No: 04

THE REPUBLIC OF ECUADOR

FEASIBILITY STUDY ON SMALL-SCALE FISHING PORT DEVELOPMENT PROJECT IN MANABI PROVINCE

APPENDICES

MARCH 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

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CONTENTS

1. Natural Conditions
1.1 Velocity of Wind

Velocity of wind on study area is not so strong. Mean velocity is less than 3.0 m/sec. Monthly mean velocities of wind on Manta, Julcuy and Lopez are shown in Table 2-8. Based on wind data obtained for INOCAR (Instituto Oceanografico de la Armada) and DAC (Direction de Aviacion Civil) at Manta location is possible to find the wind variability for normal year.
Table 2-9 and 2-10 show the mean annual direction for both year. From these tables we can estimate that during the wet season (January-June) of a normal year 40 % of the measured wind comes from the west. The wind switches to the southwest during the dry season.
During 1986-87 south-southwest wind accounts for the 52 % of total frequency.
Table 2-11 and 2-12 show the monthly mean velocity of wind taken at three different hours (7, 13 and 19) of each day.
Fig 2-4 simultaneously shows the wind speed and wind direction for a period extending from 1981 to 1988. A wind rose is constructed and it shows that a NNW-W-SSW is the predominant wind direction.

Table 2-8 Monthly Mean Wind Velocity :m/sec

Station	Jan	Feb	Mar	Apl	May	Jun	Jul	Agu	Spt	Oct	Nov	Dec	Mean
Manta	2.4	2.2	2.2	2.4	2.9	2.9	3.2	3.3	3.6	3.3	3.2	3.4	2.9
Julcuy	1.2	0.9	1.0	1.2	1.6	1.5	1.8	1.8	1.9	1.8	1.8	1.7	1.5
Lopez	3.0	2.4	3.0	2.5	2.7	2.5	3.0	3.1	3.0	3.0	3.2	2.7	2.8

Table 2-9 Monthly Wind Direction at Manta (1986-1987)

FUENTE: Instituto Oceanografico de la Armada

ESTACION MANTA — PROVINCIA MANABI — AÑO 1986-1987

MES	NUM/OBS	N	NE	E	SE	S	SW	W	NW	C
MARZO	93	4	1	2	3	14	26	24	6	13
ABRIL	90	0	1	0	9	13	30	19	5	13
MAYO	93	0	0	1	5	35	26	19	1	6
JUNIO	90	0	1	0	5	50	22	11	1	0
JULIO	93	0	0	0	5	48	28	8	2	2
AGOSTO	93	0	0	0	6	47	25	15	0	0
SEPTIEMBRE	90	0	0	0	1	51	22	15	1	0
OCTUBRE	93	0	0	0	4	43	35	9	0	2
NOVIEMBRE	90	0	0	1	4	40	32	12	0	1
DICIEMBRE	93	0	0	0	0	57	20	13	1	2
ENERO	93	1	0	3	5	19	25	27	4	9
FEBRERO	84	3	1	4	2	15	15	16	13	15
TOTAL	1095	8	4	11	49	432	306	188	34	63

TOT.OBS	FRECUENCIA								
1095,00	0,73%	0,37%	1,00%	4,47%	39,45%	27,95%	17,17%	3,11%	5,75%

Source: INOCAR

Table 2-10 Monthly Mean Wind Velocity (1986-1987)

FUENTE: Instituto Oceanografico de la Armada

ESTACION MANTA — PROV MANABI

VELOCIDADES (m/s)

	HORAS 7	HORAS 13	HORAS 19
MARZO	1,52	5,03	3,42
ABRIL	1,63	5,17	3,63
MAYO	2,61	5,74	5,00
JUNIO	3,90	5,83	5,37
JULIO	4,00	5,90	5,74
AGOSTO	3,71	6,23	6,35
SEPTIEMBRE	3,83	7,23	6,40
OCTUBRE	3,45	6,39	5,65
NOVIEMBRE	4,27	5,83	6,17
DICIEMBRE	3,74	6,26	6,23
ENERO	2,26	5,29	4,74
FEBRERO	1,43	3,68	4,07
VELOCIDAD MEDIA (m/s)	3,03	5,72	5,23

Source: INOCAR

Table 2-11 Monthly Wind Direction at Manta (1979-1980)

FUENTE: Direccion de Aviacion Civil

ANO 1979-1980

ESTACION MANTA PROVINCIA MANABI

MES	NUM/OBS	N	NE	E	SE	S	SW	W	NW	C
ENERO	93	1	0	2	3	35	8	28	5	11
FEBRERO	87	0	0	0	1	13	3	42	5	23
MARZO	93	9	2	2	4	6	1	37	2	30
ABRIL	90	2	1	0	1	10	0	46	3	27
MAYO	93	1	0	2	1	12	15	41	4	17
JUNIO	90	0	0	1	1	11	50	22	5	0
JULIO	93	0	0	0	0	17	53	21	2	0
AGOSTO	93	2	0	1	6	29	17	29	0	9
SEPTIEMBRE	90	0	1	0	6	25	24	27	0	7
OCTUBRE	93	1	0	0	0	10	48	31	2	1
NOVIEMBRE	90	0	0	0	0	4	38	40	2	6
DICIEMBRE	93	0	0	0	0	7	46	33	4	3
TOTAL	1098	16	4	8	23	179	303	397	34	134
	TOT.OBS	FRECUENCIA								
	1098,00	1,46%	0,36%	0,73%	2,09%	16,30%	27,60%	36,16%	3,10%	12,20%

Source: Direccion de Aviacion Civil

Table 2-12 Monthly Mean Wind Velocity (1979-1980)

FUENTE: Direccion de Aviacion Civil

ESTACION MANTA PROV MANABI

VELOCIDADES (m/s)

MESES	HORAS 7	13	19
ENERO	2,03	5,06	4,55
FEBRERO	0,57	5,29	3,52
MARZO	0,48	4,74	3,06
ABRIL	0,53	8,19	5,79
MAYO	1,81	8,26	6,97
JUNIO	4,53	8,73	8,23
JULIO	5,16	8,74	8,32
AGOSTO	3,29	7,29	7,55
SEPTIEMBRE	3,00	7,53	7,27
OCTUBRE	4,74	9,68	7,90
NOVIEMBRE	4,33	9,57	7,40
DICIEMBRE	4,68	8,42	7,74
VELOCIDAD MEDIA (m/s)	2,93	7,61	6,53

Source: Direccion de Aviacion Civil

Dirección	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Velocidad																
1 - 5 Nudos	1,2	0,2	0,2	0,1	0,4	0,5	0,3	0,7	5,6	5,6	3,0	2,2	1,8	1,3	0,8	1,0
6 - 10 "	1,2	0,2	0,1	0,1	0,1	0,1	0,1	0,3	5,5	9,2	7,9	6,2	5,0	9,7	4,4	3,2
11 - 15 "	-	-	-	-	-	-	-	-	0,2	0,6	0,5	0,3	0,9	3,1	0,6	0,2
16 - 20 "	-	-	-	-	-	-	-	-	-	-	-	-	0,1	0,4	-	-
Más de 20 "	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

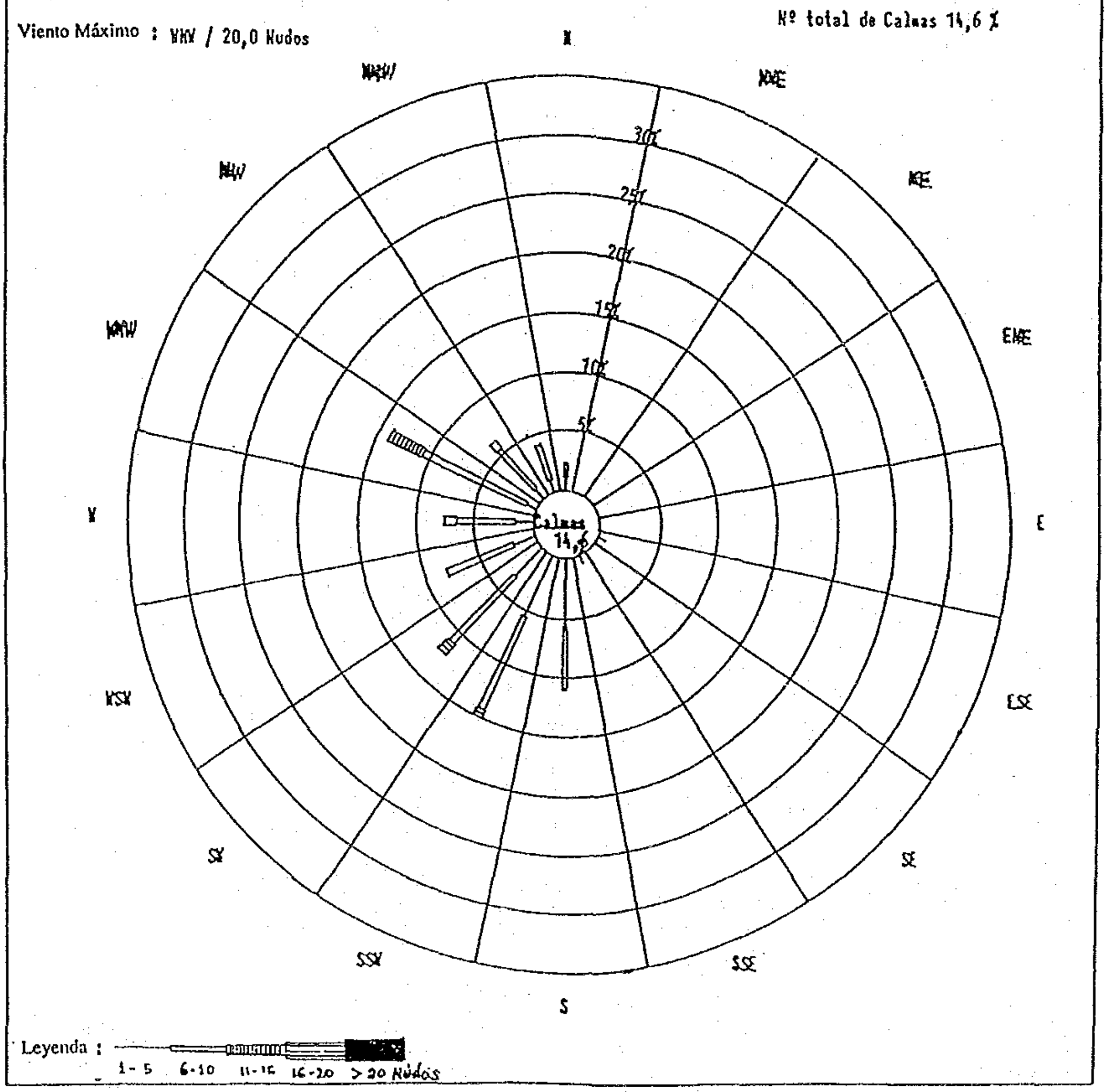


Fig 2-4 Wind Rose at Manta (1981-1988)

1.2 Oceanography

(1) Tide

Tide of Ecuador is shown in Fig 2-6 that represent two high and two low tide every 24 hours. The period interval is 12 hours. The highest tide amplitude between low and high tide is 2.9 m. Tide at Manta is shown in the followings.

MHWS = 3.46 m
MHW = 2.99 m
MSL = 2.08 m
MLW = 1.21 m
MLWS = 0.49 m

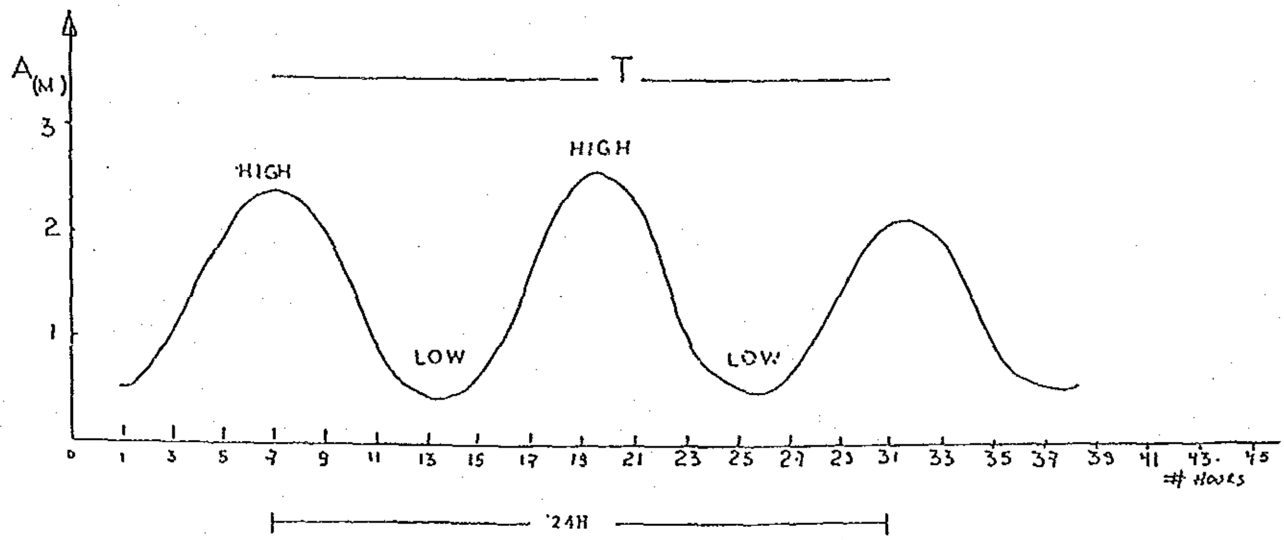
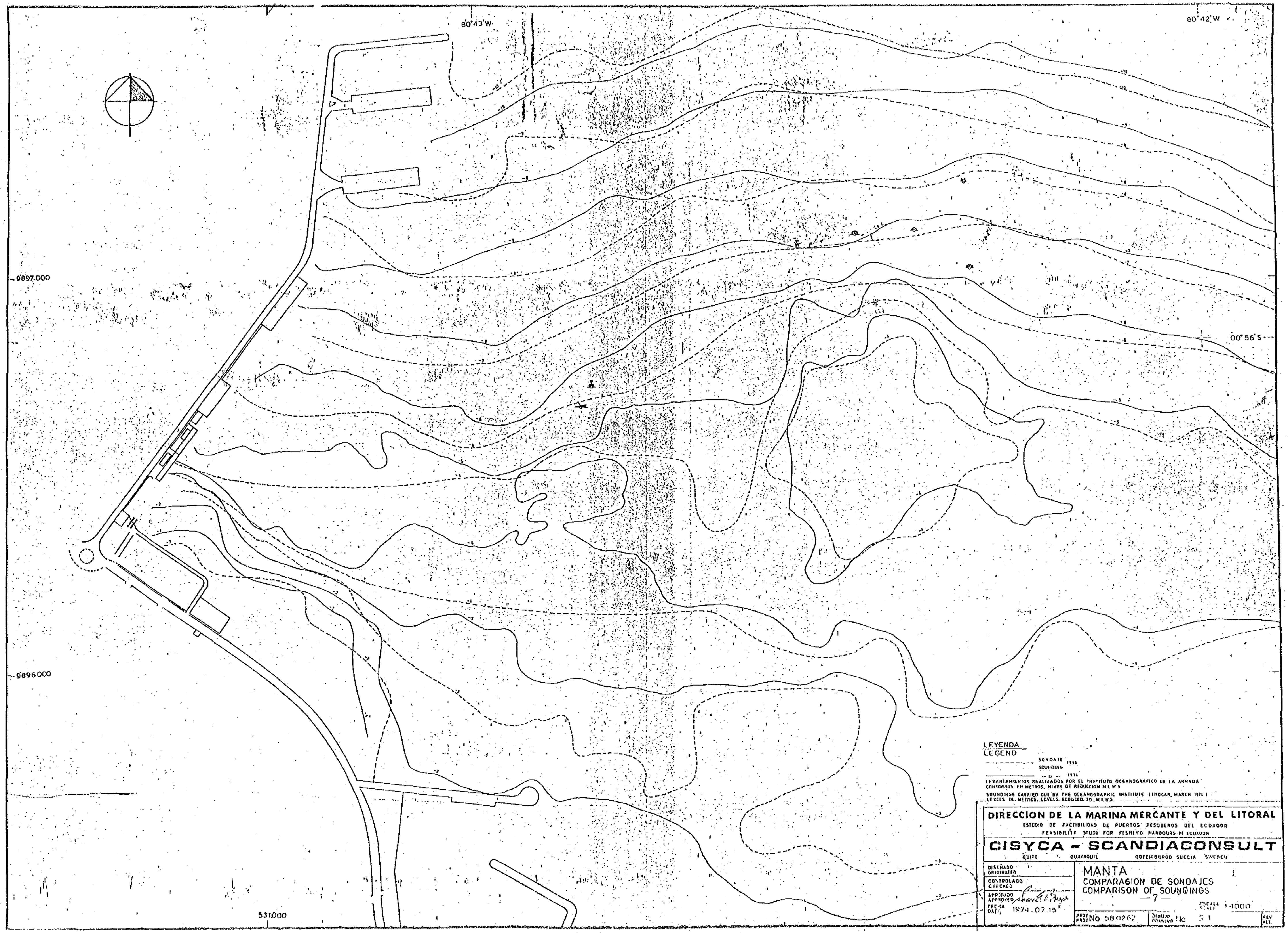


Fig 2-6 Tide of Ecuador Coast

(2) Bathymetric Maps.
Mapas Batimétricos.

There are some bathymetric maps on this Study. When we compare that of 1965 and 1974 (this comparison is shown on Fig. A), on this map the depth around the commercial port becomes shallow.

Hay varios mapas batimétricos en este Estudio. Cuando comparamos aquel de 1965 y 1974 (comparación que se puede apreciar en la Fig. A) en este mapa la profundidad alrededor del puerto comercial se convierte en menos profunda.



80°43'W
80°42'W
9897.000
9896.000
00°56'S
531.000
LEYENDA
LEGEND
SONDAJE 1965
SOUNDING
— " — 1974
LEVANTAMIENTOS REALIZADOS POR EL INSTITUTO OCEANOGRAFICO DE LA ARMADA
CONTORNOS EN METROS, NIVEL DE REDUCCION M.L.W.S.
SOUNDINGS CARRIED OUT BY THE OCEANOGRAPHIC INSTITUTE (INOCAR, MARCH 1974)
LEVELS IN METRES. LEVELS REDUCED TO M.L.W.S.
DIRECCION DE LA MARINA MERCANTE Y DEL LITORAL
ESTUDIO DE FACTIBILIDAD DE PUERTOS PESQUEROS DEL ECUADOR
FEASIBILITY STUDY FOR FISHING HARBOURS IN ECUADOR
CISYCA - SCANDIACONSULT
QUITO GUAYAQUIL GOTEMBURGO SUECIA SWEDEN
DISEÑADO ORIGINATED
CONTROLADO CHECKED
APROBADO APPROVED
FECHA DATE 1974.07.15
MANTA
COMPARACION DE SONDAJES
COMPARISON OF SOUNDINGS
— 7 —
ESCALA SCALE 1:4000
PROY PROJ No 58-0267
DIBUJO DRAWING No
REV ALT.

