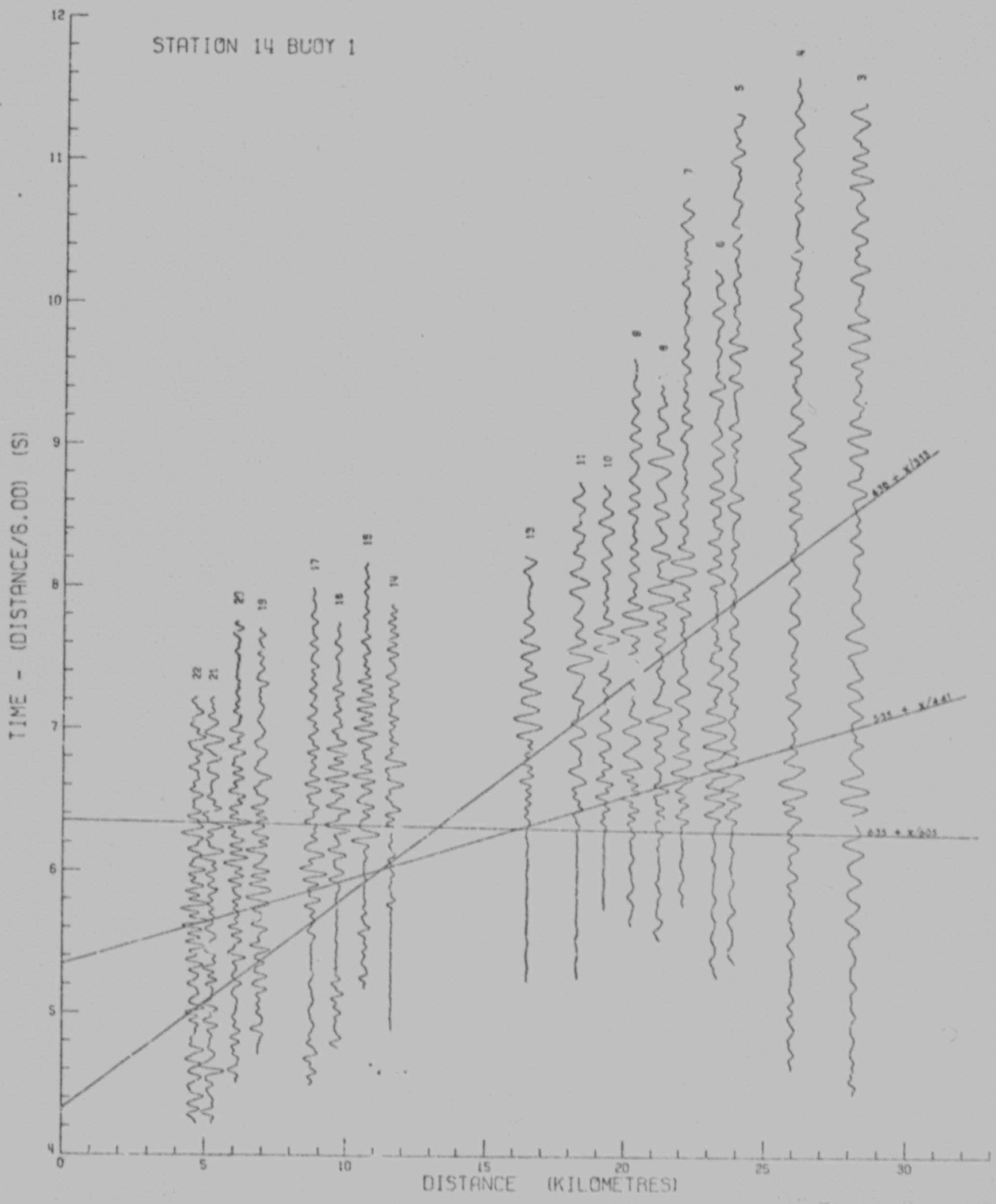

FIGURE 13. Record section from buoy 1, profile 14.

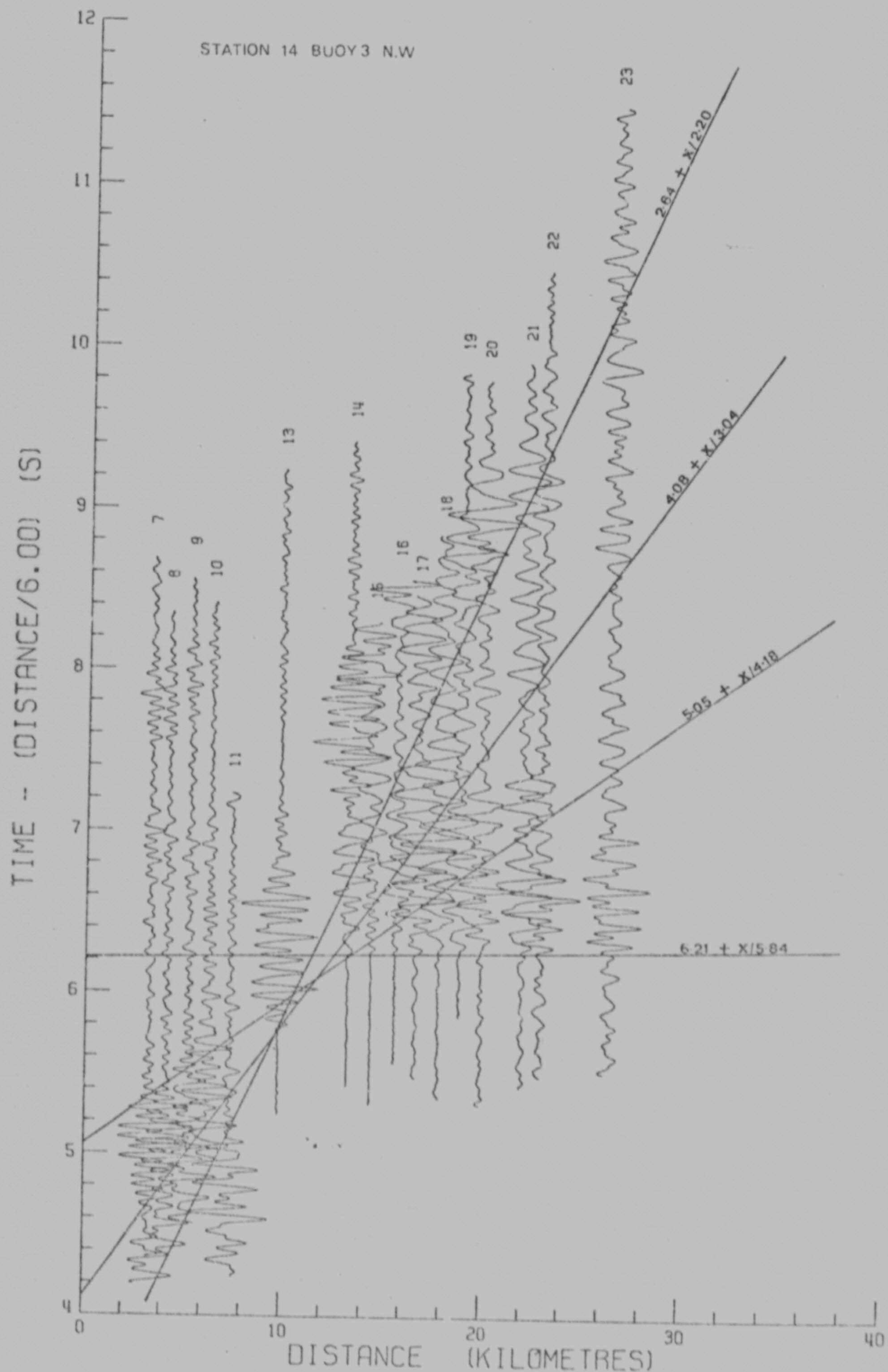

FIGURE 14. Record section from buoy 3, profile 14.

Table 2

Station 14

Apparent Velocities and Intercept Times

Layer No	Velocity (km/sec)		Intercept Time (sec)	
	S.E	N.W	S.E	N.W
1	1.51	1.51		
2	2.20 ±.02	2.20 ±.02	2.64 ±.01	2.64 ±.01
3	3.13 ±.02	3.04 ±.02	4.30 ±.04	4.08 ±.04
4	4.41 ±.09	4.18 ±.09	5.35 ±.10	5.05 ±.10
5	6.05 ±.09	5.84 ±.10	6.35 ±.05	6.21 ±.05

True Velocities, Thicknesses and Dips

Layer No	Velocity (km/sec)	Thickness(km)		Depth(km)		Dip(Deg) relative to surface
		Buoy 1	Buoy 3	Buoy 1	Buoy 3	
1	1.51	2.74	2.74	2.74	2.74	0.0
2	2.20	1.78	1.43	4.52	4.17	0.0
3	3.08	1.23	1.17	5.75	5.34	0.82
4	4.30	2.04	2.61	7.79	7.95	0.97
5	5.94	-	-			-0.37
		7.79	7.95			

the two buoys of only 0.05 km.