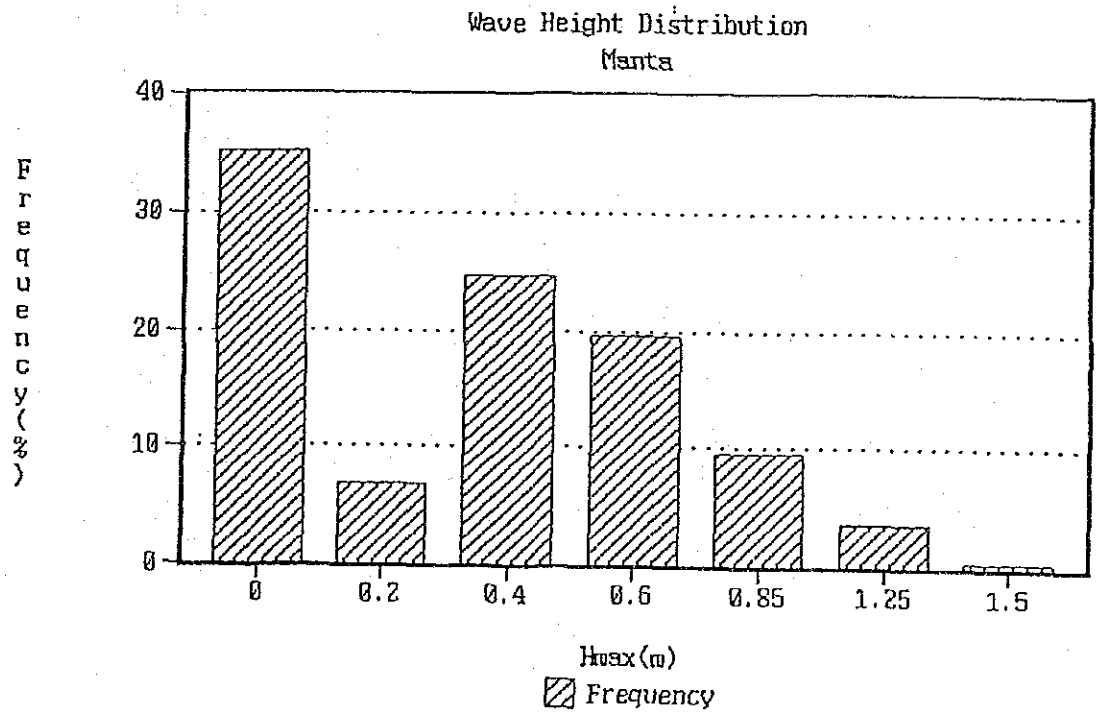
(3) Wave

1) Wave Observation

Wave Observation Data at Manta

1990.12.17-1991.1.27

T1/2 (sec)	H1/2(m)						
	<0.3	0.3-<0.5	0.5-<0.7	0.7-<1.0	1.0-<1.5	1.5<=	Total
0-9	132						132
10		2					2
11		1					1
12	1	2					3
13	1	2					3
14		1					1
15		1					1
16	2	1					3
17	2						2
18	2	1					3
19	1	2					3
20	5	2					7
21	3	2					5
22	2	1					3
23			1				1
24	2	4	1				7
25	1						1
26	4	2	1				7
27	1	1					2
28							
29		4					4
30	2	2					4
31<	38	83	34	7	9		171
Total	199	114	37	7	9		366



Appendix 4.3 (2) Wave Measurements at Manta's Bay

H mean (m)	H max (m)	T mean (sec)	Date	Time
0.1372	0.4585	37	122790	1402
0.2771	0.4610	20	122790	1602
0.3635	0.6150	24	122790	1802
0.4339	0.5719	46	122790	2002
0.4097	0.6343	46	122790	2202
0.3806	0.6274	19	122890	2
0.3515	0.7627	13	122890	202
0.3443	0.7471	11	122890	402
0.3656	0.7096	13	122890	602
0.4227	0.6784	16	122890	802
0.3985	0.5909	29	122890	1002
0.4033	0.7433	24	122890	1202
0.3811	0.7469	12	122890	1402
0.3912	0.8280	10	122890	1602
0.4281	1.0651	10	122890	1802
0.4302	0.7037	18	122890	2002
0.4002	0.6177	34	122890	2202
0.3937	0.6607	29	122990	2
0.3315	0.7108	20	122990	202
0.3031	0.5297	12	122990	402
0.2393	0.4746	12	122990	602
0.2726	0.4321	24	122990	802
0.4925	0.6397	300	122990	1002
0.4982	0.6473	133	122990	1202
0.3032	0.4015	71	122990	1402
0.2157	0.4187	21	122990	1602
0.1702	0.2819	17	122990	1802
0.2246	0.3093	63	122990	2002
0.4907	0.5190	400	122990	2202
0.5190	0.5888	400	123090	2
0.3040	0.4057	92	123090	202
0.2112	0.3346	21	123090	402
0.1726	0.4126	13	123090	602
0.1937	0.3474	26	123090	802
0.4340	0.4925	400	123090	1002
0.0000	0.0000	0	123090	1202
0.5020	0.6266	171	123090	1402
0.2738	0.3454	48	123090	1602
0.5020	0.6266	171	123090	1402
0.0278	0.3454	48	123090	1602

Appendix 4.3 (2) Wave Measurements at Manta's Bay

H mean (m)	H max (m)	T mean (sec)	Date	Time
0.1924	0.3719	20	123090	1802
0.1804	0.3110	30	123090	2002
0.3774	0.4321	400	123090	2202
0.6134	0.6172	600	123190	2
0.5568	0.6568	200	123190	202
0.2548	0.3471	55	123190	402
0.1761	0.3443	16	123190	602
0.1636	0.2682	16	123190	802
0.3698	0.4603	109	123190	1002
0.4344	0.4344		123190	1202
0.0000	0.0000	0	123190	1402
0.4527	0.4527		123190	1602
0.1844	0.2911	26	123190	1802
0.1511	0.3187	20	123190	2002
0.2292	0.3309	80	123190	2202
0.0000	0.0000	0	10191	2
0.0000	0.0000	0	10191	202
0.4379	0.4379		10191	402
0.1854	0.2867	41	10191	602
0.1275	0.2237	17	10191	802
0.1678	0.2474	92	10191	1002
0.0000	0.0000	0	10191	1202
0.0000	0.0000	0	10191	1402
0.0000	0.0000	0	10191	1602
0.3340	0.4077	120	10191	1802
0.1377	0.2409	20	10191	2002
0.1655	0.2280	75	10191	2202
0.0000	0.0000	0	10291	2
0.0000	0.0000	0	10291	202
0.0000	0.0000	0	10291	402
0.3642	0.4039	200	10291	602
0.1437	0.2323	18	10291	802
0.1186	0.1885	27	10291	1002
0.0000	0.0000	0	10291	1202
0.0000	0.0000	0	10291	1402
0.0000	0.0000	0	10291	1602
0.0000	0.0000	0	10291	1802
0.1585	0.2507	60	10291	2002
0.1282	0.1935	44	10291	2202
0.0000	0.0000	0	10391	2

Appendix 4.3 (2) Wave Measurements at Manta's Bay

H mean (m)	H max (m)	T mean (sec)	Date	Time
0.0000	0.0000	0	10391	202
0.0000	0.0000	0	10391	402
0.0000	0.0000	0	10391	602
0.1312	0.1876	80	10391	802
0.0852	0.1476	19	10391	1002
0.2679	0.3226	600	10391	1202
0.0000	0.0000	0	10391	1402
0.0000	0.0000	0	10391	1602
0.0000	0.0000	0	10391	1802
0.3302	0.3302		10391	2002
0.0991	0.1585	36	10391	2202
0.0000	0.0000	0	10491	2
0.0000	0.0000	0	10491	202
0.0000	0.0000	0	10491	402
0.0000	0.0000	0	10491	602
0.3543	0.3543		10491	802
0.1251	0.1883	22	10491	1002
0.1584	0.2320	60	10491	1202
0.3961	0.3961		10491	1402
0.0000	0.0000	0	10491	1602
0.0000	0.0000	0	10491	1802
0.0000	0.0000	0	10491	2002
0.1741	0.2470	41	10491	2202
0.1737	0.2908	44	10591	2
0.3491	0.3774	600	10591	202
0.0000	0.0000	0	10591	402
0.0000	0.0000	0	10591	602
0.4950	0.4950		10591	802
0.3603	0.3810	600	10591	1243
0.0000	0.0000	0	10591	1443
0.0000	0.0000	0	10591	1643
0.0000	0.0000	0	10591	1843
0.4285	0.4643	300	10591	2043
0.1971	0.3136	36	10591	2243
0.1692	0.3038	18	10691	43
0.2279	0.3222	86	10691	243
0.4505	0.4505		10691	443
0.0000	0.0000	0	10691	643
0.4379	0.5115	240	10691	843
0.1819	0.2945	40	10691	1043

Appendix 4.3 (2) Wave Measurements at Manta's Bay

H mean (m)	H max (m)	T mean (sec)	Date	Time
0.1813	0.2682	32	10691	1242
0.2324	0.3418	32	10691	1443
0.4699	0.4982	400	10691	1643
0.6625	0.7417	200	10691	1843
0.5512	0.6116	300	10691	2043
0.2685	0.3408	86	10691	2243
0.1887	0.2997	20	10791	43
0.2516	0.3755	26	10791	243
0.3113	0.3689	86	10791	443
0.3707	0.4579	71	10791	643
0.4050	0.6439	55	10791	843
0.4284	0.7586	26	10791	1043
0.2708	0.4438	26	10791	1242
0.2716	0.5231	25	10791	1443
0.3377	0.4726	39	10791	1643
0.4073	0.5298	39	10791	1843
0.4061	0.5525	57	10791	2043
0.3853	0.6214	34	10791	2243
0.2705	0.4962	30	10891	43
0.3305	0.5555	21	10891	243
0.3308	0.4141	31	10891	443
0.5227	0.6095	133	10891	643
0.3565	0.4239	100	10891	843
0.3374	0.4884	75	10891	1043
0.3054	0.4456	27	10891	1242
0.2889	0.4410	21	10891	1443
0.2915	0.3850	52	10891	1643
0.3894	0.6136	48	10891	1843
0.6134	0.6889	171	10891	2043
0.4025	0.5240	75	10891	2243
0.3329	0.6307	29	10991	43
0.2777	0.5275	22	10991	243
0.2968	0.4993	32	10991	443
0.3467	0.4398	92	10991	643
0.5775	0.7228	120	10991	843
0.3628	0.4326	92	10991	1043
0.3508	0.5428	52	10991	1243
0.2654	0.3367	60	10991	1443
0.2877	0.4402	55	10991	1643
0.3494	0.5100	80	10991	1843

Appendix 4.3 (2) Wave Measurements at Manta's Bay

H mean (m)	H max (m)	T mean (sec)	Date	Time
0.6039	0.6228	400	10991	2043
0.6533	0.6628	600	10991	2243
0.5246	0.5605	150	11091	43
0.2981	0.3963	71	11091	243
0.2660	0.3620	48	11091	443
0.4585	0.5340	171	11091	643
0.5924	0.6188	600	11091	843
0.0000	0.0000	0	11091	1042
0.0000	0.0000	0	11091	1242
0.2903	0.3822	100	11091	1443
0.2968	0.4219	75	11091	1643
0.4473	0.5341	300	11091	1843
0.5469	0.5469		11091	2043
0.6627	0.6627		11091	2243
0.6472	0.6943	600	11191	43
0.4982	0.6020	150	11191	243
0.3441	0.4139	100	11191	443
0.2814	0.3453	57	11191	643
0.5360	0.5360		11191	843
0.6246	0.6548	600	11191	1043
0.0000	0.0000	0	11191	1243
0.0000	0.0000	0	11191	1443
0.4793	0.5604	200	11191	1643
0.5114	0.6132	200	11191	1843
0.5718	0.6793	200	11191	2043
0.0000	0.0000	0	11291	2243
0.0000	0.0000	0	11291	43
0.6870	0.7342	600	11291	243
0.2956	0.3667	75	11291	443
0.4755	0.6377	120	11291	643
0.3312	0.3926	71	11291	843
0.0000	0.0000	0	11291	1043
0.0000	0.0000	0	11291	1243
0.0000	0.0000	0	11291	1443
0.5038	0.5454	400	11291	1643
0.4847	0.5092	600	11291	1843
0.5359	0.5849	240	11291	2043
0.0000	0.0000	0	11291	2243
0.0000	0.0000	0	11391	43
0.0000	0.0000	0	11391	243

Appendix 4.3 (2) Wave Measurements at Manta's Bay

H mean (m)	H max (m)	T mean (sec)	Date	Time
0.4753	0.5659	600	11391	443
0.4359	0.5264	133	11391	643
0.4472	0.4774	200	11391	843
0.5560	0.5560		11391	1043
0.0000	0.0000	0	11391	1243
0.0000	0.0000	0	11391	1443
0.0000	0.0000	0	11391	1643
0.3869	0.3869		11391	1843
0.4076	0.4491	600	11391	2043
0.5905	0.6509	600	11391	2243
0.0000	0.0000	0	11491	43
0.0000	0.0000	0	11491	243
0.0000	0.0000	0	11491	443
0.4038	0.4302	300	11491	643
0.4491	0.4567	600	11491	843
0.0000	0.0000	0	11491	1043
0.0000	0.0000	0	11491	1243
0.0000	0.0000	0	11491	1443
0.0000	0.0000	0	11491	1643
0.0000	0.0000	0	11491	1843
0.2585	0.4377	600	11491	2043
0.4449	0.4449		11591	2243
0.0000	0.0000	0	11591	43
0.0000	0.0000	0	11591	243
0.0000	0.0000	0	11591	443
0.4718	0.4926	400	11591	643
0.4113	0.4717	133	11591	843
0.0000	0.0000	0	11591	1043
0.0000	0.0000	0	11591	1243
0.0000	0.0000	0	11591	1443
0.0000	0.0000	0	11591	1643
0.5961	0.6150	600	11591	1843
9.4811	0.5321	600	11591	2043
0.4793	0.6076	171	11591	2243
0.7151	0.7151		11591	43
0.0000	0.0000	0	11691	243
0.0000	0.0000	0	11691	443
0.6397	0.7831	150	11691	643
0.3105	0.4472	46	11691	843
0.2844	0.3666	75	11691	1043

Appendix 4.3 (2) Wave Measurements at Manta's Bay

H mean (m)	H max (m)	T mean (sec)	Date	Time
0.6605	0.7058	400	11691	1243
0.0000	0.0000	0	11691	1443
0.0000	0.0000	0	11691	1643
0.0000	0.0000	0	11691	1843
0.3325	0.4061	71	11691	2043
0.3150	0.4069	80	11691	2243
0.6359	0.7529	300	11791	43
0.0000	0.0000	0	11791	243
0.0000	0.0000	0	11791	443
0.7587	0.9719	171	11791	643
0.3408	0.5230	34	11791	843
0.3097	0.3896	55	11791	1043
0.4429	0.5950	71	11791	1243
0.0000	0.0000	0	11791	1443
0.0000	0.0000	0	11791	1643
0.0000	0.0000	0	11791	1843
0.4134	0.6918	37	11791	2043
0.3506	0.5926	41	11791	2243
0.6812	0.8265	109	11891	43
1.1152	1.1152		11891	243
0.0000	0.0000	0	11891	443
1.2815	1.3834	400	11891	643
0.4157	0.7938	26	11891	843
0.4406	0.6747	24	11891	1043
0.4688	0.7358	50	11891	1243
1.1676	1.3061	400	11891	1443
0.0000	0.0000	0	11891	1643
0.0000	0.0000	0	11891	1843
0.5470	1.0839	26	11891	2043
0.4641	0.7963	30	11891	2243
0.4888	0.8724	36	11991	43
1.2323	1.5097	133	11991	243
0.0000	0.0000	0	11991	443
0.0000	0.0000	0	11991	643
0.4776	1.0113	29	11991	843
0.4761	1.0154	21	11991	1043
0.5498	1.1059	23	11991	1243
1.0472	1.1547	240	11991	1443
0.0000	0.0000	0	11991	1643
0.0000	0.0000	0	11991	1843

Appendix 4.3 (2) Wave Measurements at Manta's Bay

H mean (m)	H max (m)	T mean (sec)	Date	Time
0.5186	0.9109	24	11991	2043
0.4483	0.8175	24	11991	2243
0.5265	0.7483	34	12091	43
0.9209	0.9945	400	12091	243
0.0000	0.0000	0	12091	443
0.0000	0.0000	0	12091	643
0.4813	0.7690	32	12091	1313
0.8812	1.3624	109	12091	1513
0.0000	0.0000	0	12091	1713
0.0000	0.0000	0	12091	1913
1.4419	1.6496	400	12091	2113
0.4853	0.7656	41	12091	2313
0.4053	0.7828	22	12191	113
1.1396	1.1396		12191	313
0.0000	0.0000	0	12191	513
0.0000	0.0000	0	12191	713
0.0000	0.0000	0	12191	913
0.4401	0.6350	80	12191	1113
0.3709	0.6686	19	12191	1313
0.0000	0.0000	0	12191	1513
0.0000	0.0000	0	12191	1713
0.0000	0.0000	0	12191	1913
0.0000	0.0000	0	12191	2113
0.3630	0.5899	75	12191	2313
0.2802	0.4271	40	12291	113
0.7584	0.7584		12291	313
0.0000	0.0000	0	12291	513
0.0000	0.0000	0	12291	713
0.0000	0.0000	0	12291	913
0.8124	0.8124		12291	1113
0.2512	0.3361	48	12291	1313
0.0000	0.0000	0	12291	1513
0.0000	0.0000	0	12291	1713
0.0000	0.0000	0	12291	1913
0.0000	0.0000	0	12291	2113
0.0000	0.0000	0	12291	2313
0.2396	0.3465	57	12391	113
0.3810	0.3810		12391	313
0.0000	0.0000	0	12391	513
0.0000	0.0000	0	12391	713

Appendix 4.3 (2) Wave Measurements at Manta's Bay

H mean (m)	H max (m)	T mean (sec)	Date	Time
0.0000	0.0000	0	12391	913
0.0000	0.0000	0	12391	1113
0.2525	0.3289	48	12391	1313
0.5170	0.5793	300	12391	1513
0.0000	0.0000	0	12391	1713
0.0000	0.0000	0	12391	1913
0.0000	0.0000	0	12391	2113
0.0000	0.0000	0	12391	2313
0.6019	0.7472	171	12491	113
0.2658	0.4482	24	12491	313
0.0000	0.0000	0	12491	513
0.0000	0.0000	0	12491	713
0.0000	0.0000	0	12491	913
0.0000	0.0000	0	12491	1113
1.3434	1.3434		12491	1313
0.4399	0.8224	14	12491	1513
0.5572	0.7323	100	12491	1713
0.0000	0.0000	0	12491	1913
0.0000	0.0000	0	12491	2113
0.0000	0.0000	0	12491	2313
0.0000	0.0000	0	12591	113
0.3548	0.6219	15	12591	313
0.3649	0.6268	33	12591	513
1.1150	1.1150		12591	713
0.0000	0.0000	0	12591	913
0.0000	0.0000	0	12591	1113
0.0000	0.0000	0	12591	1313
0.4625	0.6496	30	12591	1513
0.4354	0.6722	20	12591	1713
0.0000	0.0000	0	12591	1913
0.0000	0.0000	0	12591	2113
0.0000	0.0000	0	12591	2313
0.0000	0.0000	0	12691	113
4.4256	0.6562	43	12691	313
0.4113	0.5331	31	12691	513
0.8265	0.9001	200	12691	713
0.0000	0.0000	0	12691	913
0.0000	0.0000	0	12691	1113
0.0000	0.0000	0	12691	1313
0.0000	0.0000	0	12691	1513

Appendix 4.3 (2) Wave Measurements at Manta's Bay

H mean (m)	H max (m)	T mean (sec)	Date	Time
0.3341	0.4814	36	12691	1713
0.0000	0.0000	0	12691	1913
0.0000	0.0000	0	12691	2113
0.0000	0.0000	0	12691	2313
0.0000	0.0000	0	12691	113
0.0000	0.0000	0	12791	313
0.3807	0.4960	33	12791	513
0.3788	0.5088	75	12791	713

The wave/gage records 2.400 values, according to the waves measurenment period, at intervals of 0.5 seconds each. After data are registered an algorithm is used to determine waves height according to the distance peakvalley in a wave series. H mean and Hmax is later calculated. T mean is calculated as the measuring time duration, 20 minuted (1,200 seconds) divided by the number of waves registered as higher or same as the minimum allowed, 5cm.

2) Previous Wave Study Along Ecuatorian Coast.

There have been different previous studies dealing with wave regime along the Ecuatorian Coast.

CIYSCA-SCANDIA CONSULT carried out in 1973 a prefeasibility and design study for Artisanal Fisheries Ports for Manta and Posorja (Guayas Province), as part of a project for the development of Fisheries Port in Ecuador.

There also exists some wave studies related with the influence zone of Manta. Among them, we can mention: INOCAR (1979) in Jaramijo; R.H. Equipment and Constructions Ltd. (1980) in Manta; Cornejo Rodriguez (1984) in Jaramijo; Allauca and Cardin (1987) in Jaramijo and ESPOL (1990) in Manta.

Allauca and Cardin (1987) made an estimation of the wave regime for the central part of the Ecuatorian coast (including Manabi Province). They estimate a wave configuration using data from Bahia de Caraquez and Jaramijo on Manabi Province and Valdivia and Monteverde, near Manabi border; from that it follows:

i) Wave pattern approaching the central part of the Ecuatorian coast has a swell caracteristics with periods varyng from 17-21 sec., and 0.4-0.6 m. of significant height.

ii) Earlier months of the year presents waves above the mean; In summmer season (June-November) we will find the highest significatives waves of the year.

ESPOL (1990) has prepared a report about waves on the Bay of Manta, obtained from a wave and tide gauge during summer time of 1989 (August-November); from that we can see a wide significant height wave spectrum. Figure 2.4.2.1 shows a significant wave height distribution for this period based on Hs ocurrence percentage. Approximately 65% of waves belongs to 0.2-0.6 m ; it confirms before studies. A more dramatic representation for this information is observed for mean periods; Figure 2.4.2.2 shows a percentage distribution for waves period. Approximately 33.4% of total data belongs to a mean period of 20.1 sec. The great percentage observed for periods higher than 30 sec. could probably be attributed to a long calms period.

Table 2.4.2.3 and Figures 2.4.2.2 and 2.4.2.3 shows the detailed description of wave height and period before reported: Aproximately an 82.03% of total data belongs to a range between 0.45-1.05 m. and 6-16 sec; it serves to confirm a short summary presented on Table 2.4.2.2

Based on refraction diagrams elaborated using the same measurements period it will possible to observe waves approaching the coast perpendicularly to the coast line.

Waves Information at the Equatorial Sea

Finally and using waves information provided from opportunity ships on Guayaquil-Galapagos route and Inocar Oceanographic cruises on Ecuatorial Sea, it is possible to elaborate Table 2.4.2.4 and Figure 2.4.2.4 which show a detailed description of Wave Height and Wave Period and the correspondent ocurrence percentage for the observed waves. Approximately a 74% of the occurrenced waves have a wave height range of 0.6-2.0 m. ; it correspond to a predominant South-Southwest direction which account for the 53.1% of the total observed waves direction.

As a final statement we can conclude that a great percentage of waves generated at Equatorial sea might sometimes strikes our coast and the coast of Manabi as well.

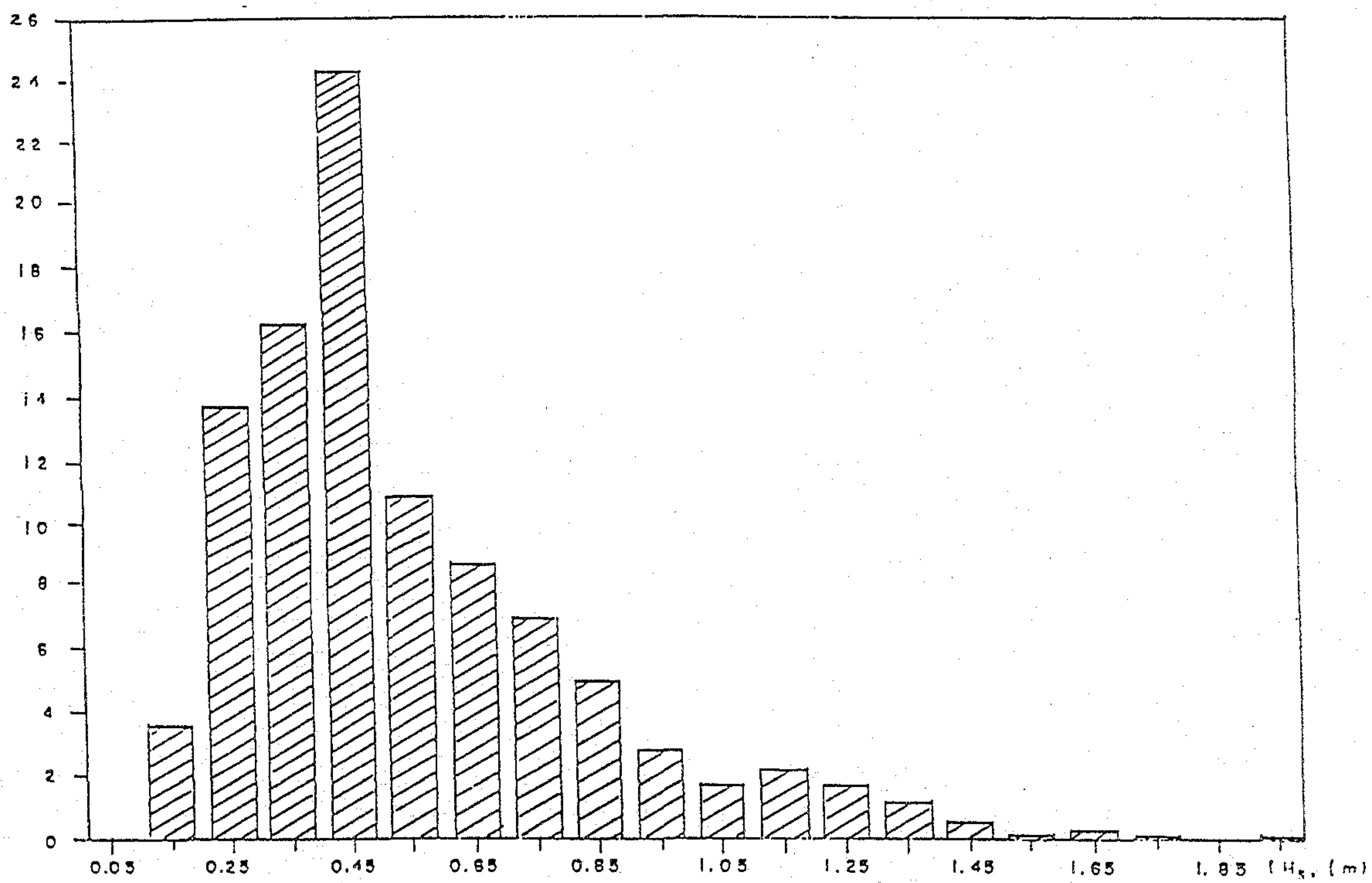


Fig 2.4.2.1 Significant Wave Height Distribution at Manta

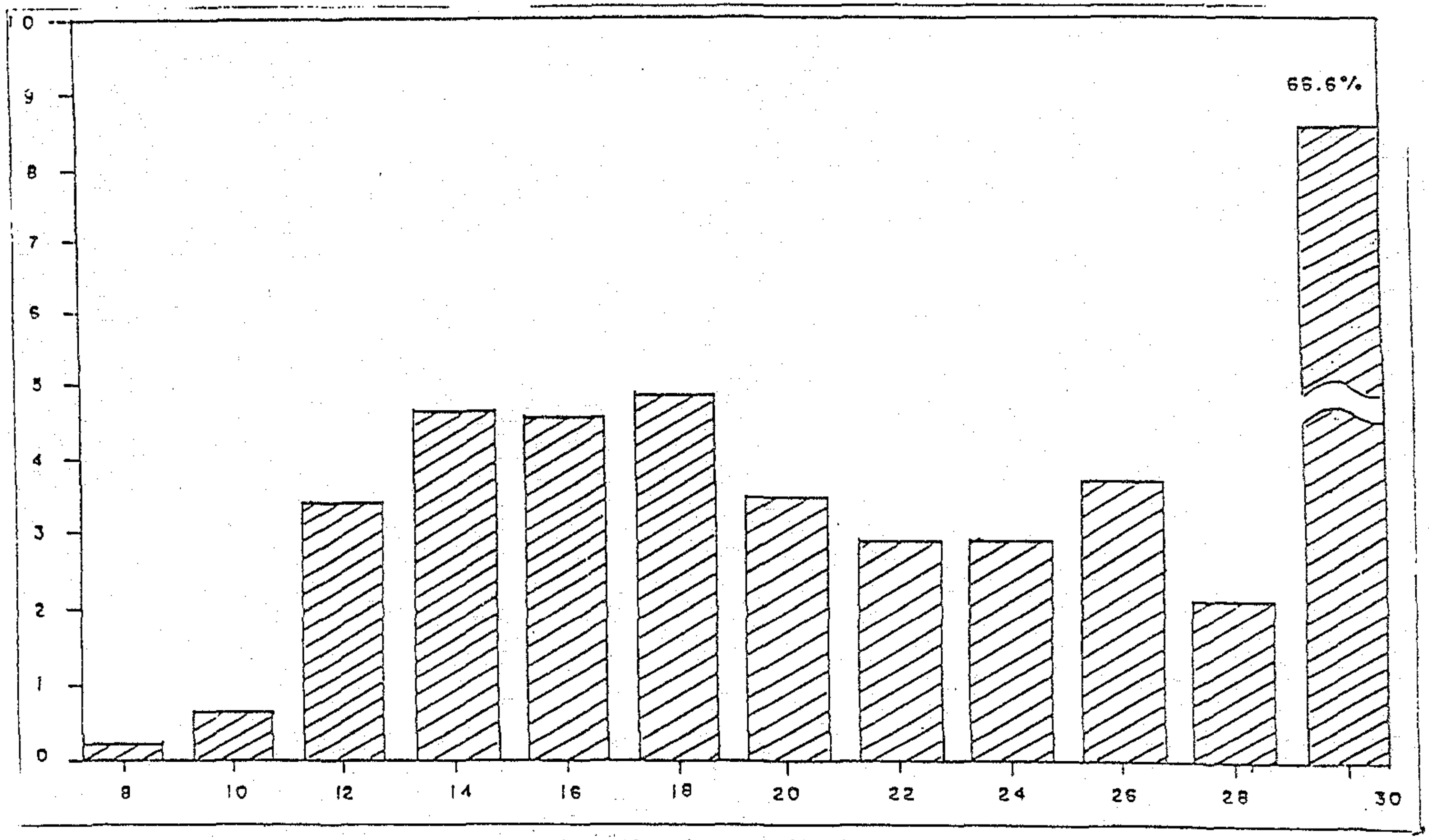


Fig 2.4.2.2 Wave Period Distribution at Manta

Botton Topography Effects on Wave Regime

Based on previous wave analysis carried out off Jaramijo north of Manta, it is possible to find a predominant wave period of 14-20 sec. On the other hand and based on the configuration of Manta coastline waves coming from West, North and Northwest (270, 0 and 315 degrees, respectively) and reaching the coast it was possible for ESPOL (1990) to elaborate some refraction diagrams offshore Manta. Table 2.4.2.1 shows the period coefficients and wave direction approaching the coast of Manta, from deep water.

Table 2.4.2.1 Wave Refraction Coefficients approaching the coast from deep water.

	P E R I O D S			
0	14	16	18	20
270	0.4495	0.4540	0.5020	0.5027
315	0.7390	0.7939	0.7278	0.7516
0	0.5642	0.5275	0.3527	0.6344

Wave Information at Puerto Lopez

Table 2.4.2.2 shows a short summary of waves information at Puerto Lopez and Machalilla based on a Thecnical report elaborated by INOCAR in 1978. Despite those data can be taken as a representative information of the wave regime at this site of Manabi coast, only for the observed period, it will result very useful for future evaluation.

Table 2.4.2.2 Wave observations at Puerto Lopez and Machalilla

NUMBER OF WAVES OBSERVED	MEAN DIRECTION (mag. deg)	SIGNIFICANT HEIGTH (m)	MEAN HEIGTH (m)	PERIOD (sec)
1035	221.5	0.75	1.08	10.95

A predominant wave direction from 221.5 (magnetic degrees) is observed for this short period in winter season. A maximun Heigth of 1.80 m. with a wave period of 12.3 sec. and a minimun Heigth of 0.3m. with a wave period of 7.6 sec is reported.

Table 2.4.2.3 Wave height and Period at Puerto Lopez

	Wave Period (sec)							
	0-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20
Wave Height (m)								
0.00-0.25	0	1	0	0	2	0	0	0
0.25-0.45	0	5	16	18	10	3	0	0
0.45-0.65	5	49	97	121	63	19	2	0
0.65-0.85	8	34	90	115	89	41	0	0
0.85-1.05	3	13	30	42	32	14	3	0
1.05-1.25	0	4	7	15	21	12	0	0
1.25-1.45	0	1	1	4	9	7	0	0
1.45-1.65	0	1	0	2	1	2	0	0
1.65-1.85	0	1	1	0	2	0	0	0

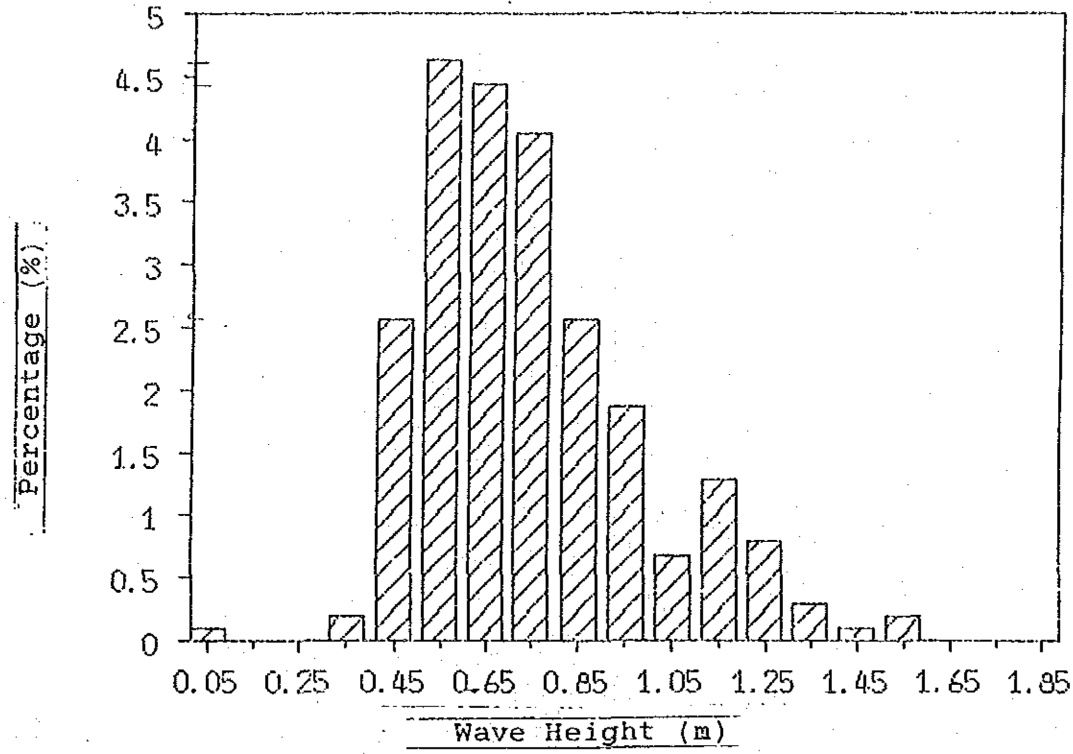


Fig 2.4.2.2 Wave Height at Puerto Lopez (27/Apl - 03/May ,1978)

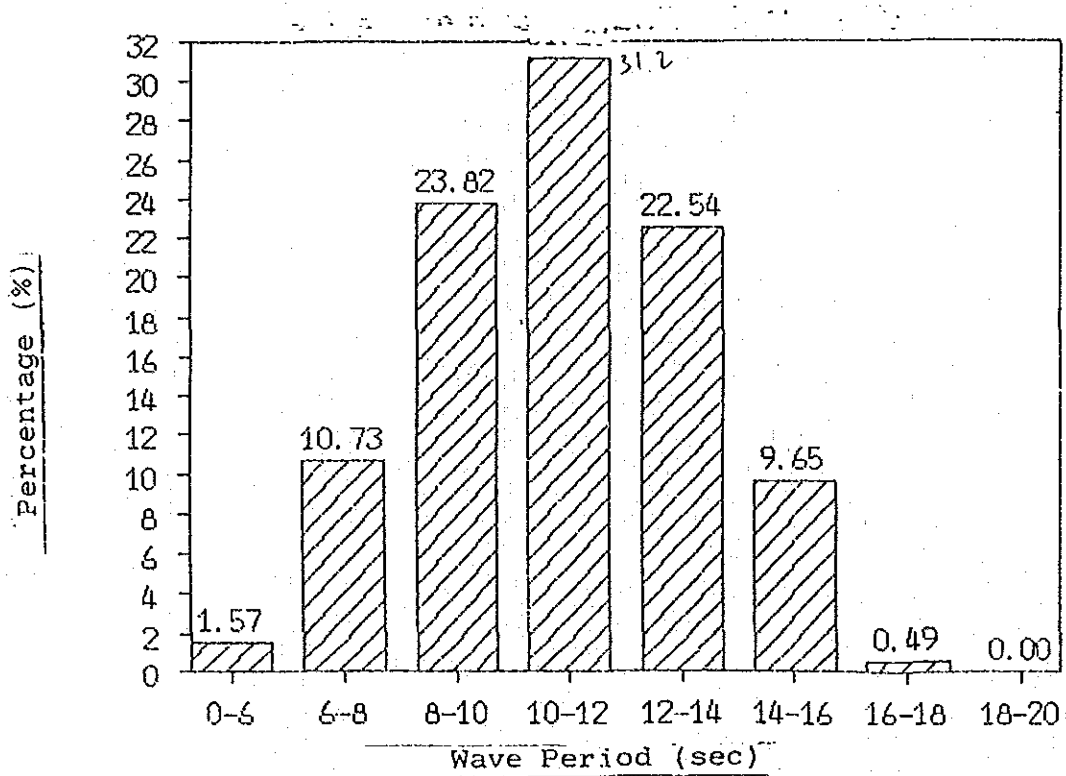
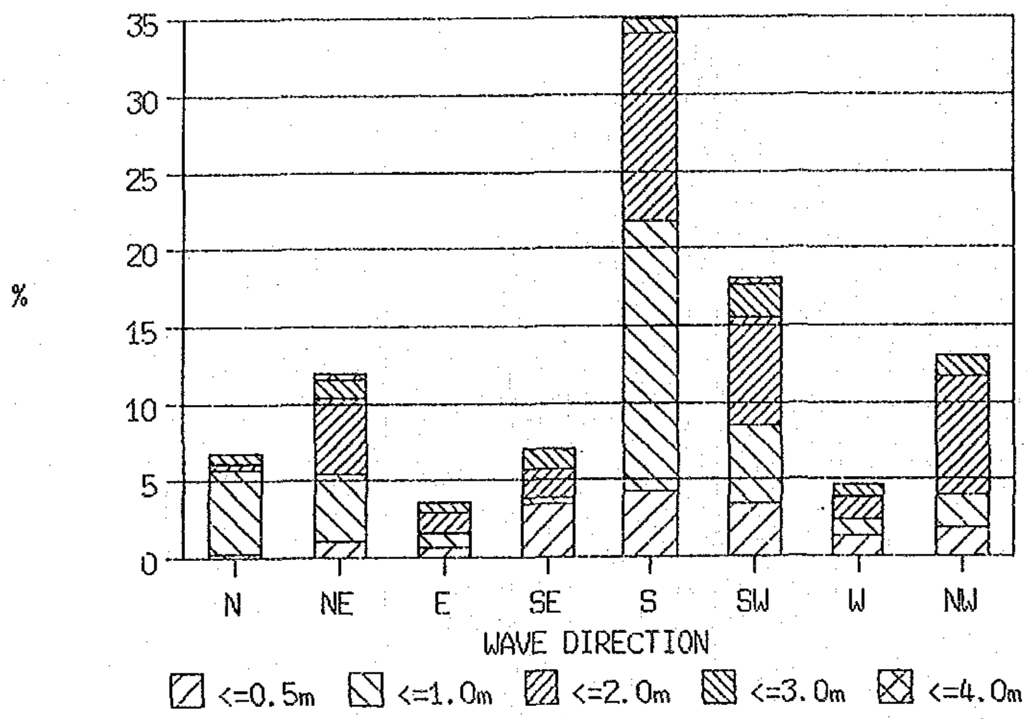


Fig 2.4.2.3 Wave Period at Puerto Lopez (27/Apl - 03/May ,1978)

Table 2.4.2.4 Wave height and Direction :%

Direction	N	NE	E	SE	S	SW	W	NW
Wave Height(m)								
0.0 - 0.5	0.2	1.1	0.7	3.5	4.2	3.5	1.3	1.8
0.6 - 1.0	5.5	4.4	0.9	0.4	17.5	5.0	1.1	2.2
1.1 - 2.0	0.4	4.8	1.3	1.8	12.3	7.0	1.5	7.7
2.1 - 3.0	0.7	1.3	0.7	1.3	0.9	2.2	0.7	1.3
3.1 - 4.0	0.0	0.4	0.0	0.0	0.0	0.4	0.0	0.0
4.1 -	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	6.8	12.1	3.5	7.0	34.9	18.2	4.6	12.9

Fig 2.4.2.4 WAVE HEIGHT AND DIRECTION



(4) Tidal Currents

A comprehensive understanding of the circulation pattern near the coast will be very useful for the engineering desing of the potential Port.

Previous Current studies

There exists some work regarding coastal currents along the Manabi coast; however, most of those studies have been taken place on Manta, Jaramijo and Bahia de Caraquez. No available data is found for places south of San Mateo.

Drifting drogue current measurements on Manta Bay. February 17-18, 1980. R-H Equipment and Constructions.

Current Meter observations on Manta Bay. May 13-15, 1980. R-H Equipment and Constructions.

Drifting drogue current measurements at Jaramijo. 1980. INOCAR-ESPOL

Current Meter observations at Port of Manta (Station 1). February 13-15, 1984. TACTI Thecnical International Consulting.

Current Meter observation at Port of Manta (Station 2). April 4-6, 1984. TACTI Thecnical International Consulting.

Current Meter observations at Pta. Bellaca (Bahia de Caraquez) 1985 INOCAR

Current Meter observations at Manta Bay. March 1986-February 1987 ESPOL

Current Meter observations at Manta Bay. August-October 1989

Surface currents at Manta

From above information it is possible to elaborate a Table 2.4.3.1. which shows some useful surface current information obtained from a current meter deployed for a whole year on Manta Bay.

Table 2.4.3.1. Monthly mean values of speed and direction of the surface currents registered at Manta Bay.

Months	Mean Velocity cm/sec	Mean Direction Degrees	Max. Velocity cm/sec
January	14.40	238.43	29.4
February	6.64	278.23	16.5
March	6.31	226.48	23.8
April	6.71	214.72	31.9
May	7.33	188.69	21.1
June	5.49	260.27	27.1
July	8.45	203.33	16.7
August	7.21	216.02	23.4
September	6.31	290.69	17.4
October	5.53	268.10	16.9
November	7.01	275.52	20.5
December	14.00	269.03	29.6
Global Mean	7.95	244.12	22.85

From Table 2.4.3.1. it is easily shown a maximun mean speed occuring in January (14.40 cm/sec). A Maximun speed of 31.9 cm/sec was recorded on April of the same year. The Mean Direction was 244.12.