B. Station 14

Profile 14 located on the continental slope close to Port St Johns is under 2.7 km of water. The profile was shot in a southeast-northwest direction, perpendicular to the coast and during the 9 hour operation the buoys drifted 19 km in a southwest direction. The distance between buoy 1 and buoy 3 was 24.4 km.

The observations from this profile are shown in figure (12) and figures (13-14) are the record sections for the two buoys and the velocities, intercept times and thickness for the two buoys are listed in table 2. No first arrivals were observed for the 2.2 and 3.1 km/sec velocity layers. The distance over which the refractions from these two layers would appear as first arrivals is short and the shot spacing was too great to observe them as first arrivals, and should ther fore be considered unreliable. Layer 2, the unconsolidated sediment, attains a thickness of more than 1.6 km and it is more likely that the sediment has a velocity gradient similar to that found for the profiles in the Transkei basin. This implies that the base of the sediment would have a velocity higher than 2.20 km/sec. The apparent velocities 3.13 and 3.04 km/sec for layer 3 are typical of the semi consolidated sediments, interpreted as dipping 0.8^{o} to the northwest at a depth of 1.4 km below the sea bottom. The apparent velocities 6.05 and 5.84 km/sec for layer 5 are very well determined by 9 and 8 first arrivals observed for the southwest and northeast profiles respectively.

The velocities obtained for this profile are similar to those of profile 20, with the layer thicknesses increased. The profile was not long enough to determine velocities from layers deeper than the 5.9 km/sec material.

C. Geological Setting

The geological strata present on the south eastern part of the South African landmass belong in the main to the Cape and Karroo Supergroup. The base of the Cape Supergroup is Upper Ordovician and the top of the Karroo is of lower Jurassic age (Truswell, 1970). These strata lie unconformably on Precambrian basement assembledges which have been subjected to varying degrees of deformation, metamorphism and granitisation up to late Precambrian times.

In the Cape St Francis area the succession is represented by;

System or Group	Series of Beds
Tertiary	
Cretaceous	Marine beds Wood Beds Enon conglomerate
Karroo	Stormberg Beaufort Ecca Dwyka
Cape	Witteberg Bokkeveld T.M.S.
Precambrian	Malmesbury Cango

Inliers of Malmesbury and Cango formation rocks occur to the West and North of the Cape itself. Both are exposed in synclinal-troughs of the strongly folded Cape system rocks. The northern exposure extends to Port Elizabeth and in this area it forms the floor of the Algoa basin.

The Cape Supergroup comprises a shallow geosynclinal succession of fossileferous marine to estuarine quartzitic sandstones and shales of mid Paleozoic age. They are strongly folded about an East-West axis and the basal member, the T.M.S.* is exposed in anticlines and forms Cape St Francis as well as other promontories along the coast. The thickness of the Cape system increases eastward from 3 km in a typical area to approximately 6 km near Port Elizabeth.

The northern limit of the Cape system rocks occurs between Port Elizabeth and East London and it trends east-west. Conformable with the Cape system are the Karroo Supergroup rocks. These rocks possess the same east-west trend as do the Cape Supergroup. The Karroo Supergroup has also been affected in the orogenic episode which produced the Cape fold belt. Cretaceous sediments were deposited in the intermontane valleys of the Cape fold belt and this system rests unconformably upon the older rocks. This sediment is indicative of a marine transgression. The fluviatile Enon conglomerate grades into the estuarine Woodbeds which in turn are succeeded by the marine beds. The main outcrop of the latter lies on the coastline of St Francis Bay and they represent parts of the northern margin of a depositional basin or basins beneath the adjacent continental shelf (Simpson, 1966). Tertiary strata are represented by calcified sand, approximately 0.2 km thick, which cover large sections in the Port Elizabeth and St Francis Bay areas.

To the north of Port St Johns the Karroo Supergroup overlies the Cape Supergroup, the latter being represented by only the T.M.S.. In this area the T.M.S. is approximately 0.2 km thick, unfolded except north of Port St Johns where 1.2 km are preserved. The Karroo Supergroup rocks in this area attain a thickness of 1.2 km in the eastern depositional trough as opposed to 9 km in the Southern Cape depositional trough (Woodward, 1966). The structural pattern is complicated by numerous tilted blocks bounded by arcuate faults of pre-Cretaceous age and having displacements as great as 1.5 km (Beater and Maud, 1960; Maud, 1961). Thus in this area

* Table Mountain Series

Table 3

Location of Stations, Velocities(km/sec) and Thicknesses (km) of Layers.

Profile	South Latitude	East Longitude	Layer No	Velocity	Thickness
			1	1.51	0.11
	34° 21'	24° 44'	2	1.98	0.41
20			3	2.70	0.67
	34° 10.0'	25° 50'	4	3.51	1.36
			5	4.38	1.58
			6	*6.31	-
			1	1.50	0.11
			2	1.70	0.34
	34° 31'	24° 40'	3	2.66	0.67
152			4	3.75	1.32
(Ludwig	34° 15.5'	25° 06'	5	4.39	2.82
et al			6	5.85	-
1968)					
			1	1.51	2.74
	33° 0'	30° 08'	2	2.20	1.60
14			3	3.08	1.20
	32° 27'	30° 33'	4	4.30	2.32
			5	5.94	-

* Unreversed velocity from one side of single buoy only.

the Cape and Karroo rocks vary greatly in thickness over relatively short distances.

From the foregoing résumé it is assumed that the continental structure and lithology extend seaward beneath the continental shelf and that it is feasible to consider a tentative correlation between the offshore seismic section and the stratigraphic section of the adjacent landmass.

D. Velocity Correlation with Geology

The velocity structure obtained in this work and in the work of Ludwig et al (1968) for profile 152 are in very good agreement. The velocities and thickness of layers are listed in table 3. The thickness given for each layer is the average of the total thickness for the two buoys.

The layers with velocities from 1.98 to 3.51 km/sec found in this study are probably sediments of Cretaceous and younger age. Velocities of 2.0-4.0 km/sec were determined by Saaiman (1962) for Cretaceous sediments in a series of land refraction surveys near Port Elizabeth. Bryan and Simpson (1971) cite K.W.T. Graham of Soekor to the effect that seismic velocity surveys of deep wells penetrating thick Cretaceous sediments in the Algoa basin east of Port Elizabeth indicate that velocity contrasts between basal Cretaceous sediments and the underlying Paleozoic Cape sediments are generally small at relatively great depths. The wells indicate velocity maxima of the order of 3.9 and 4.9 km/sec in Cretaceous sediments buried to depths of about 2 and 3 km respectively. The higher values probably representing the basal Enon conglomerate. Spence (1972) states that at depths exceeding 2 km the velocities of the Enon and the Bokkeveld differ by as little as 0.2-0.3 km/sec. Thus for a situation of Enon overlying Bokkeveld rocks at depths greater than 2 km the Enon beds

Table 4

Velocities, thicknesses and Probable

Formation of layers on the Continental

Shelf and Slope

Velocity (km/sec)	Shelf (Profile 20) Thickness (km)	Slope (Profile 14) Thickness (km)	Probable formation
1.98-2.20	0.41	1.60	Tertiary to Present
2.70-3.51	2.03	1.20	Cretaceous
4.30	1.58	2.32	Upper Ordovician
5.94-6.31	-	-	Precambrian

would probably not be detected by refraction methods.

Directly below the above-mentioned velocity group are rocks with a velocity of 4.30 km/sec at depths of 2.55 and 5.54 km for profiles 20 and 14 respectively. Ludwig et al (1968) noted that the Cape and Karroo strata were considered to be represented by overlapping velocity ranges between 4.0 and 5.8 km/sec with the Karroo probably absent along the south coast. They considered the 4.0-5.5 km/sec velocity ranges as representative of the Karroo and Cape systems respectively. A velocity range of 4.0-5.5 km/sec was calculated for the Karroo system at a depth of 500 metres from a well log in the East London area (Fatti 1970). This correlates with the average value of 4.80 km/sec inferred for beds of Karroo age off the coast of Kenya (Francis et al 1966).

In the Ceres earthquake area where the Cape system was strongly deformed during the Cape folding period (Permo-Carboniferous) a velocity of 5.15 km/sec was obtained by Green and Bloch (1971) from aftershock data.

The velocities 6.31 and 5.94 km/sec for the above profiles are representative of velocities of some basement granites as well as Malmesbury strata (Green, 1972 Unpublished). This layer is traced consistently along the shelf and is termed continental basement and it has velocities ranging from 5.3 to 6.5 km/sec (average 5.90 km/sec) (Ludwig et al, 1968; Leyden et al, 1971). On the continental shelf between Cape Hatteras and Cape Fear a velocity of 5.95 km/sec was obtained for the basement by Dowling (1968). Spence (1972) correlates the velocity range 5.69-6.33 km/sec on the Agulhas bank, south of Cape Infanta with Granite or Malmesbury Strata.

Table (4) summarises the velocities, thicknesses and probable formation of the geologic structures measured for profiles 20 and 14 on the continental shelf and slope.

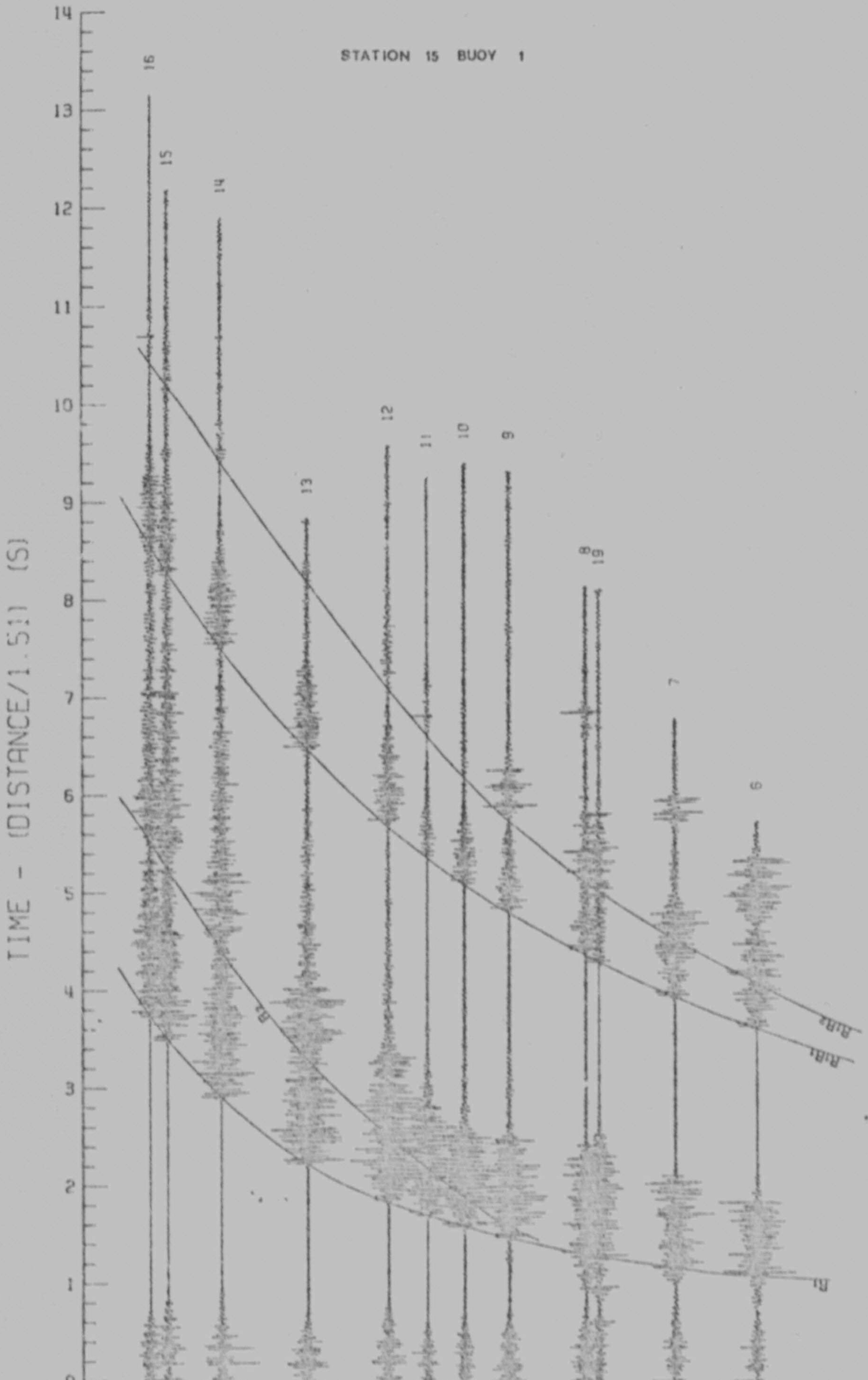

FIGURE 15. Reflection record section from buoy 1, profile 15.

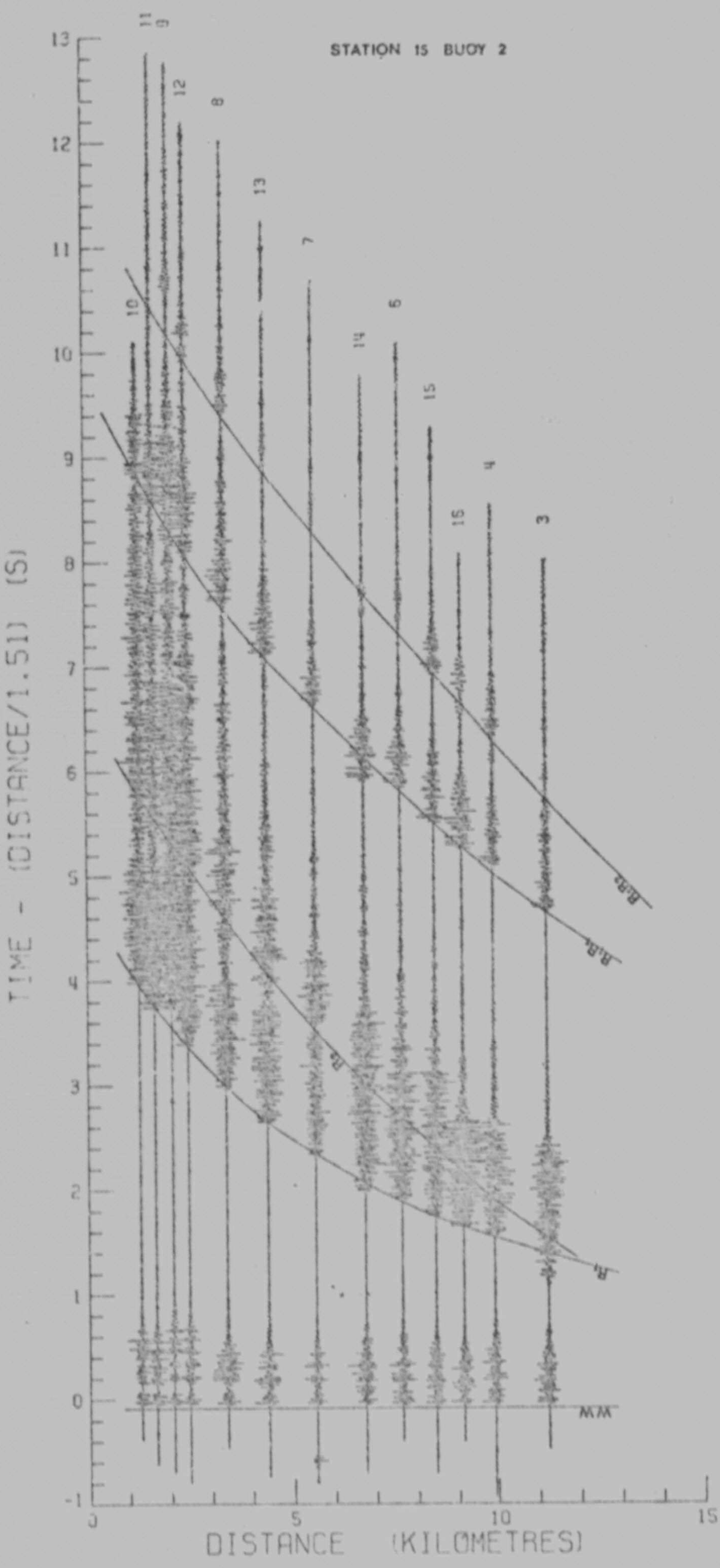

FIGURE 16. Reflection record section from buoy 2, profile 15.