Figures 2.4.3.2 to 2.4.3.40 (ANNEX 1) show the variation of speed and direction of surface current at Manta location from each of the month detailed on table 2.4.3.1. (F. Medina, 1989); all data used are from within the 1986-1987 EL NINO moderated event. Table

A N N E X

Time Series of Surface currents measurements at Manta (March 1986 - February 1987)

Vector Diagram (Straw) of Surface currents measurements at Manta (March 1986 - February 1987)

Polar Diagram of Surface Current measurements at Manta (March 1986 - February 1987)

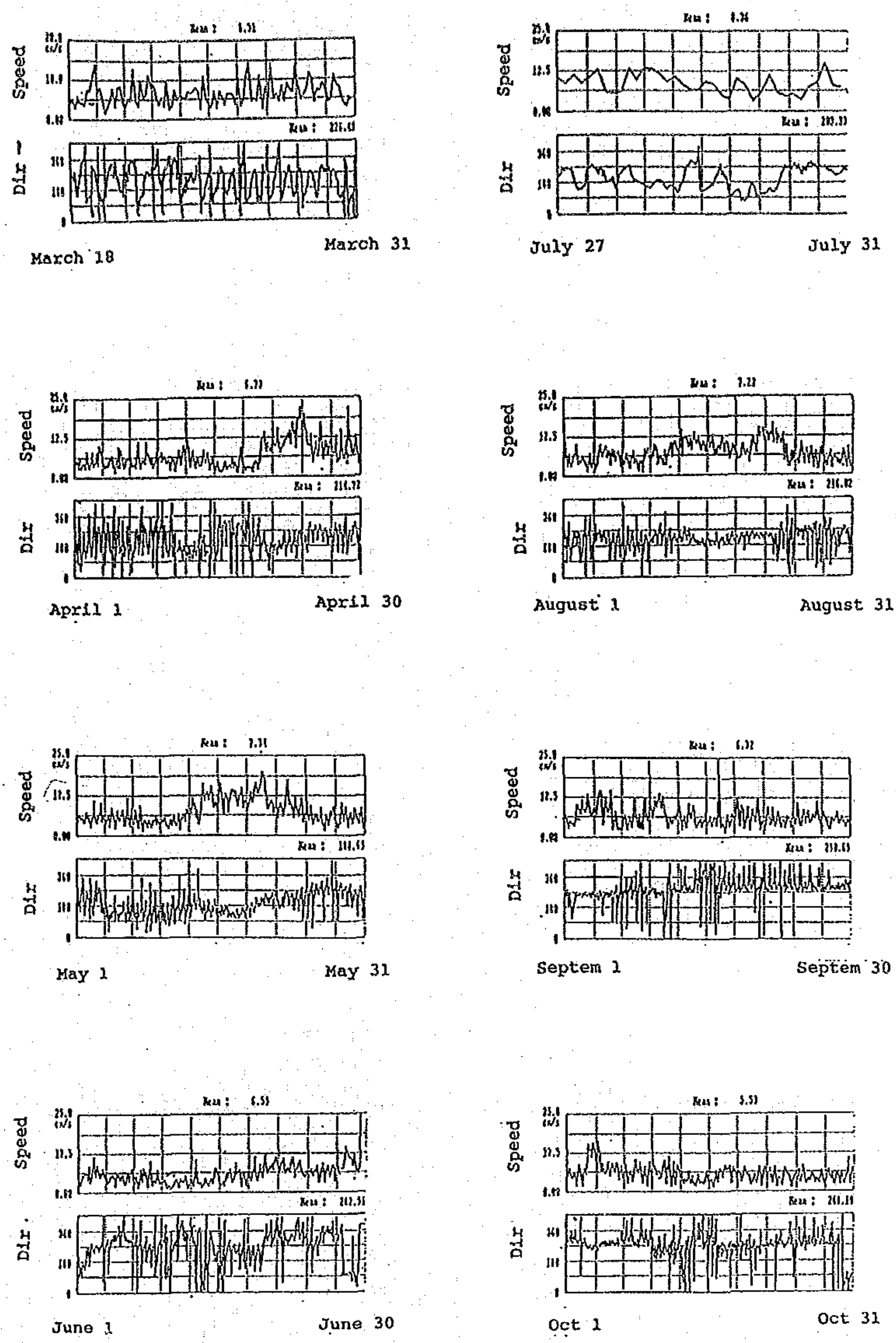


Fig 2-13 Velocity and Direction of Tidal Current at Manta (1)

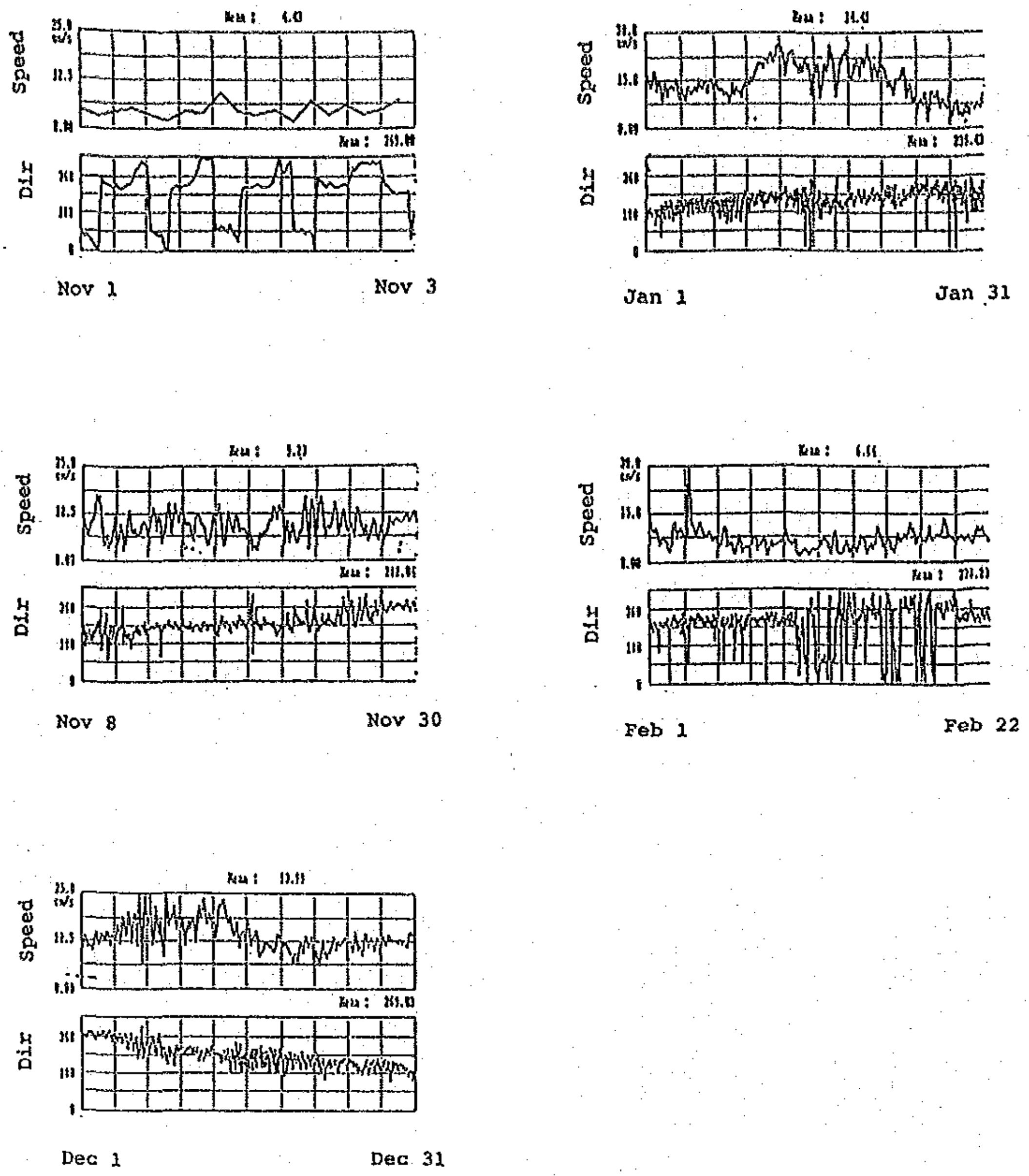


Fig 2-14 Velocity and Direction of Tidal Current at Manta (2)

A N N E X

Time Series of Surface currents measurements at Manta (March 1986 - February 1987)

Vector Diagram (Straw) of Surface currents measurements at Manta (March 1986 - February 1987)

Polar Diagram of Surface Current measurements at Manta (March 1986 - February 1987)

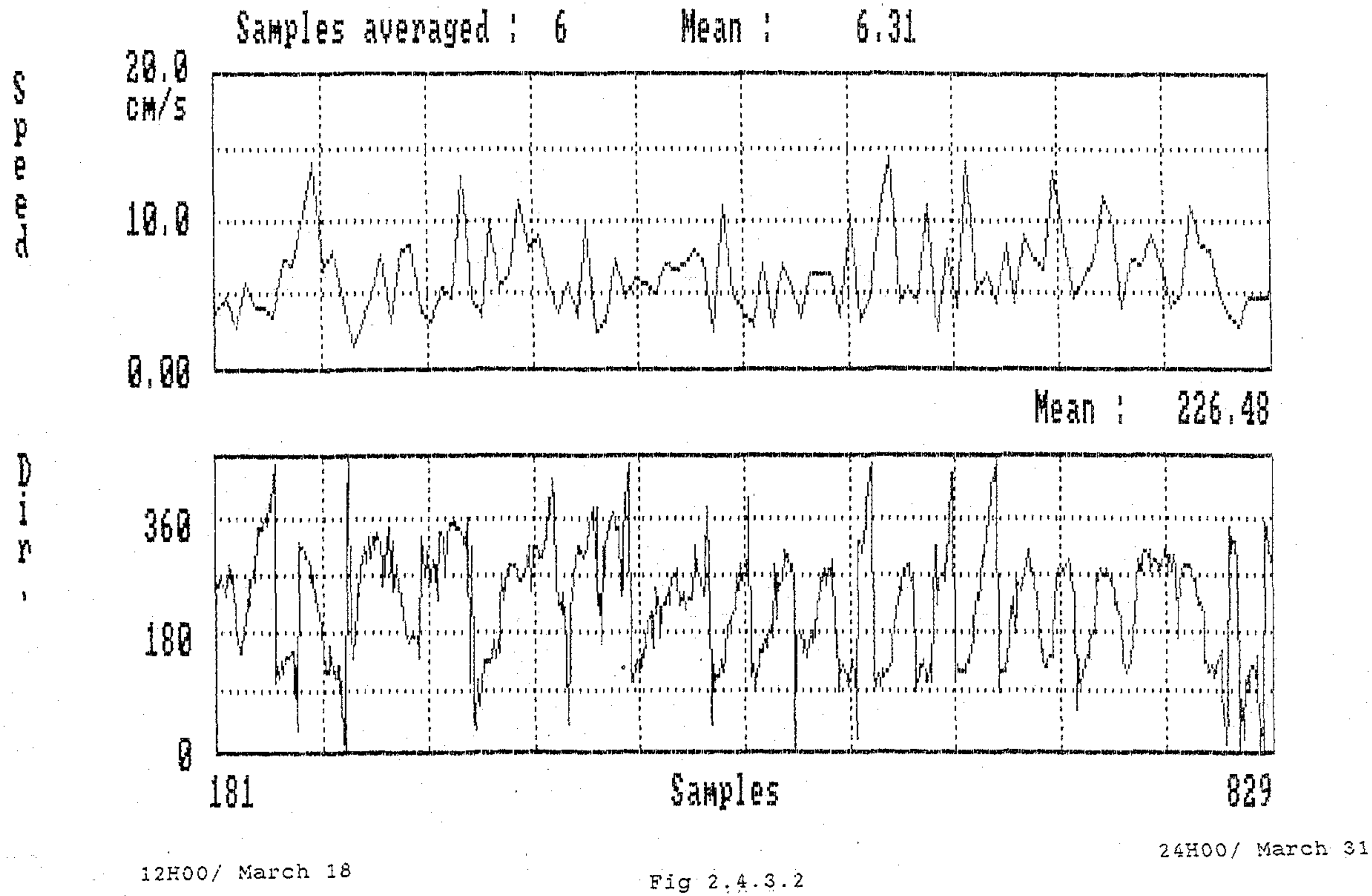
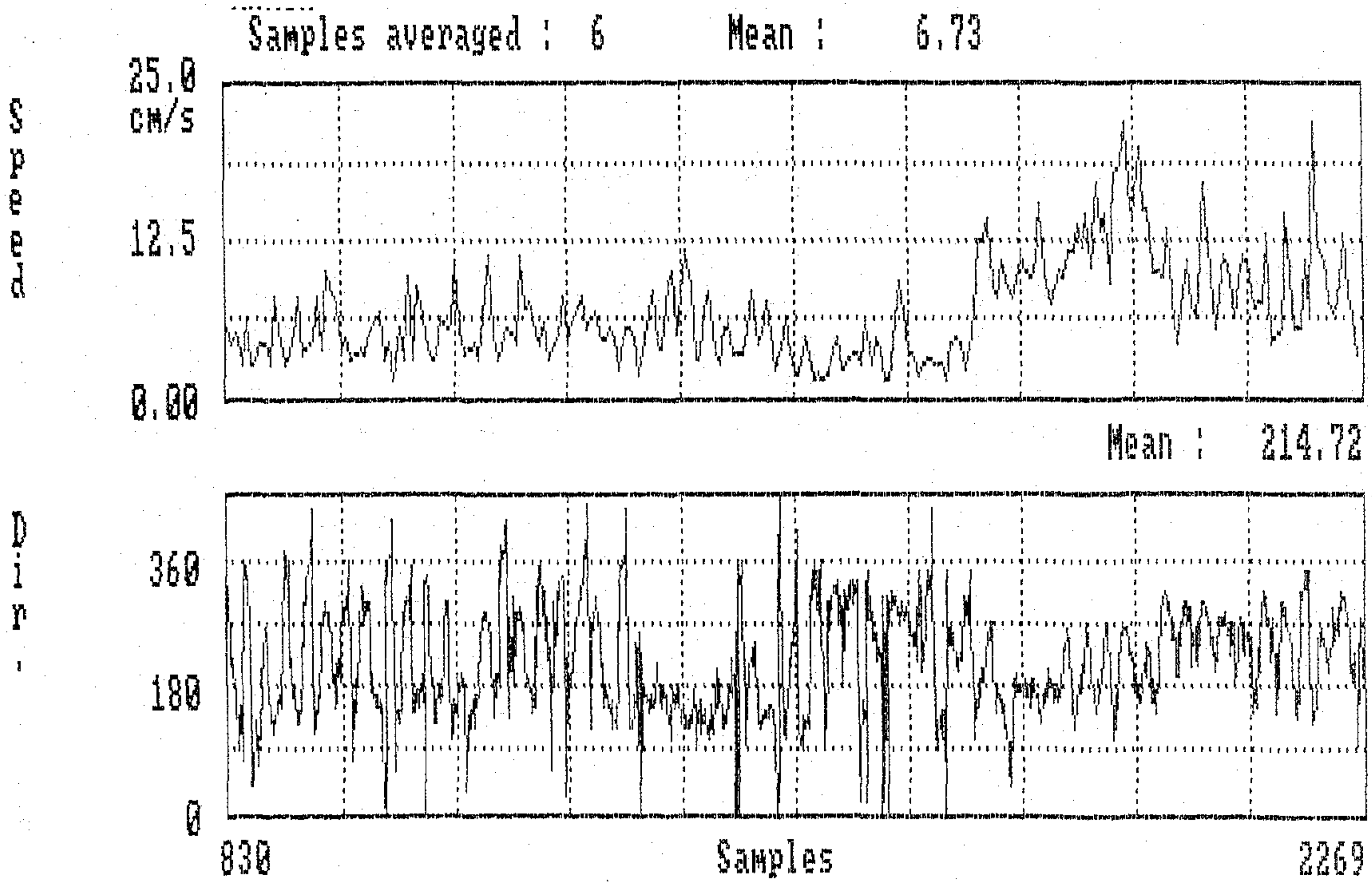

Samples averaged : 6
Mean : 6.31
Speed
20.0 cm/s
10.0
0.00
Mean : 226.48
Dir.
360
180
0
181
Samples
829
12H00/ March 18
24H00/ March 31

Fig 2.4.3.2



00H30/ April 1

24H00/ April 30

Fig 2.4.3.3

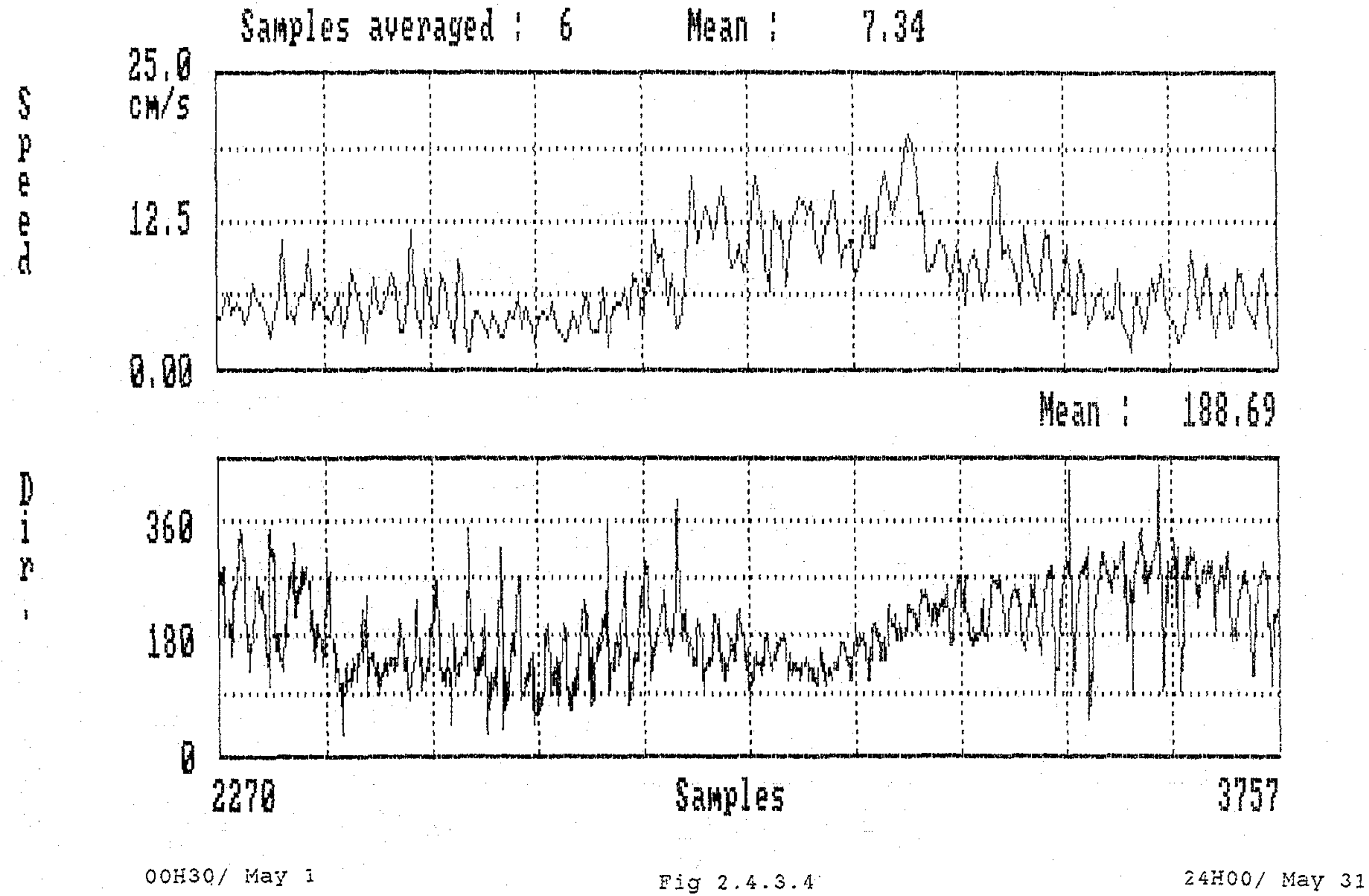
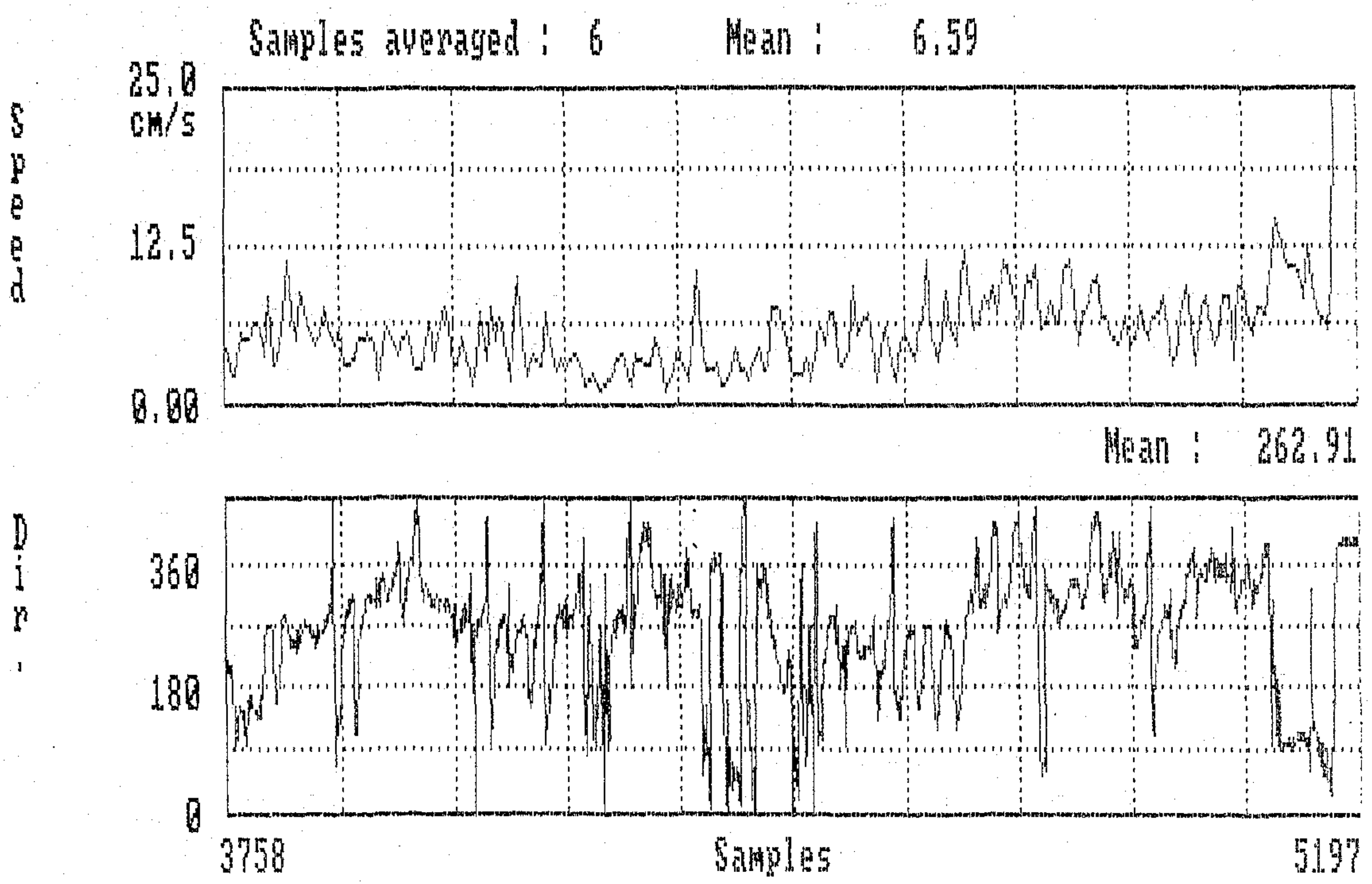

Samples averaged : 6
Mean : 7.34
Speed
25.0 cm/s
12.5
0.00
Mean : 188.69
Dir.
360
180
0
2270
Samples
3757
00H30/ May 1
24H00/ May 31

Fig 2.4.3.4



00H30/ June 1

Fig 2.4.3.5

24H00/ June 31

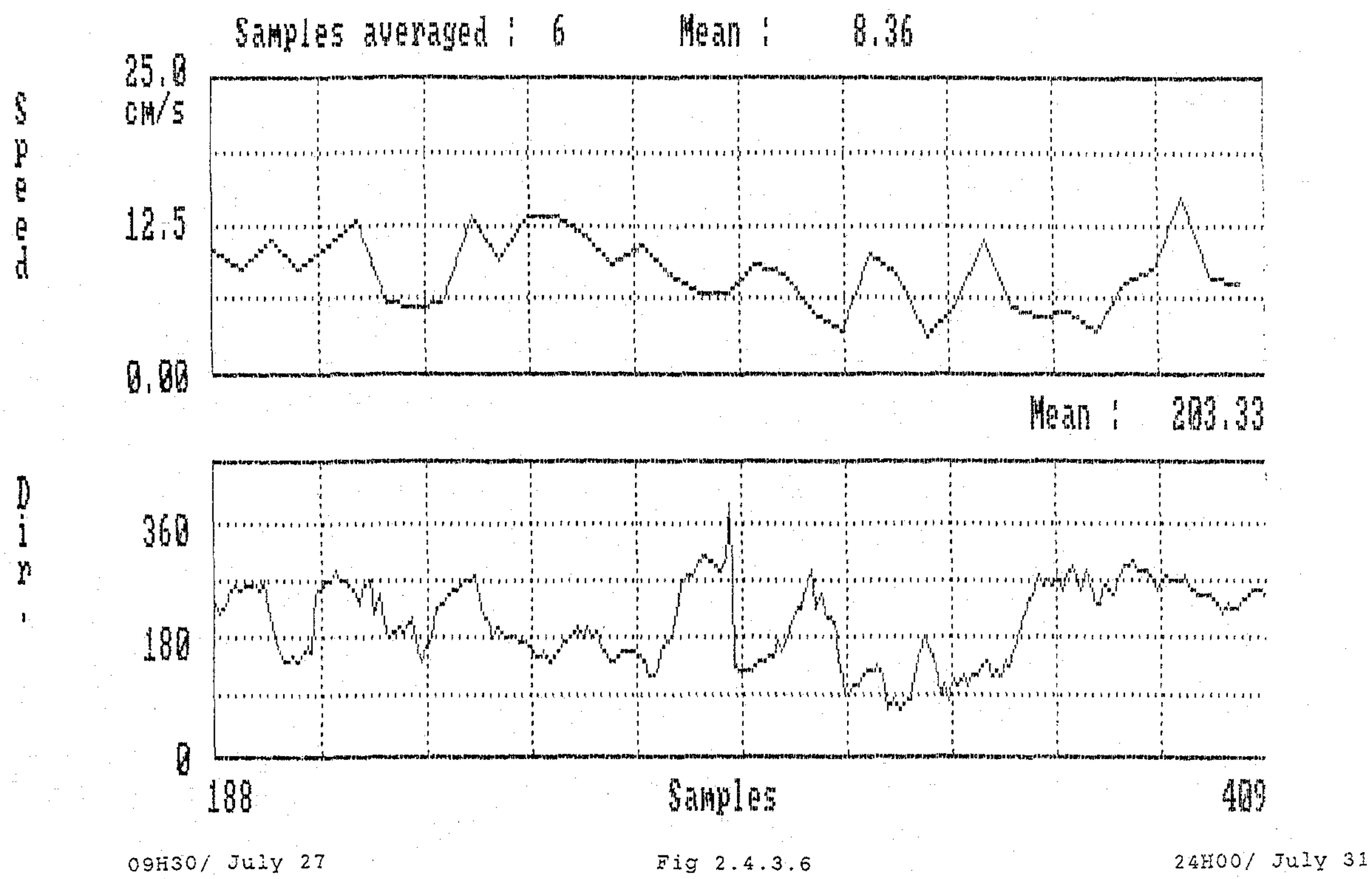

Samples averaged : 6
Mean : 8.36
Speed
25.0
cm/s
12.5
0.00
Mean : 203.33
Dir.
360
180
0
188
Samples
409
09H30/ July 27
24H00/ July 31

Fig 2.4.3.6

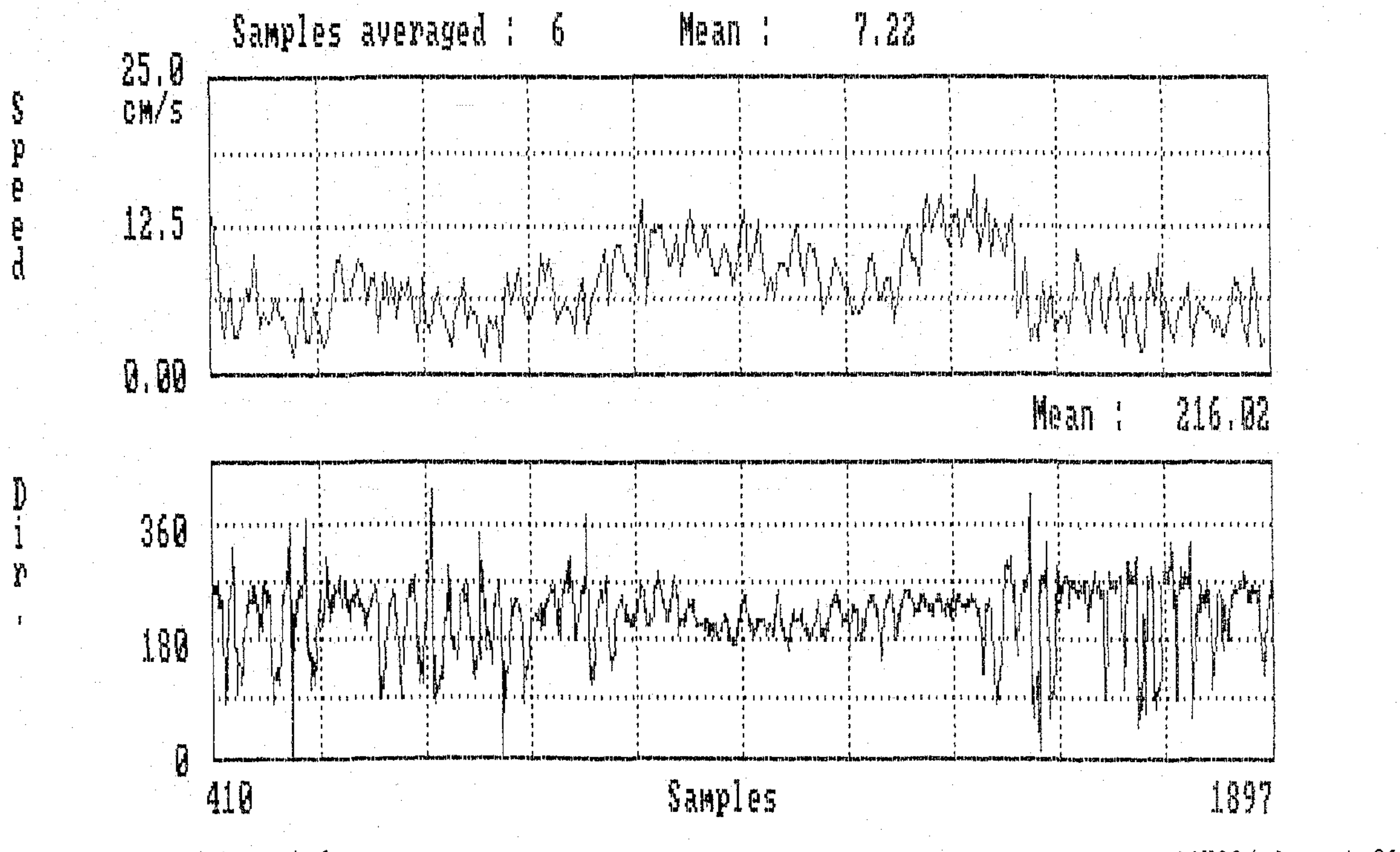
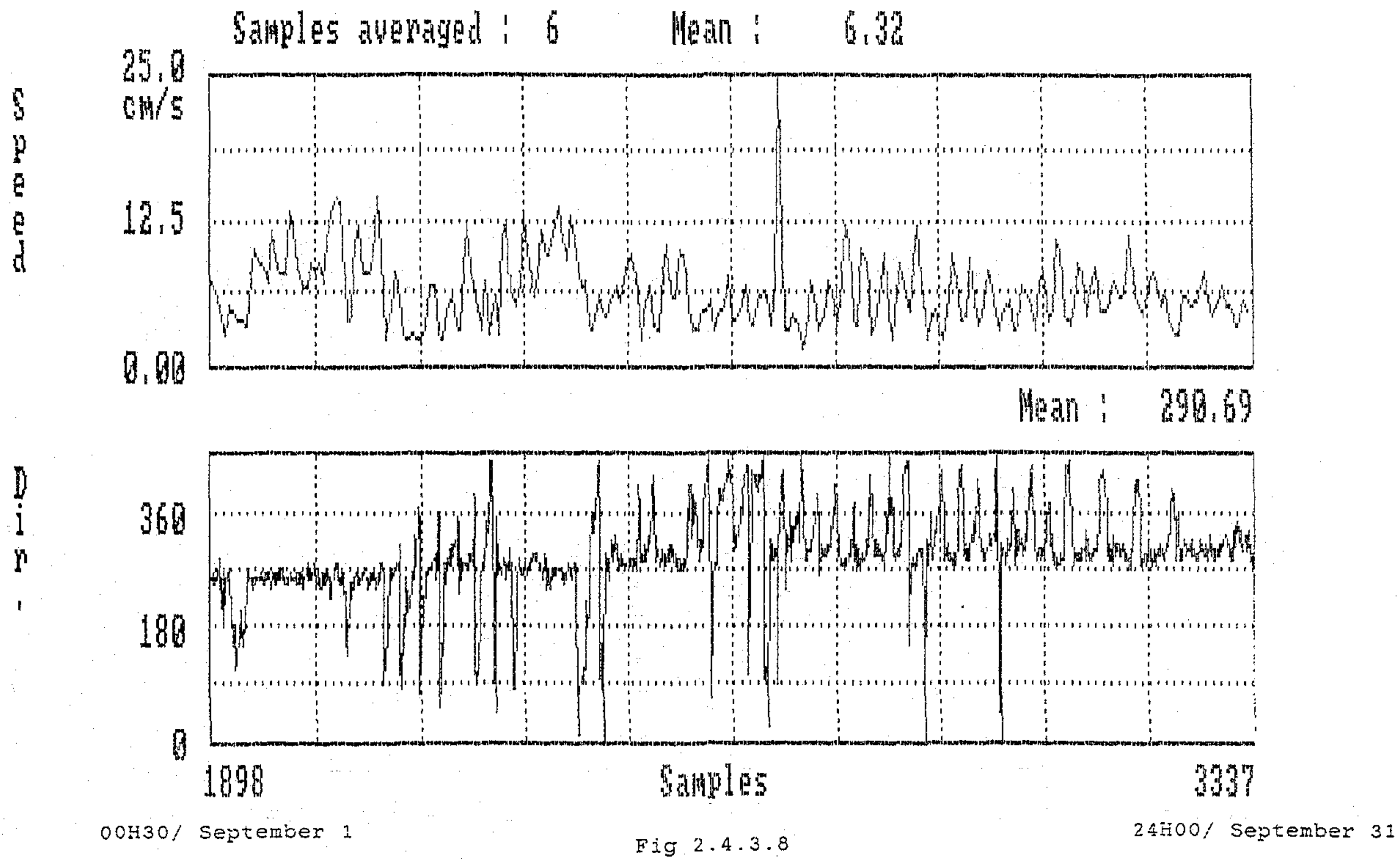
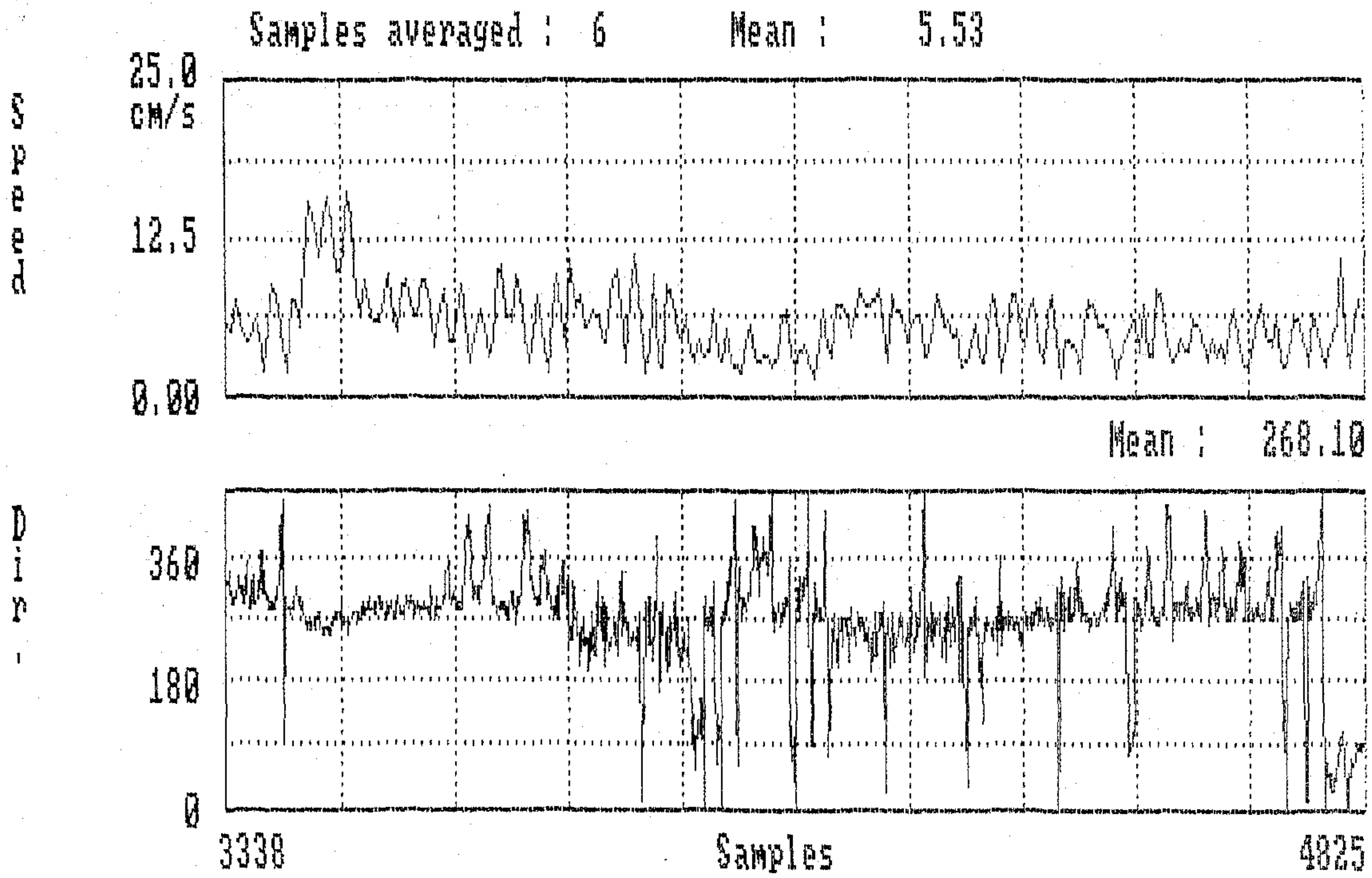

Samples averaged : 6
Mean : 7.22
Speed
25.0 cm/s
12.5
0.00
Mean : 216.02
Dir.
360
180
0
410
Samples
1897
00H30/ August 1
24H00/ August 31

Fig 2.4.3.7

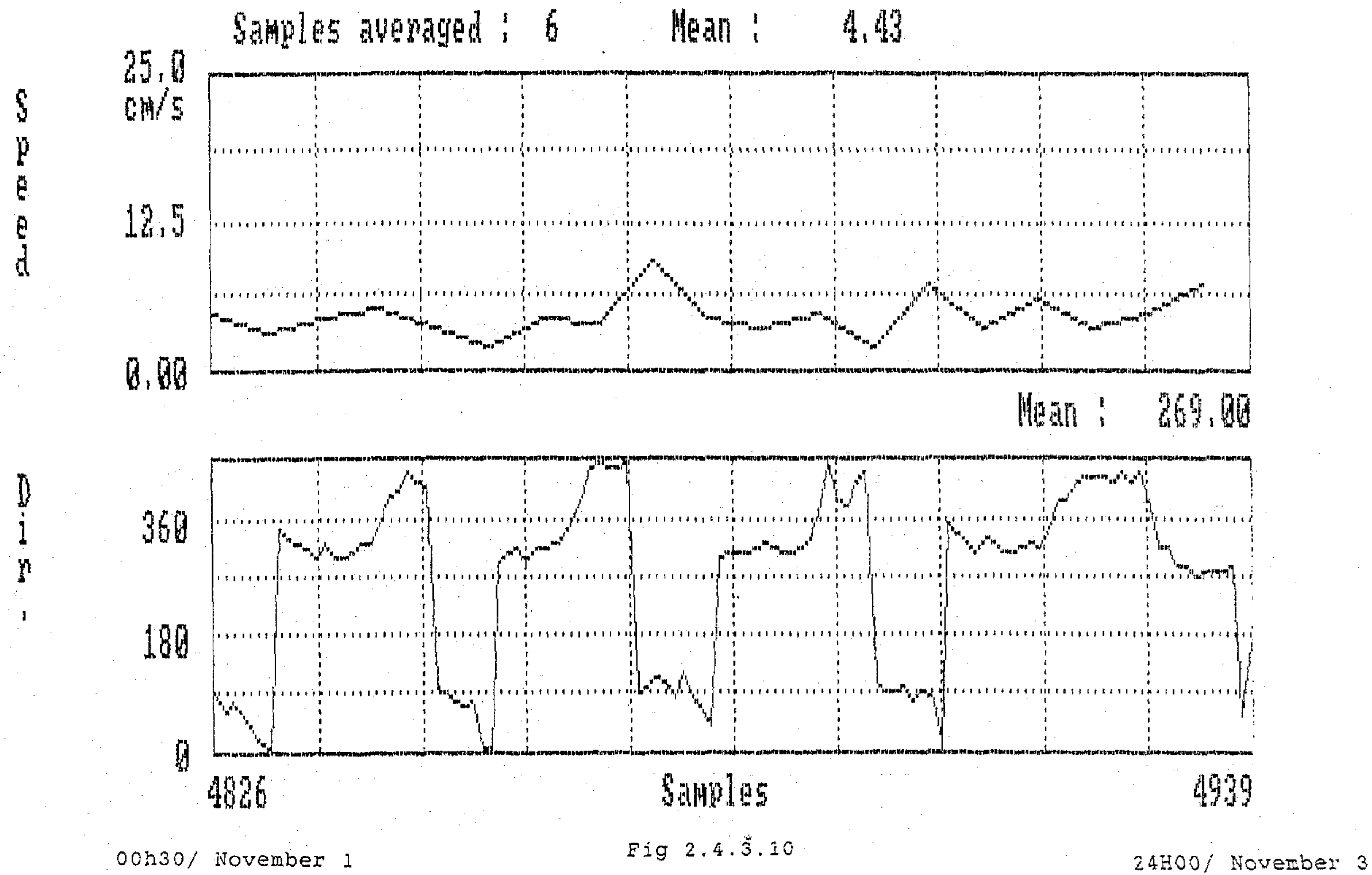

Samples averaged : 6
Mean : 6.32
25.0
cm/s
12.5
0.00
Speed
Mean : 290.69
360
180
0
Dir -
1898
Samples
3337
00H30/ September 1
24H00/ September 31
Fig 2.4.3.8