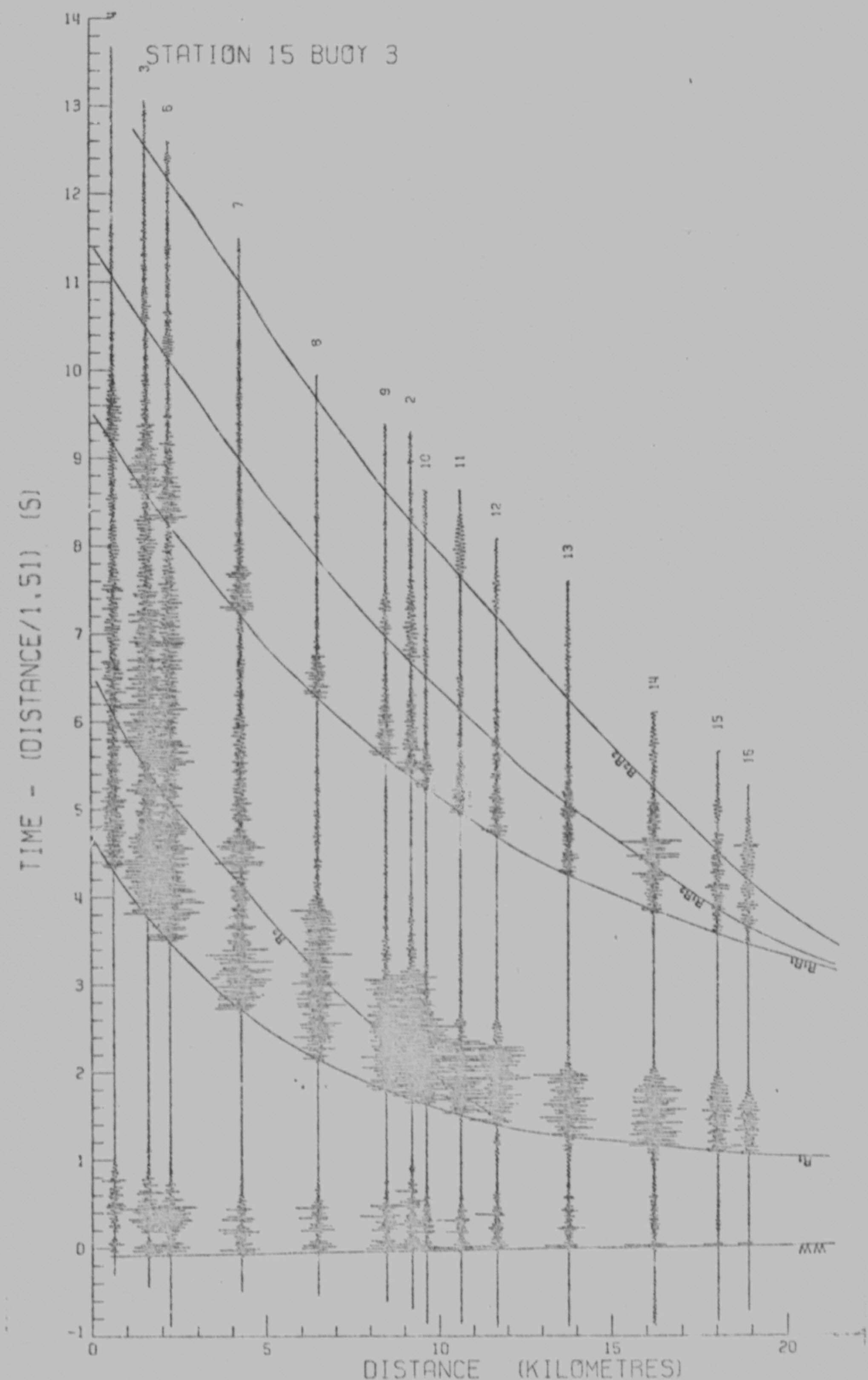

FIGURE 17. Reflection record section from buoy 3, profile 15.

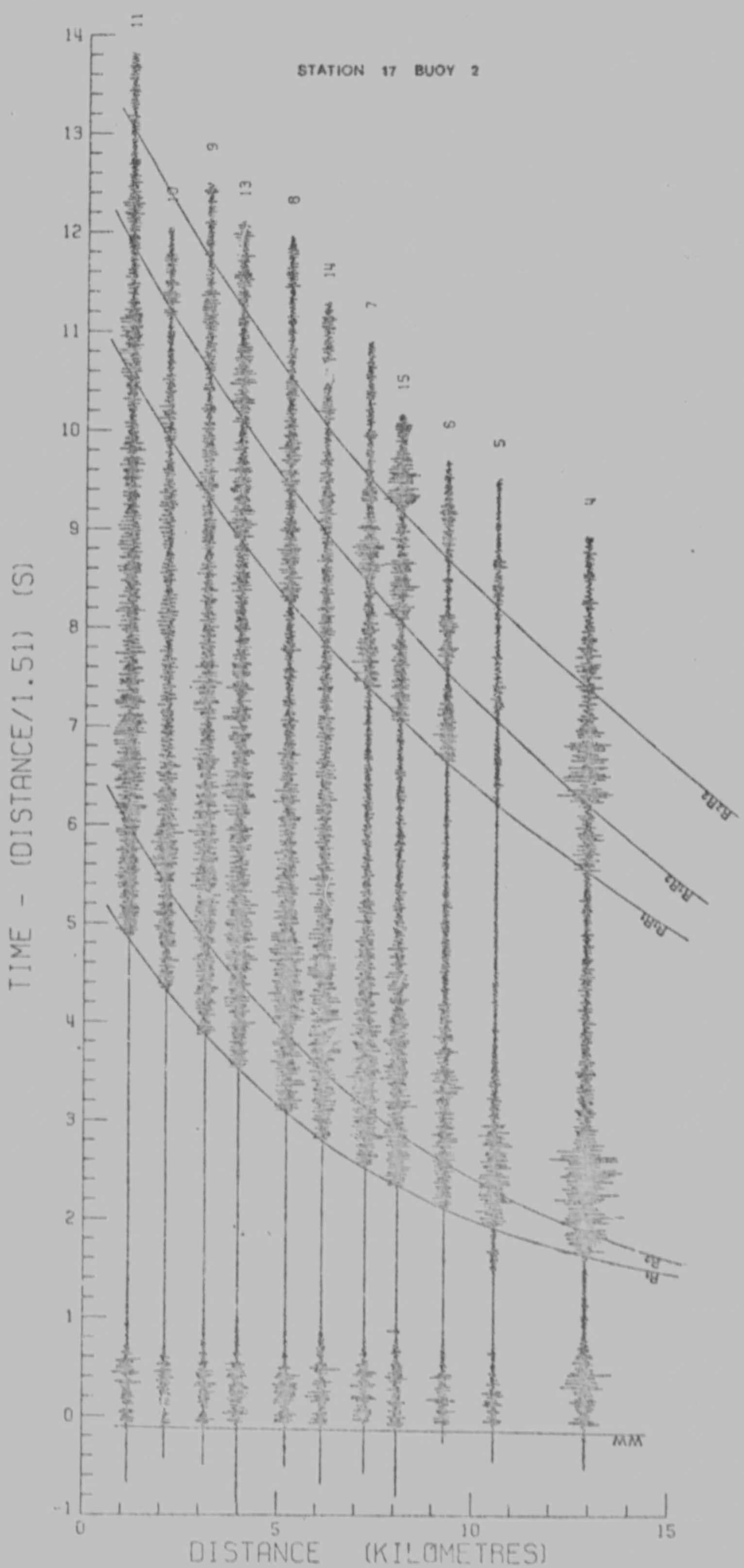

FIGURE 18. Reflect on record section from buoy 2, profile 17.