00H30/ October 1

Fig 2.4.3.9

24H00/ October 31



Samples averaged : 6
Mean : 4.43
25.0
cm/s
12.5
0.00
Speed
Mean : 269.00
360
180
0
Dir.
4826
Samples
4939
00h30/ November 1
24H00/ November 3

Fig 2.4.3.10

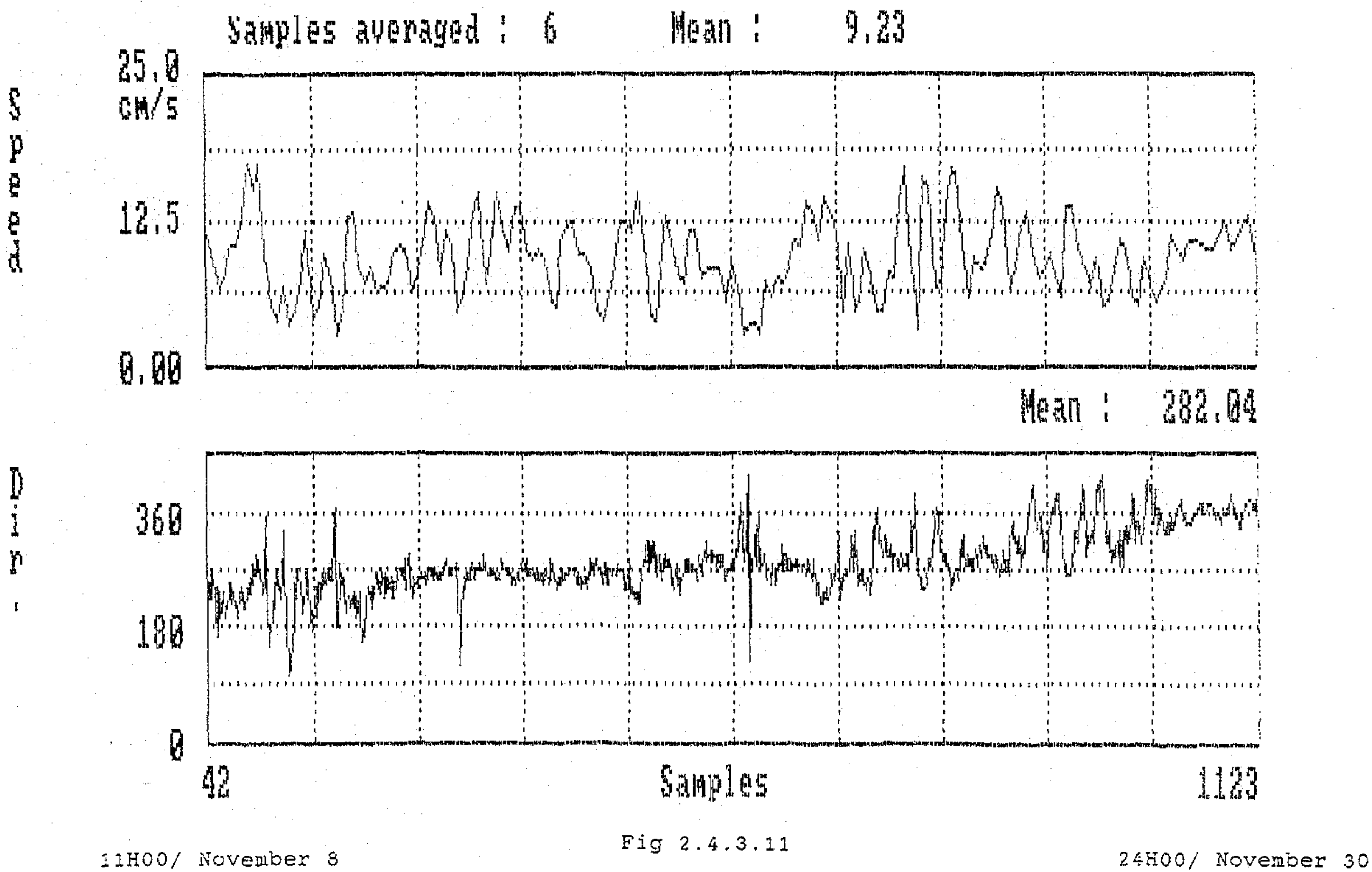

Samples averaged : 6
Mean : 9.23
25.0
cm/s
12.5
0.00
Speed
Mean : 282.04
360
180
0
Dir -
42
Samples
1123
11H00/ November 8
24H00/ November 30