Table 5

Root mean Square Deviation for Travel Times of model Structures and Observations for Profiles 15 and 17

Station 15

Buoy No	Arrival	No of Observations	Linear Velocity Gradient (sec^{-1}) 0.80	0.85	0.90	0.95	1.00
			R.M.S. Error X 10^{-2}sec				
1	R_2	9	6.30	3.10	3.10	6.30	10.00
1	R_1R_2	11	8.20	4.90	2.80	4.60	8.00
1	R_2R_2	11	7.30	3.90	1.50	3.90	7.40
2	R_2	13	8.40	5.30	3.50	4.70	7.60
2	R_1R_2	13	5.20	3.50	2.60	3.50	5.30
2	R_2R_2	12	5.00	3.40	3.10	4.30	6.20
3	R_2	9	7.50	3.70	1.00	4.50	8.30
3	R_1R_2	14	5.70	3.20	3.10	7.70	14.60
3	R_2R_2	13	12.50	6.50	3.30	7.80	13.80
		Mean	7.30	4.20	2.70	5.30	9.00

Table 5 (Continued)

Station 17

Buoy No	Arrival	No of Observations	Linear Velocity Gradient (sec^{-1}) 0.80	0.85	0.90	0.95	1.00
			R.M.S. Error X 10^{-2}sec				
1	R_2	9	6.00	4.80	4.20	4.50	5.40
1	R_1R_2	9	5.00	4.90	4.10	5.60	6.30
1	R_2R_2	9	6.10	4.90	4.00	3.40	3.60
2	R_2	14	8.20	7.20	6.70	6.80	7.40
2	R_1R_2	14	5.30	4.90	4.70	4.60	4.70
2	R_2R_2	14	6.10	5.30	4.70	4.30	4.20
3	R_2	9	8.90	7.50	6.40	5.90	5.90
3	R_1R_2	9	5.90	5.80	5.80	6.00	6.20
3	R_2R_2	9	5.80	5.40	5.10	5.10	5.20
		Mean	6.40	5.60	5.10	5.10	5.40

TABLE 6

Water and Sediment Structure for Profiles 15 and 17

Profile	Buoy 1		Buoy 2		Buoy 3		mean	
	Velocity (km/sec)	Thickness (km)	Velocity (km/sec)	Thickness (km)	Velocity (km/sec)	Thickness (km)	Velocity (km/sec)	Thickness (km)
15	1.51 1.51 - 3.62	3.60 2.34	1.51 1.51 - 3.63	3.57 2.36	1.51 1.51 - 3.57	3.63 2.29	1.51 2.49	3.60 2.33
17	1.51 1.51 - 2.66	4.24 1.28	1.51 1.51 - 2.65	4.25 1.27	1.51 1.51 - 2.62	4.20 1.23	1.51 2.00	4.23 1.26

IV. Seismic Studies in the Transkei Basin

A. Profiles 15 and 17

Profiles 15 and 17 were located in the Transkei basin where the water exceeds 3.5 km in depth. Station 15's profile trends in a southwest-northeast direction and during the observation of the profile the maximum buoy drift was 12 km in a southwesterly direction. Profile 17 to the south of profile 15, trends in a north - south direction and during the 9 hr operation the buoys drifted 19 km in a north-east direction.

Sedimentary structure for the two profiles was calculated utilising . model with velocity proportional to depth of burial, i.e.

$$C_2 = \text{Grad}^* H + 1.51 \text{ km/sec}$$

where H is the depth of burial. The velocity gradient in the unconsolidated sediments was determined from the sub-bottom reflections R_2, R_1R_2 and R_2R_2 (Chapter IIC) (Green 1966). Figures (15-18) are the reflection record sections for these two profiles.

The mean square deviations from five proposed models of linear velocity gradients are given in table (5) and the results suggest that the velocity gradient of 0.9 sec^{-1} fit the observations best, although there is not a significant difference in the r.m.s. results for profile 17. The poor results for profile 17 are probably due to the thickness of sediment viz 1.3 km whilst for profile 15 the sediments are 2.3 km thick. The water depth and sediment structure obtained for the 3 buoys of the profiles is given in table (6) and the table shows that the three buoys are in good agreement.

The deeper structure was determined from the first and second arrival refracted waves and the travel time plots (figures (19-20)) and record sections (figures (21-23)) are shown for the two profiles. The apparent velocities and intercept times for the 3 buoys are listed in

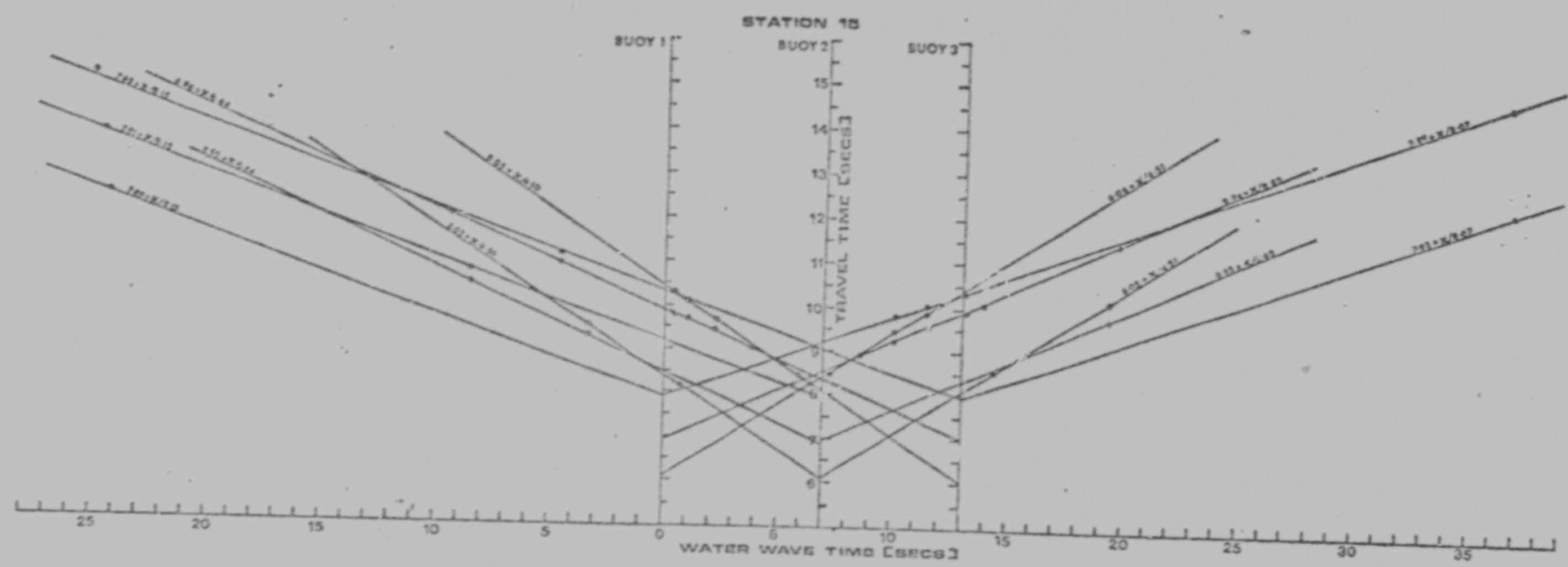

FIGURE 19. Travel-time plot for profile 15.

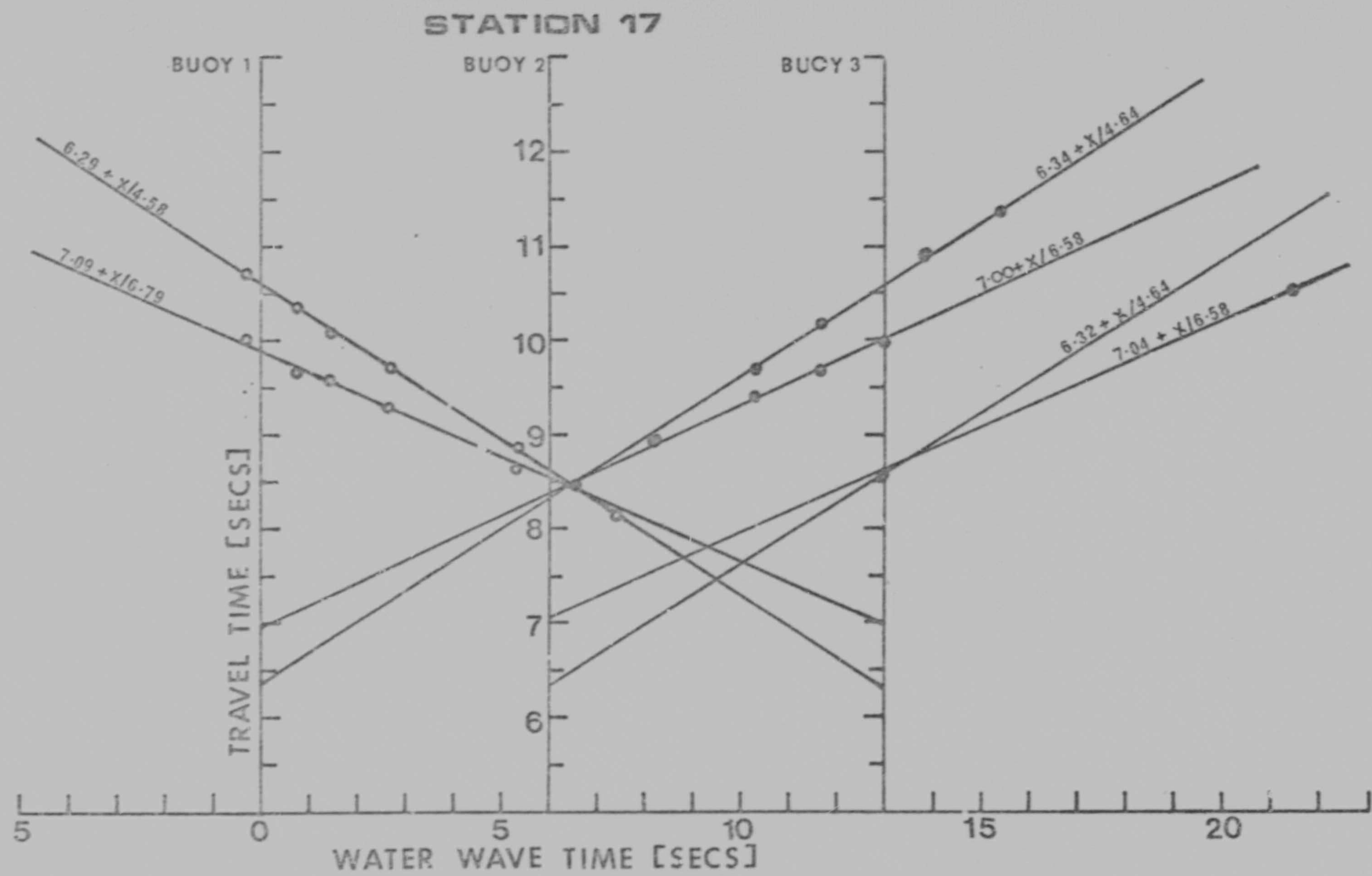

FIGURE 20. Travel-time plot for profile 17.

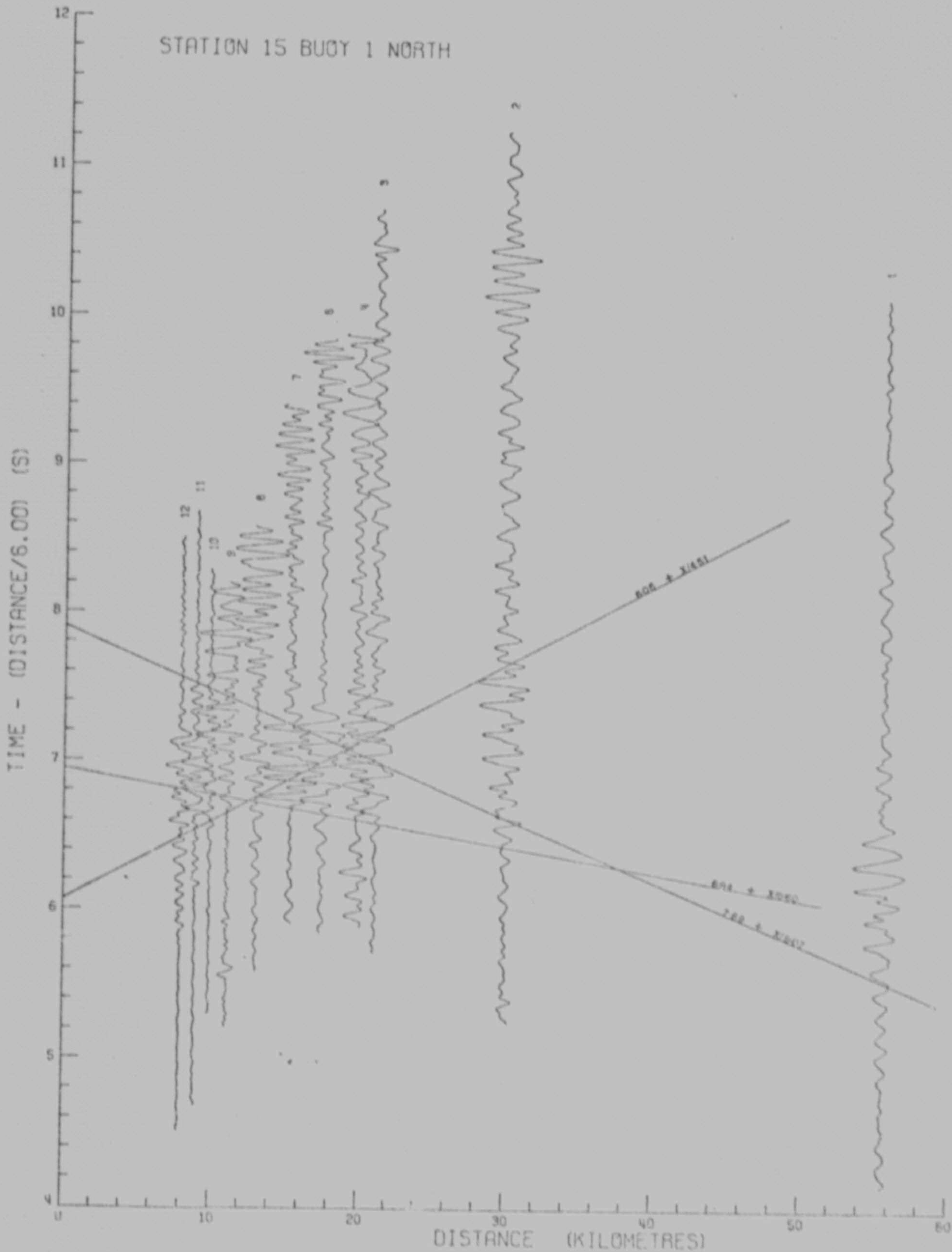

FIGURE 21. Refraction record section from buoy 1, profile 15.

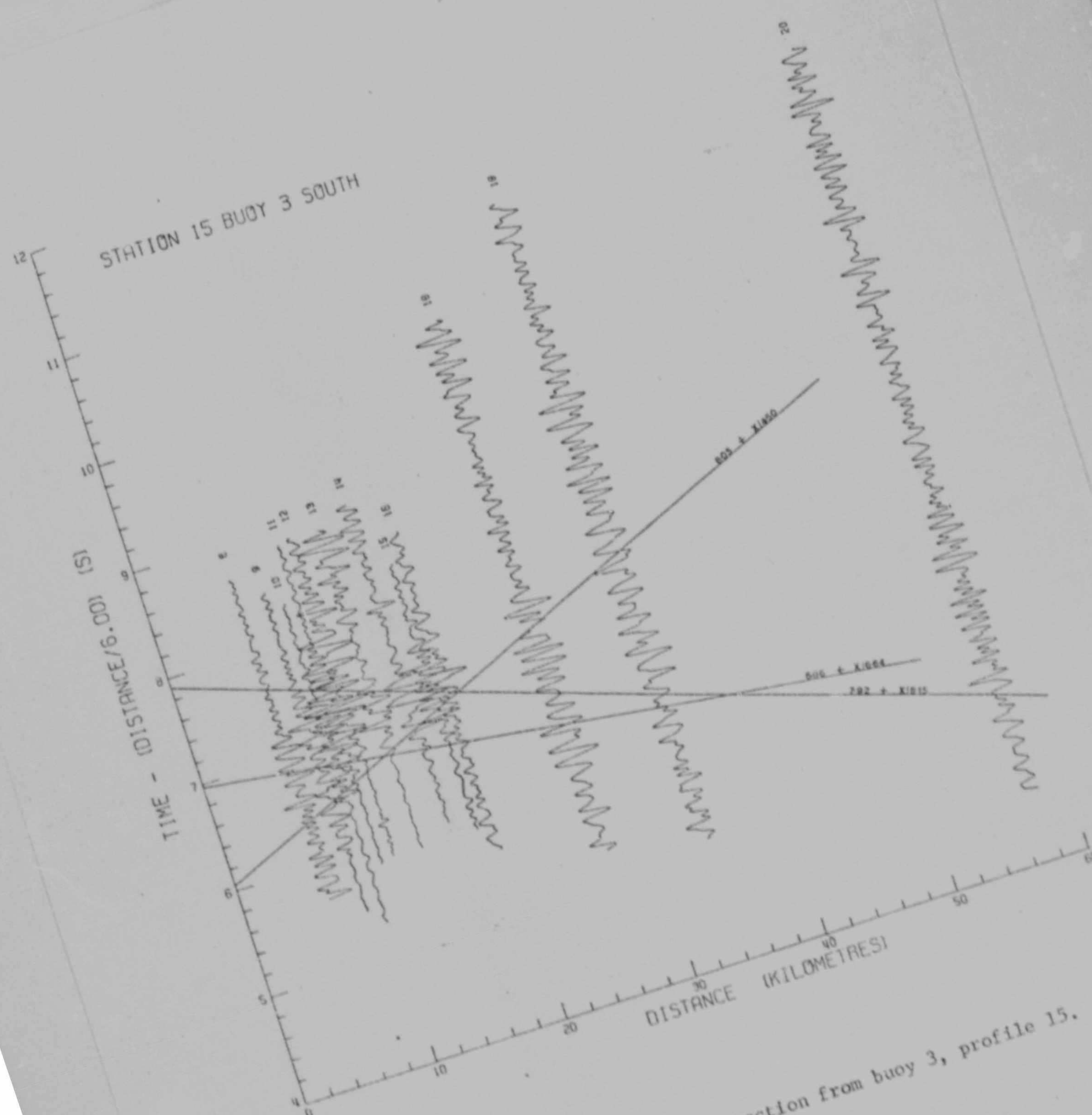

FIGURE 22. Refraction record section from buoy 3, profile 15.