Fig 2.4.3.11

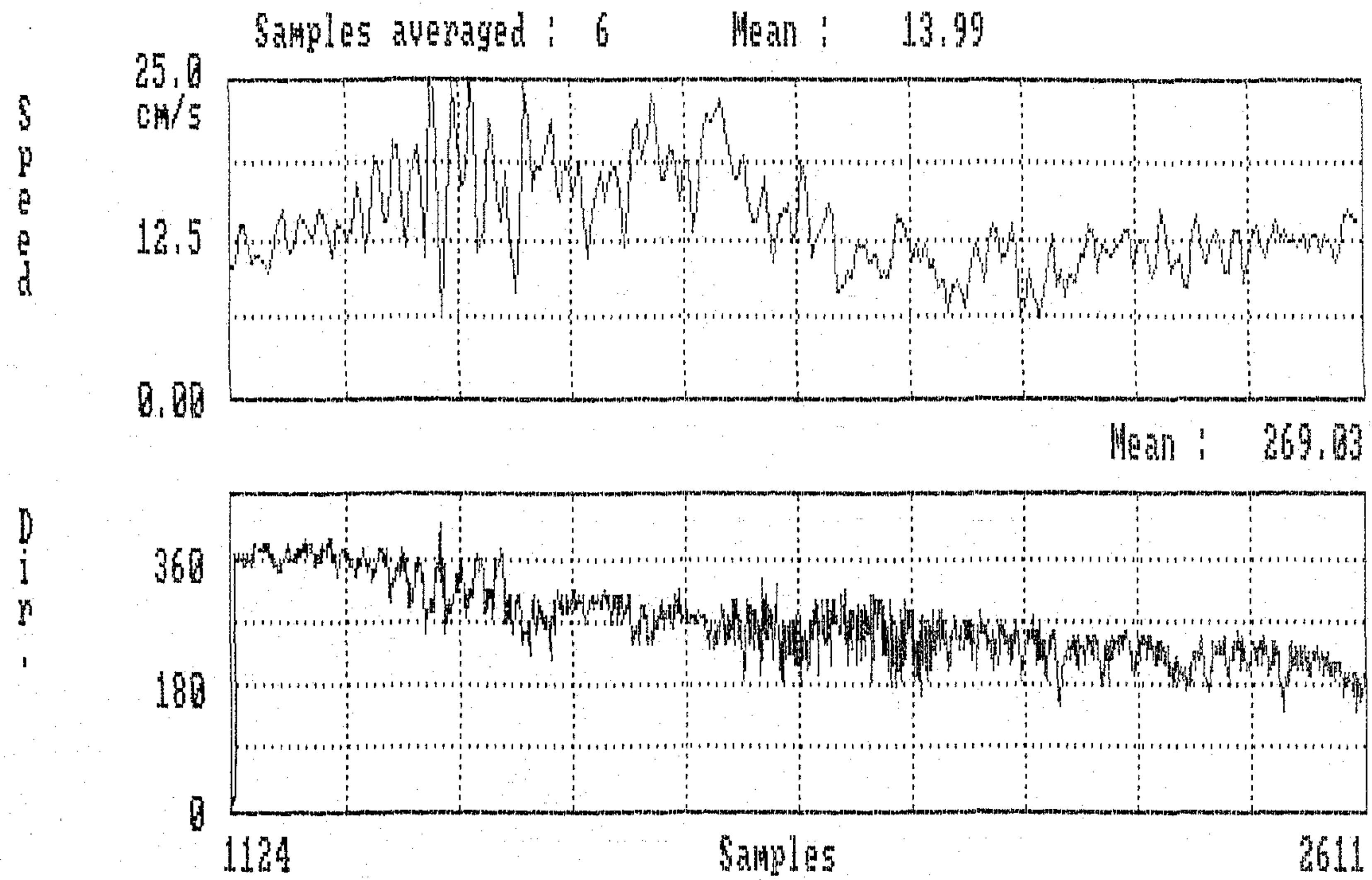


Fig 2.4.3.12

00H30/ December 1

24H00/ December 31

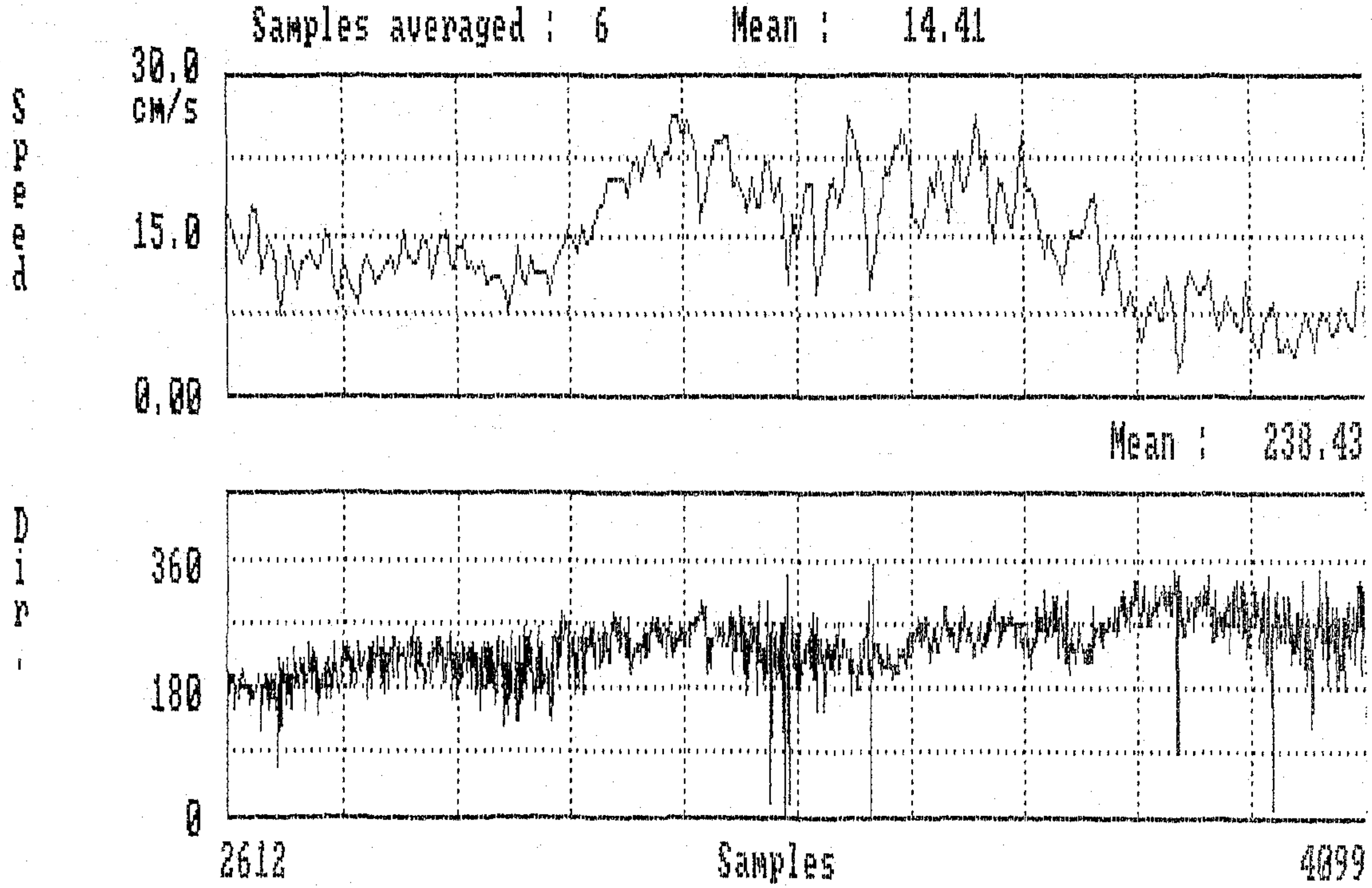


Fig 2.4.3.13

00H30/ January 1

24H00/ January 31

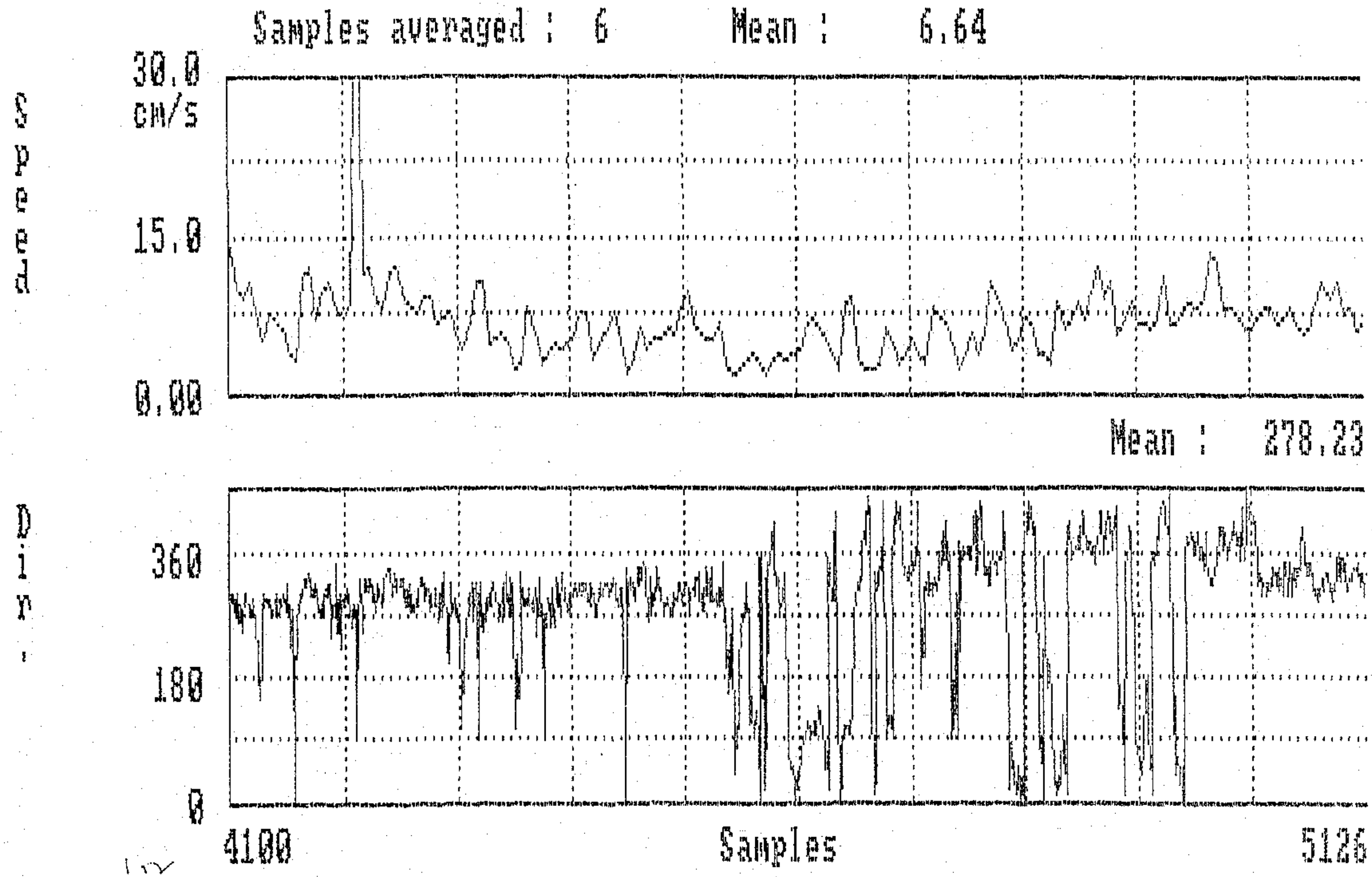


Fig 2.4.3.14

00H30/ February 1

10H00/ February 22

Polar

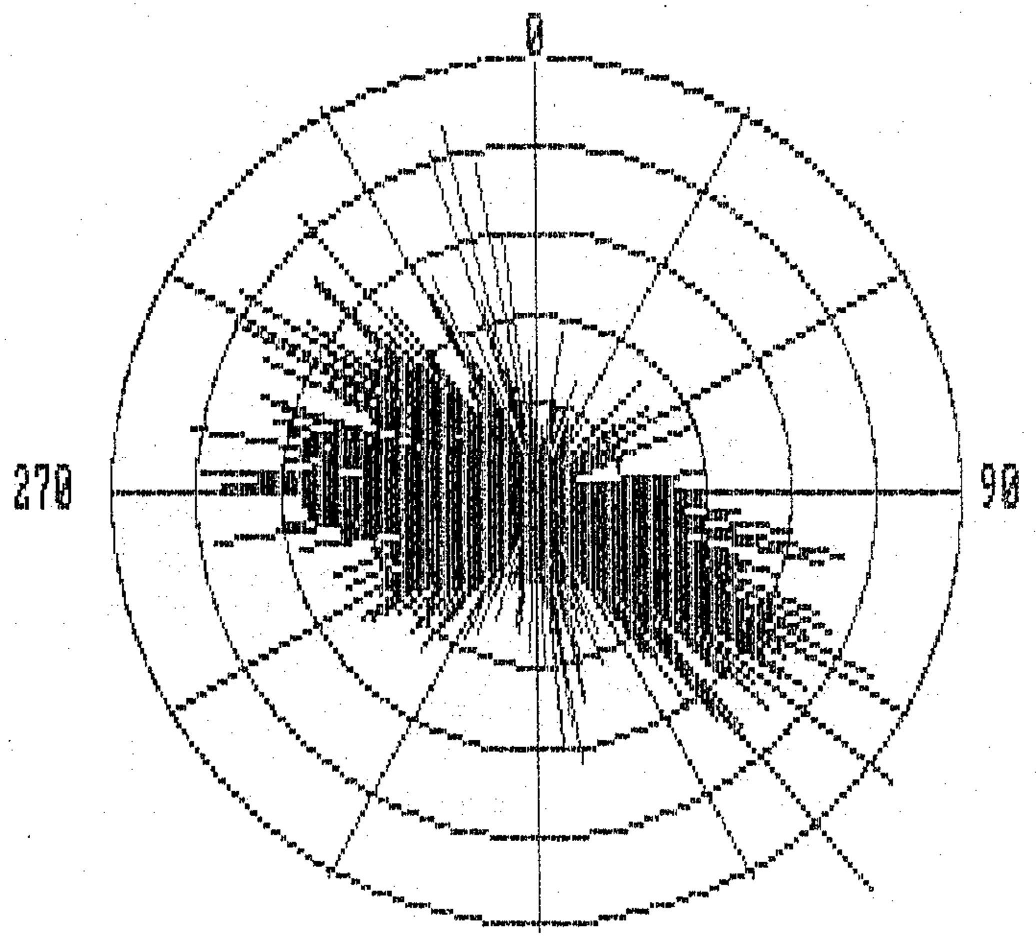


Fig 2.4.3.14

Polar

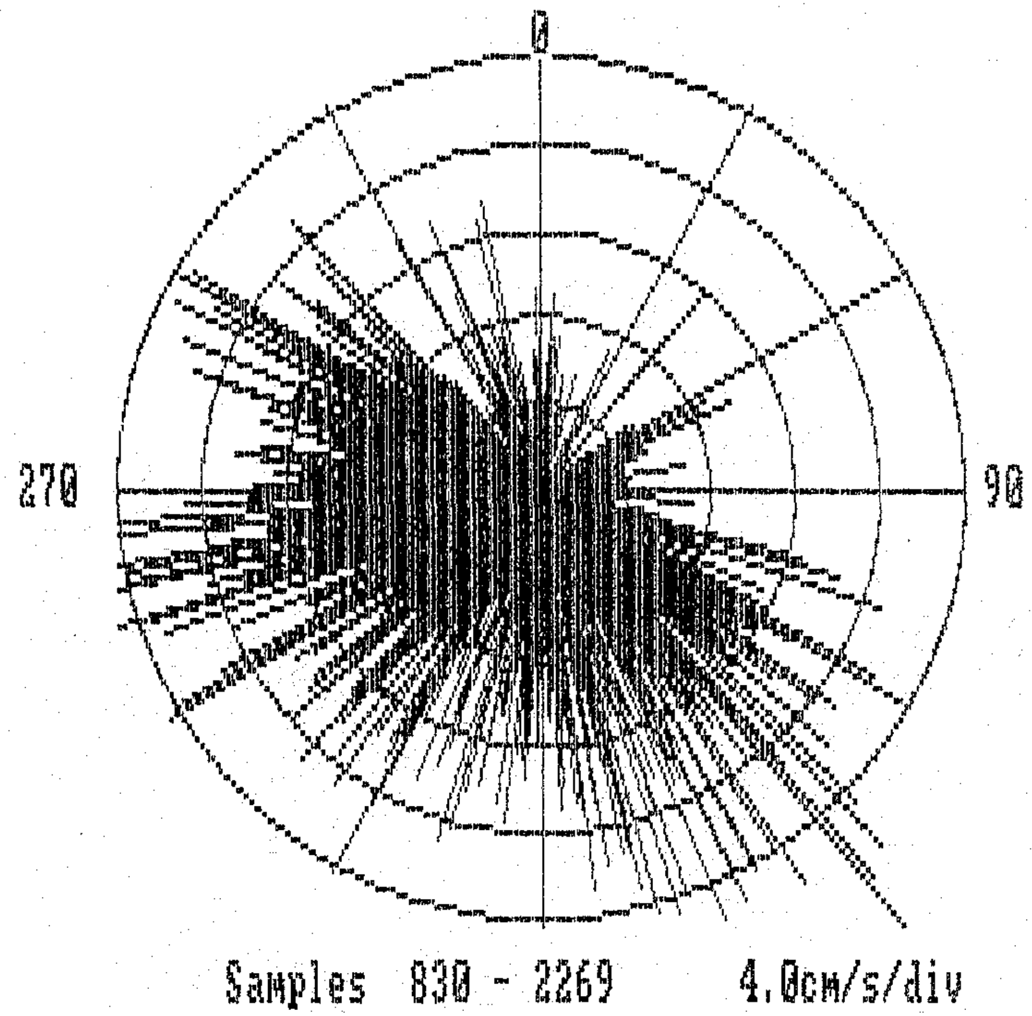


Fig 2.4.3.15

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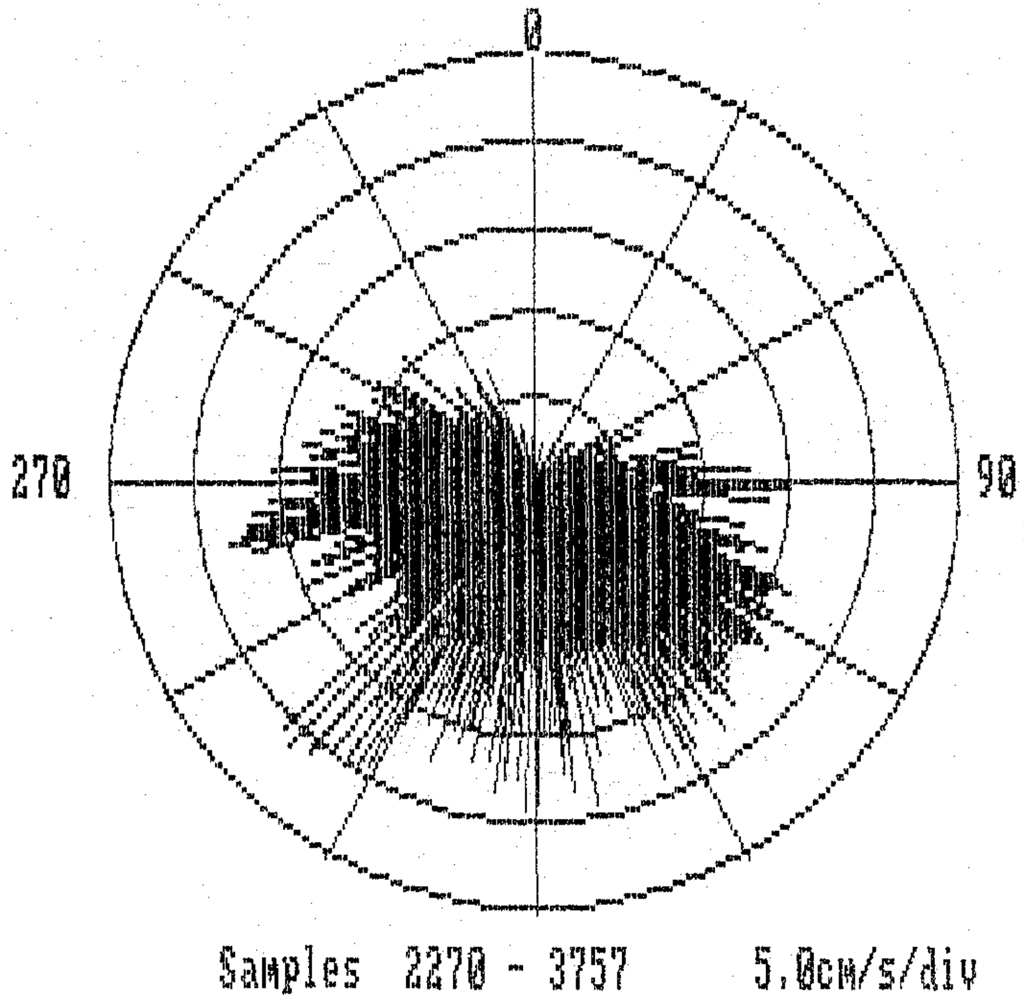
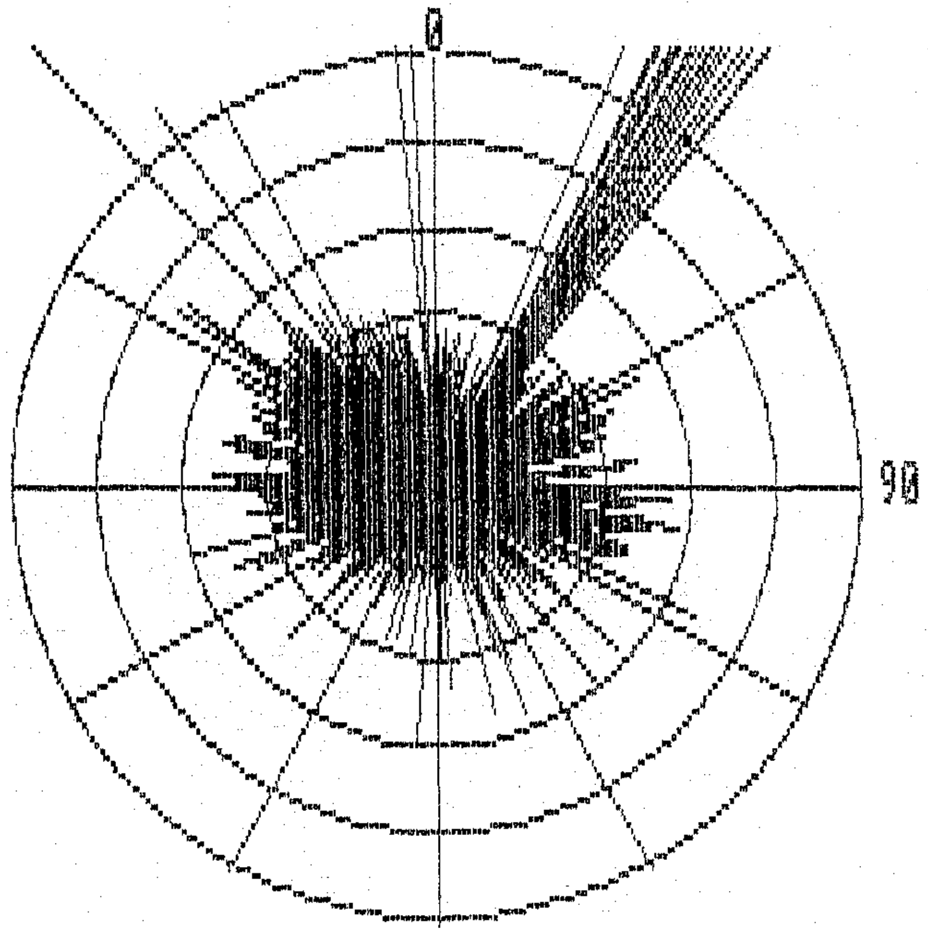


Fig 2.4.3.16

Polar



Samples 3758 - 5197 5.0cm/s/div

Fig 2.4.3.17

Polar

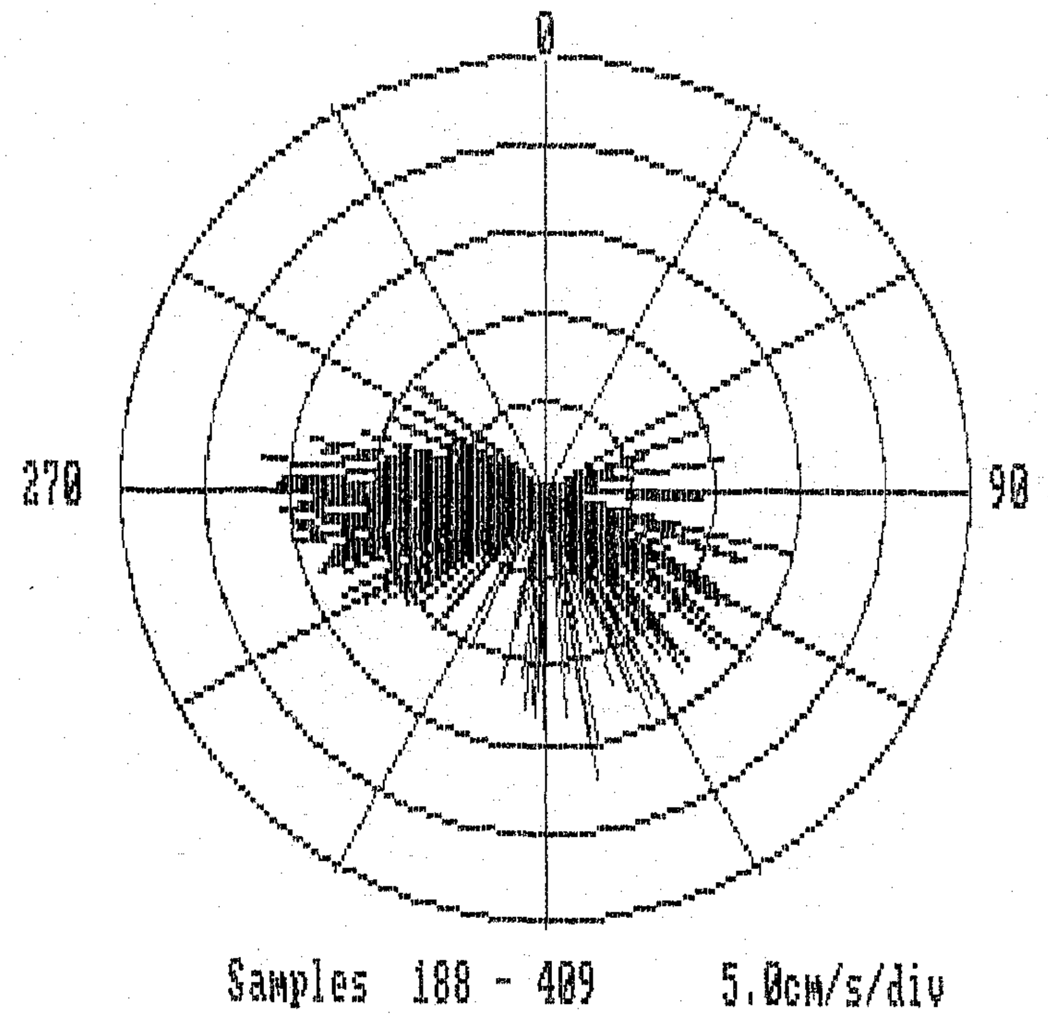


Fig 2.4.3.18

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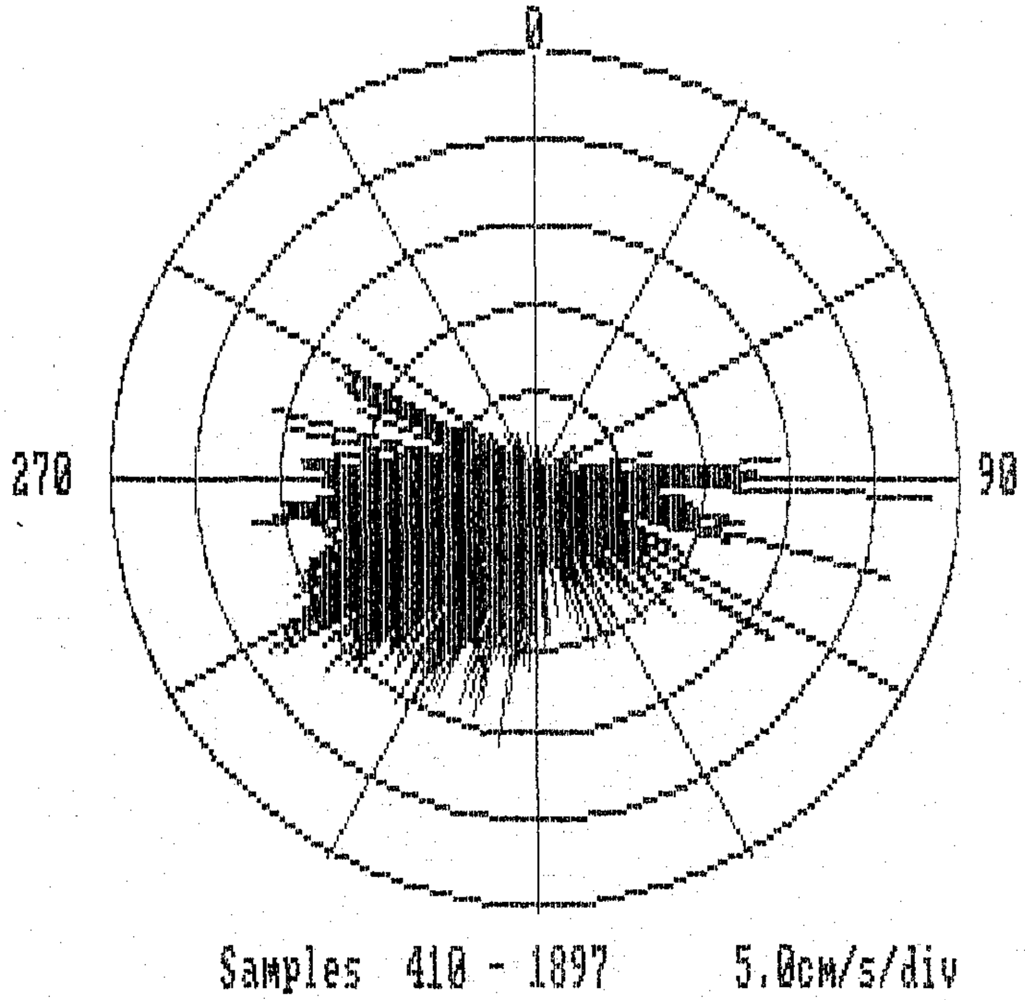