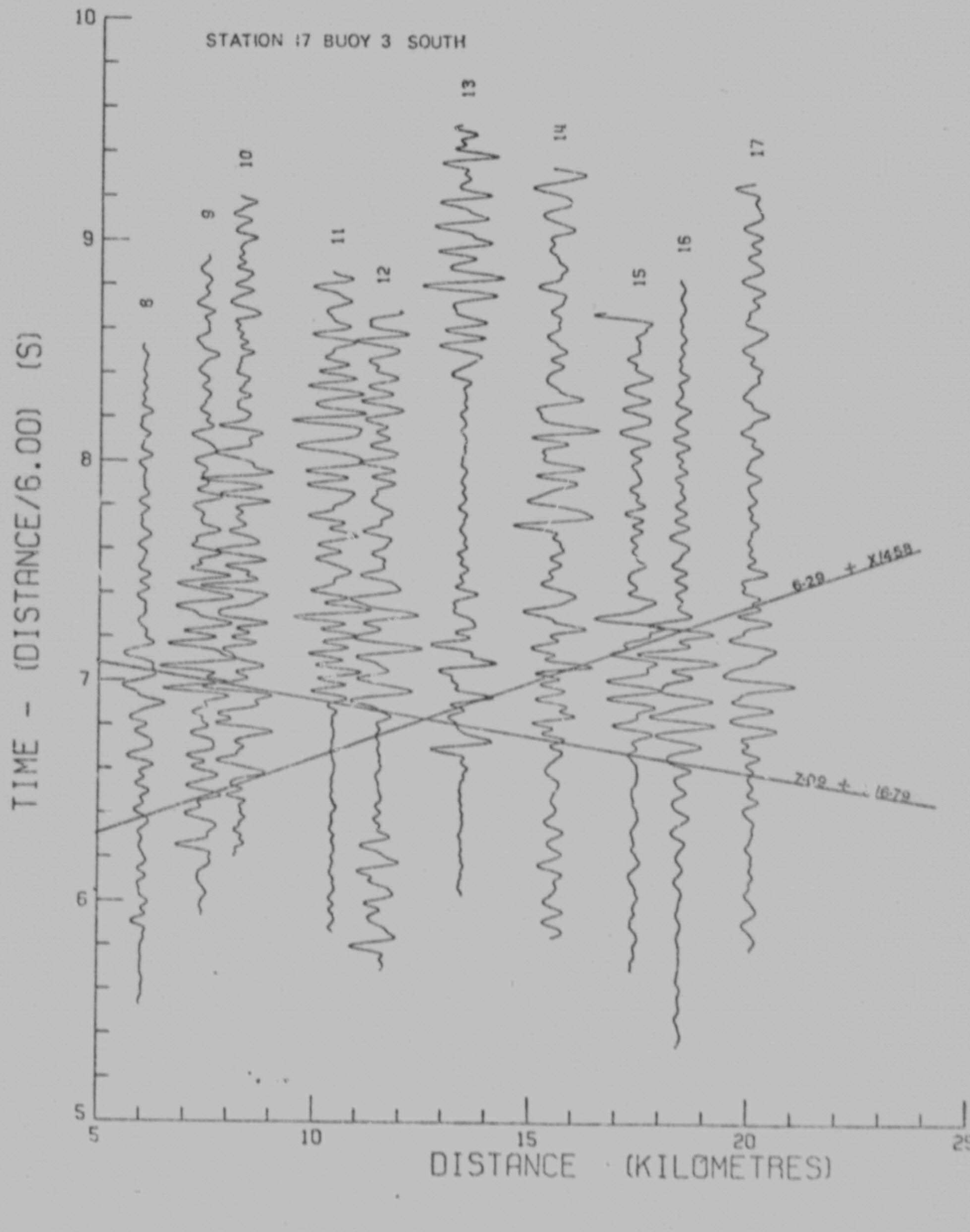

FIGURE 23. Refraction record section from buoy 3, profile 17.

Table 7

Apparent Velocities and Intercept times for

profiles 15 and 17

Station 15

Buoy No	Layer No	Velocity (km/sec)		Intercept Time (sec)
		S.W	N.E	
1	2	4.51 ±.03	-	6.06 ±.02
	3	6.60 ±.05	6.64 ±.04	6.94 ±.02
	4	8.07 ±.05	8.15 ±.06	7.89 ±.03
2	2	4.51 ±.03	4.50 ±.04	6.05 ±.02
	3	6.60 ±.05	6.64 ±.04	6.95 ±.02
	4	-	8.15 ±.06	7.91 ±.03
3	2	-	4.50 ±.03	6.04 ±.02
	3	6.60 ±.05	6.64 ±.04	6.96 ±.02
	4	8.07 ±.05	8.15 ±.06	7.92 ±.03

Station 17

Buoy No	Layer No	Velocity (km/sec)		Intercept Time
		N	S	
1	2	4.64 ±.04	-	6.34 ±.03
	3	6.58 ±.23	-	7.00 ±.10
2	2	4.64 ±.04	-	6.32 ±.03
	3	6.58 ±.23	-	7.04 ±.10
3	2	-	4.58 ±.04	6.29 ±.03
	3	-	6.79 ±.29	7.09 ±.10

Table 8

True Velocities, Thicknesses and Dips for

profiles 15 and 17

Station 15

Layer No	Velocity (km/sec)	Thickness (km)	Depth (km)	Dip (Relative to Surface) (Deg)
0	1.51	3.60	3.60	0.00
1	1.51-3.61	2.33	5.93	0.00
2	4.51	1.76	7.69	0.10
3	6.62	4.49	12.18	-0.22
4	8.11	-		0.27
		12.18	12.18	

Station 17

Layer No	Velocity (km/sec)	Thickness (km)	Depth (km)	Dip (Relative to Surface) (Deg)
0	1.51	4.23	4.23	0.00
1	151-2.66	1.26	5.49	0.00
2	4.61	1.33	6.82	0.18
3	6.69	-	-	-1.18
			6.82	

table (7) whilst table (8) lists the true velocity, dip and thickness for each layer of the two profiles.

The refractions from layer 2 which first appear at the closest ranges as first arrivals are clearly distinguishable out to more than 15 water wave secs as second arrivals. The early arrivals appear after the water break and just before the first bottom reflection. The arrival with velocity 4.5 km/sec obtained for profile 15 is fairly well determined by 5 first arrivals obtained from the 3 buoys; however no arrivals were obtained from the southwest and northeast for buoys 1 and 3 respectively due to the spacing of the shots. The 4.6 km/sec velocity for profile 17 is based on 3 first arrivals and 9 second arrivals with only 1 reading obtained from the northern side of buoy 2. The Southern profile of buoy 1 and the northern profile of buoy 3 did not yield any 4.6 km/sec arrivals. The difference in thickness for this layer for the two profiles is 0.4 km.

The 6.6. km/sec velocity from the oceanic layer is well determined from first arrivals for both the profiles. This refracted phase is clear (figures (21-23)). The suggested dip obtained for this layer is in the northeast direction; however when the errors are considered the dip is insignificant.

The moho velocity of 8.1 km/sec obtained for profile 15 is not well determined and is therefore unreliable. The 5 first arrivals for the 3 buoys came from depth charges which had a low signal to noise ratio. Moreover the shots furthest from the buoys were too few and widely spaced being about 22 km apart. No moho velocity was obtained for profile 17 because the time marks failed for the shots on the southern section of the profile and the furthest shots on the northern section were too poor to be utilized.

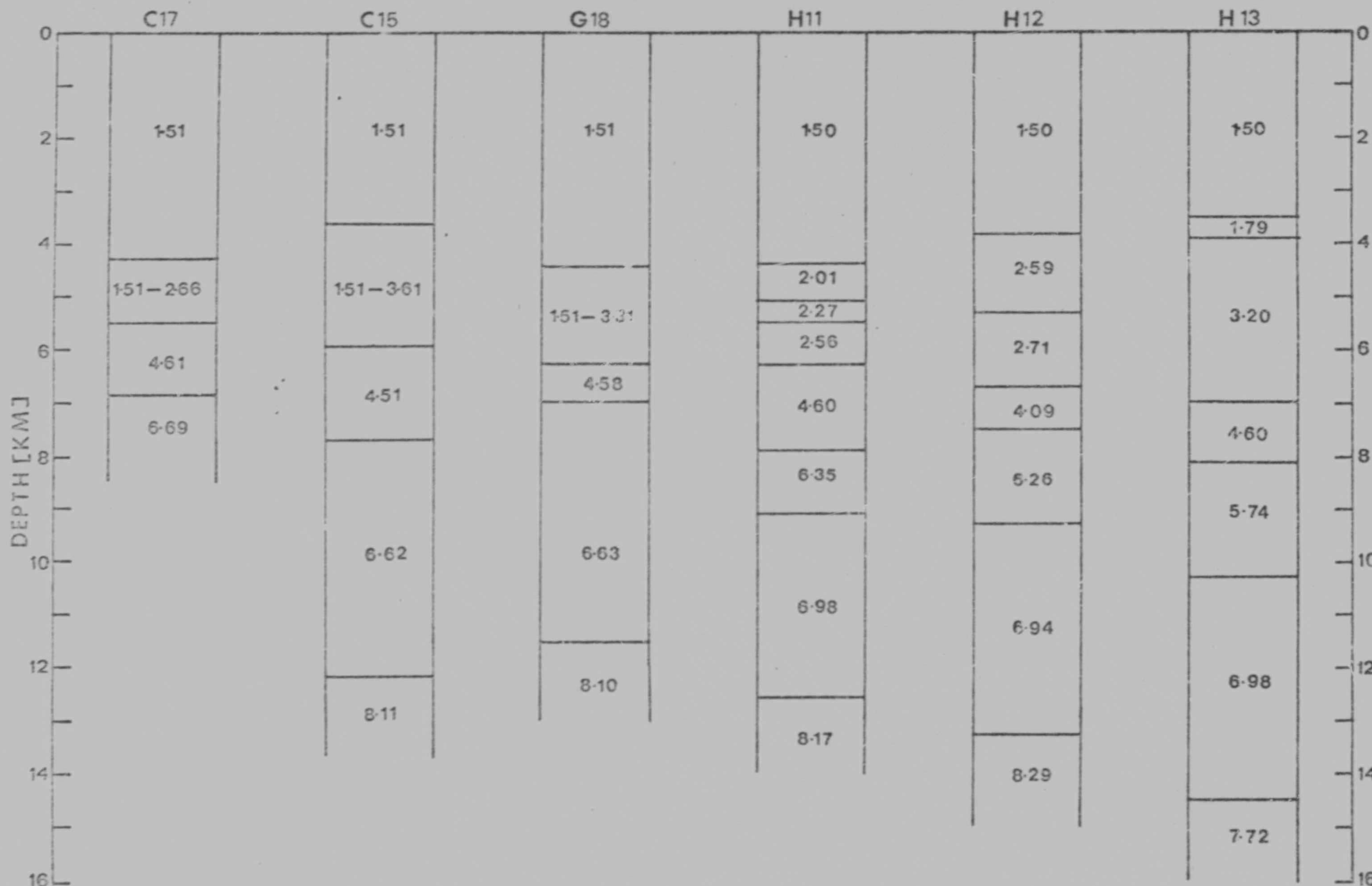

FIGURE 24. A summary of the results of seismic profiles in the Transkei basin. Profile G18 is from Green and Hales (1966), profiles H(11-13) from Hales and Nation (1973) and C17 and C15 from present study.

B. Discussion of the Transkei Basin Profiles.

The sediment thickness with velocity less than 4.0 km/sec for these profiles are 2.33 km for 15 and 1.26 km for 17. The sediment thickness obtained for profile 15 is similar to the value found by Hales and Nation (1973) for profile 12 viz 2.84 km. Velocities and layer thicknesses for profile 11, 12, 13 by Hales and Nation (1973) and 18 by Green and Hales (1966) are given in figure (24).No refracted or reflected arrivals could be identified from layers within the sediment column as was found for the profiles of Hales and Nation. Taking an average of the six profiles an average sediment thickness of more than 2 km is obtained. These sediment thicknesses are similar to the Argentine basin of the Atlantic Ocean where the sediments attain a thickness of more than 2.5 km (Ewing et al, 1965). In the Indian Ocean, the Somali basin, Arabian basin and the Central Indian basin sediment thicknesses of 1 to 2.5 km have been measured (Laughton et al, 1970). These sediments have probably been derived from erosion of the adjacent continents and transferred to the basins by turbidity currents and in the manner described by Ewing (1965). It was suggested (Hales and Gough, 1960) that the negative isostatic gravity anomaly in the Southern Cape could be accounted for by the removal of about 1.4 km of material over a strip of width 80 km, the removal process probably beginning in early or middle Jurassic time and being well established by mid-Cretaceous time. The anomaly dips below -60 milligal over a strip more than 200 km in length. Using this data Hales and Nation (1973) worked out that the area of drainage (shown in dashed line in figure (1)) to be of the order of 150,000 km^2 which is half the area of the Transkei basin outlined by the dotted curve. It appears, therefore, that about 4 km has been eroded from the whole of the drainage area of figure (1). According to these measurements they suggest that much more has been eroded than was estimated from the gravity anomalies.

The velocity and thickness of layer 2 for profiles 15 and 17 is in good agreement with that obtained for profiles 11 and 13 of Hales and Nation (1972). Taking all the basin profiles, the velocities and thicknesses for this layer range from 4.1-4.6 km/sec and 0.7-1.8 km respectively, indicating its rough topography. The mean velocity value of 4.5 km/sec is lower than that of the Pacific Ocean basins (5.15 km/sec) (Shor et al, 1970) and the Western North Atlantic Ocean (5.14 km/sec) (Raitt, 1963.) For the five Indian Ocean stations measured by Gaskell and Swallow (1953) during the Challenger Expedition the mean thickness of layer 2 was approximately 2 kms and the velocity 4.6 km/sec. Seismic velocities for "Layer 2" from 75 cores (32 sites) of the Deep Sea Drilling Project range from 3.46 km/sec to 6.4 km/sec, with a vast majority of these results falling within the range 4.4 to 5.6 km/sec (Christensen, 1973; Schreiber and Fox, 1973). This variability may result from several causes; weathering, differences in accoustic properties of basalts and interlayering of basalts with sediments. Recent sonobuoy studies indicate that layer 2 is characterized by two velocity layers (Talwani et al, 1971). The upper portion layer 2A (2.5 - 3.8 km/sec) is made up of a fractured pile of glassy pillow basalts and flows; the lower portion (4.0 - 6.0 km/sec) is made up of zeolite and greenschist facies meta-basalt and minor meta-dolerite (Schreiber and Fox, 1973).

The velocity 6.6 km/sec in the third layer (oceanic layer) agrees well with that measured for profile 18 of Green and Hales; however for these profiles only one basement phase could be identified, compared to the two phases identified by Hales and Nation. These authors report that the travel time differences between the one and two layer interpretations are small, being less than 0.3 secs. The data for profiles 15 and 17 was not clear enough to justify a two basement layer interpretation and it is possible that the arrivals from the low 6.0 km/sec layer were combined with the 6.9 km/sec layer to give an average oceanic layer velocity of 6.6 km/sec. The mean of the two velocities for the oceanic layer obtained by Hales and Nation give values of 6.7, 6.6 and 6.4 km/sec. In the Argentine basin a velocity range of 6.4-6.5 km/sec was obtained by Ewing et al (1964) for this layer. The mean velocity for this layer in the Pacific ocean is 6.32 km/sec with a mean thickness of 4.57 km (Shor et al, 1970).

The velocity obtained for the mantle for the above 5 profiles (8.07 ± 0.19 km/sec) is consistent with the average mantle velocity for the Indian Ocean (8.11 ± 0.18 km/sec). Francis and Raitt (1967) report that this is significantly lower than the Pacific Ocean average of 8.20 ± 0.18 km/sec. The mantle velocity 7.72 km/sec for profile H13 is based mainly on second arrivals and since no errors on the velocities and thicknesses are given by Hales and Nation it is not possible to say whether the depths to mantle for the 5 profiles in figure (24) are significantly different.