Fig 2.4.3.19

Polar

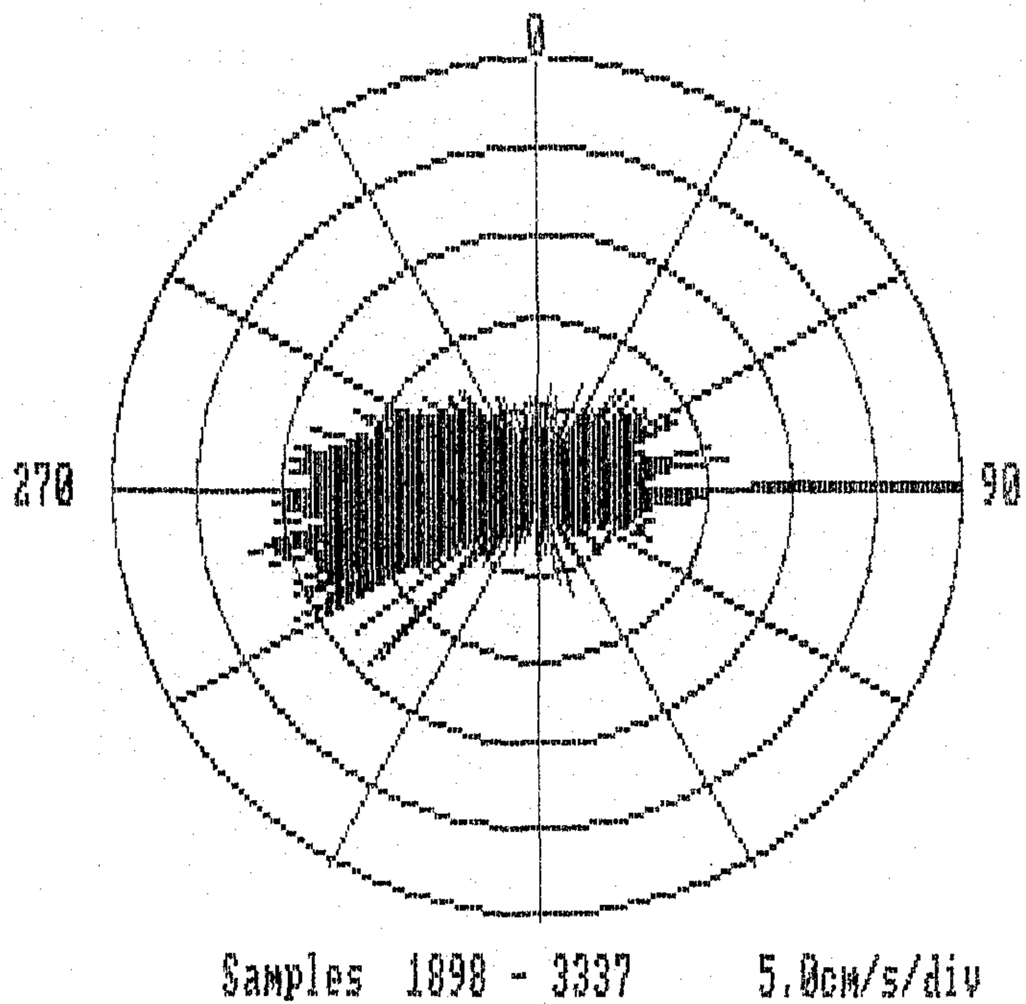


Fig 2.4.3.20

polar

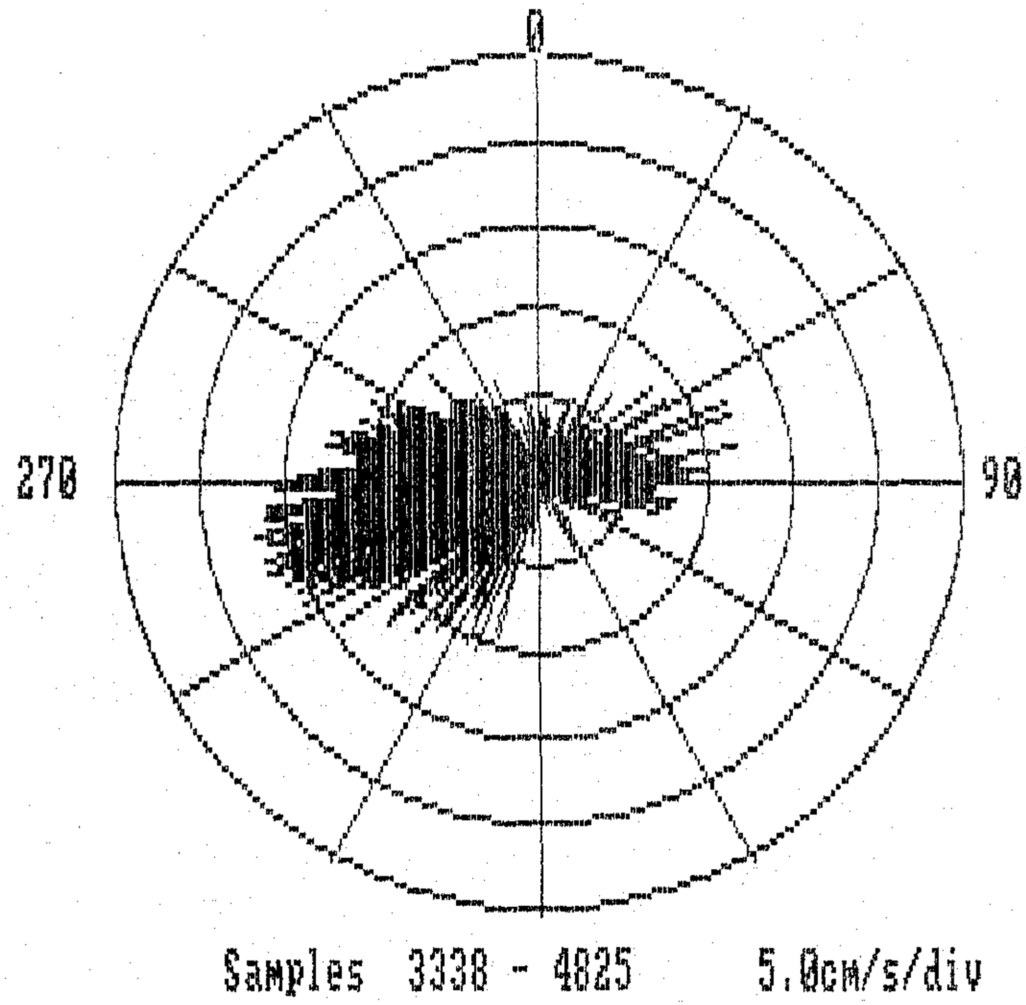


Fig 2.4.3.21

Polar

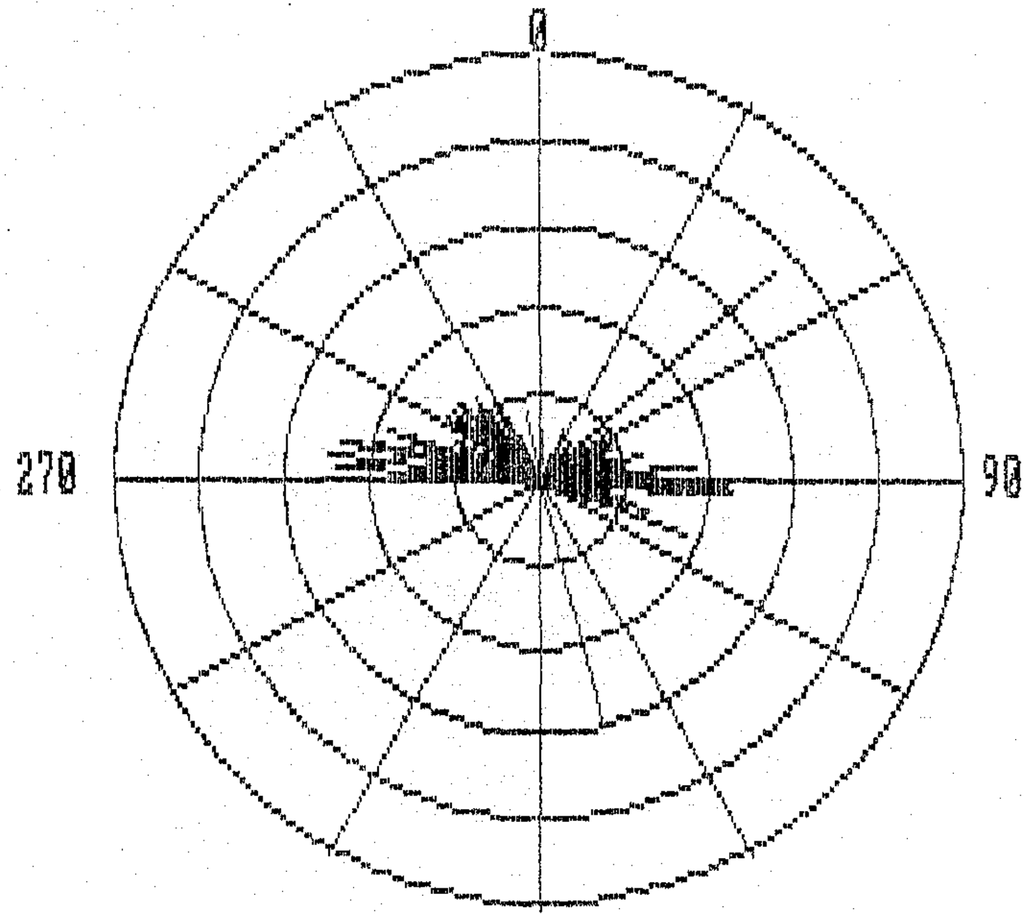


Fig 2.4.3.22

Polar

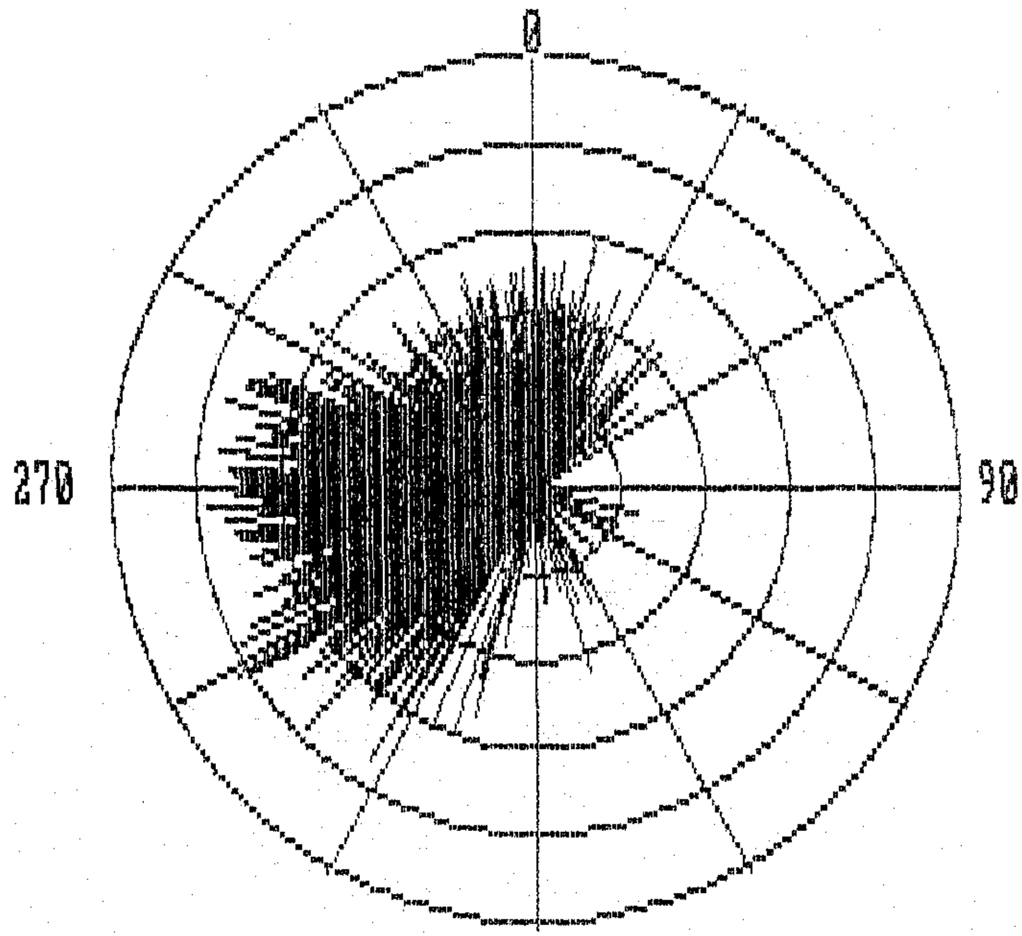


Fig 2.4.3.23

Polar

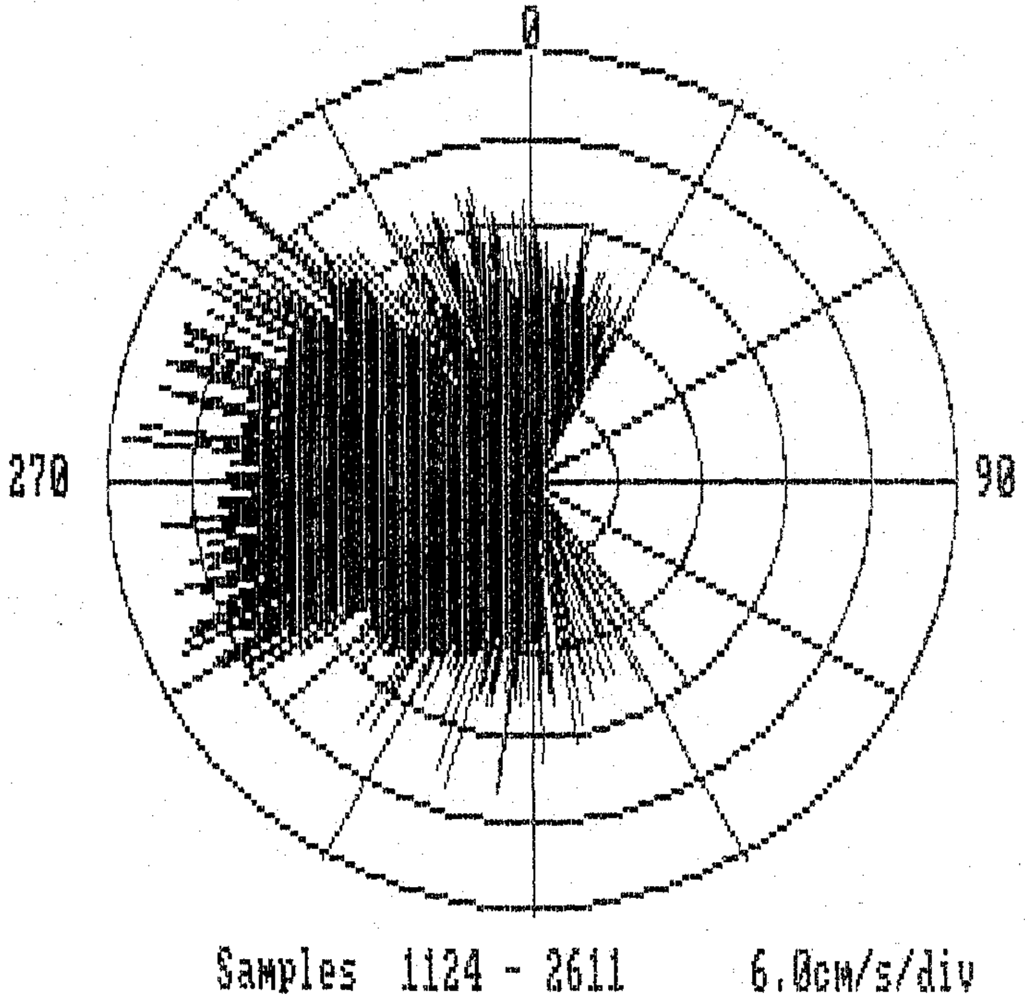


Fig 2.4.3.24

Polar

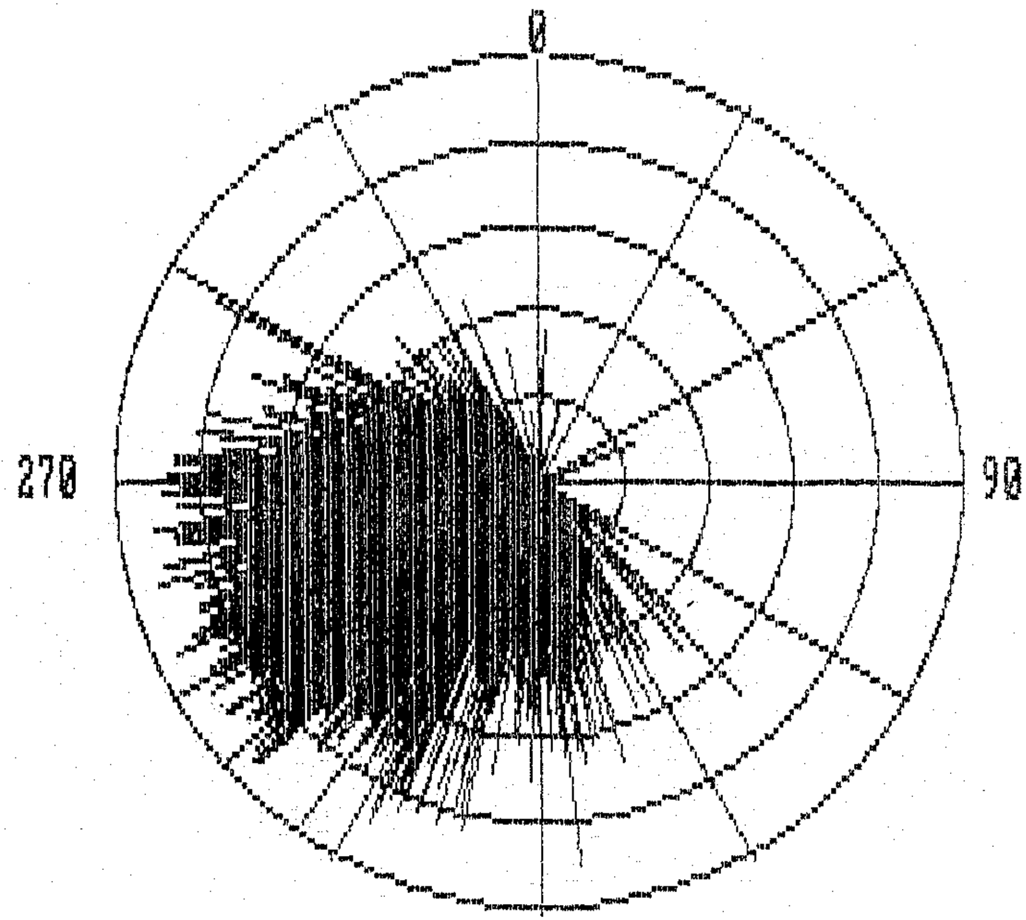
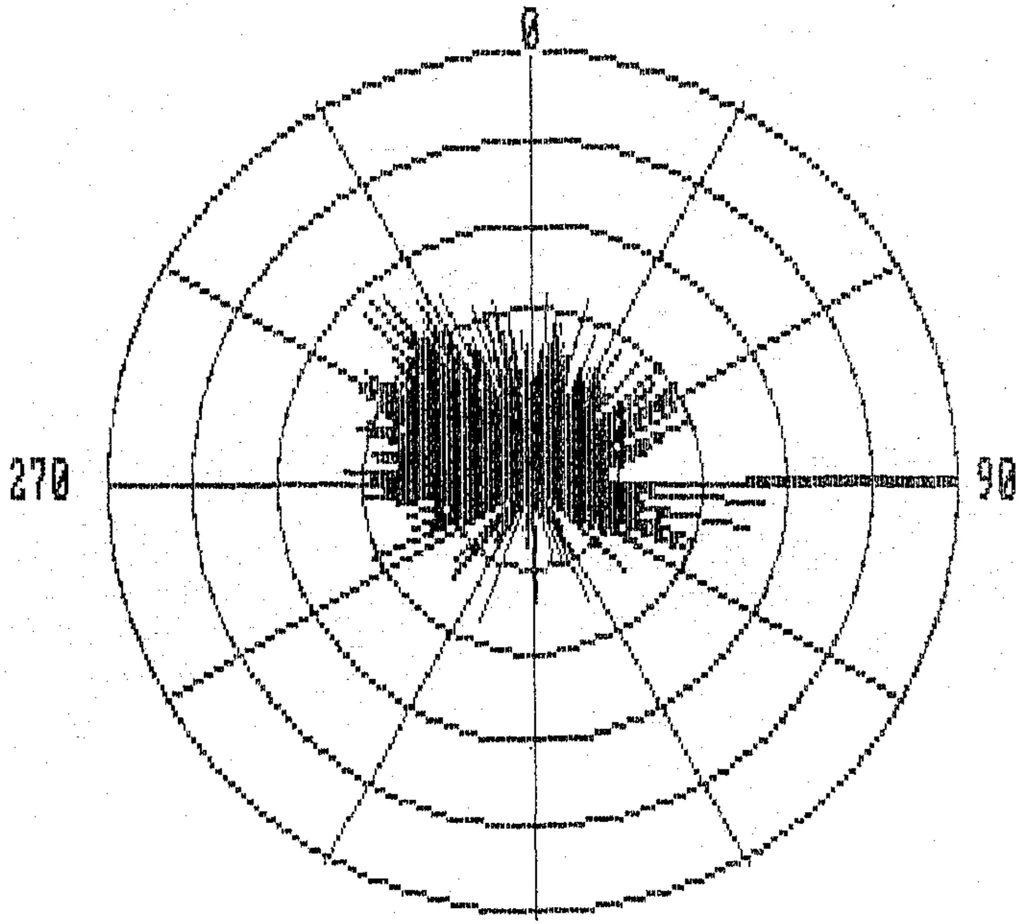


Fig 2.4.3.25

Polar



Samples 4100 - 5126 6.0cm/s/div

Fig 2.4.3.26

Straw

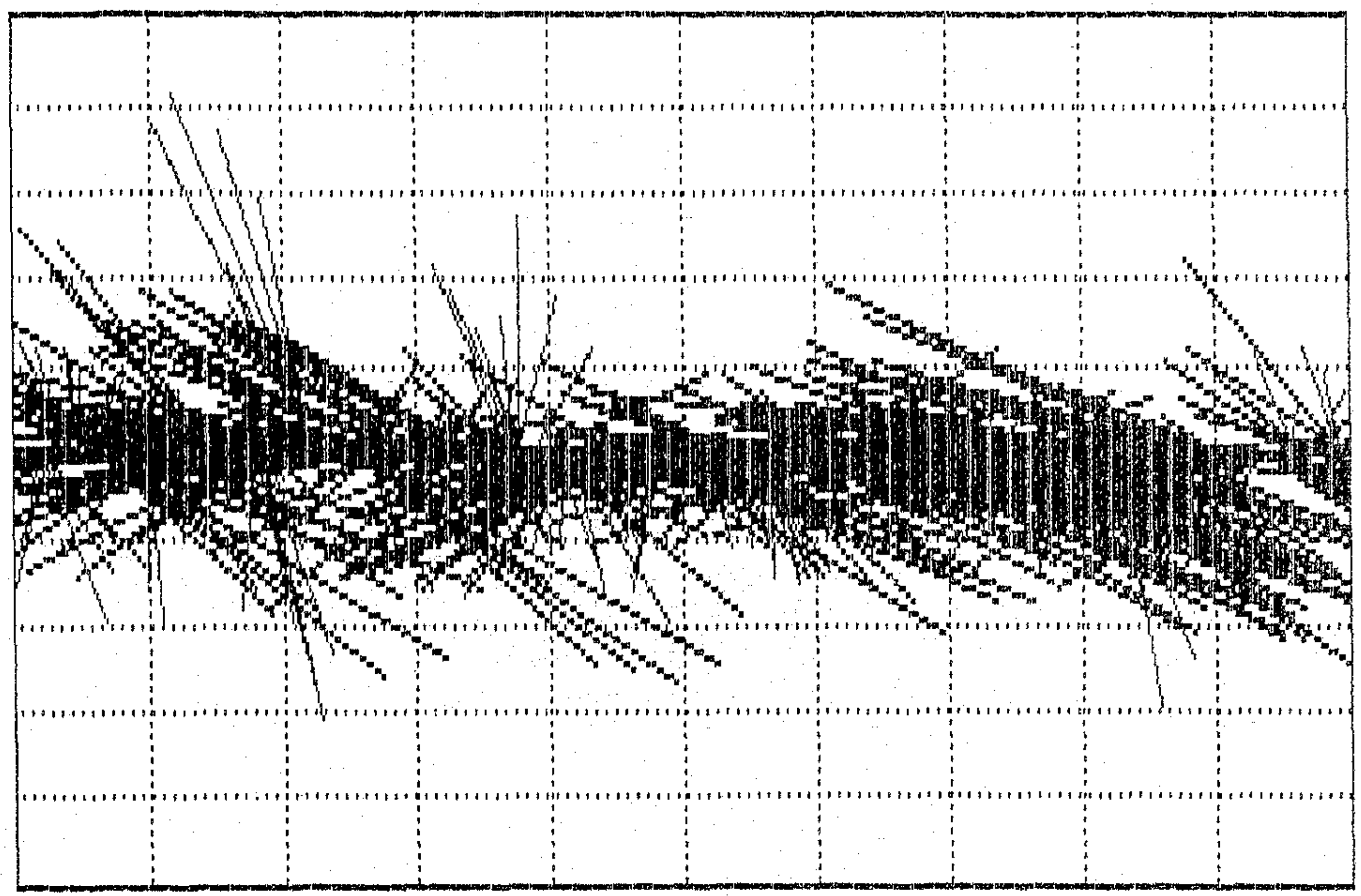


Fig 2.4.3.27

Straw

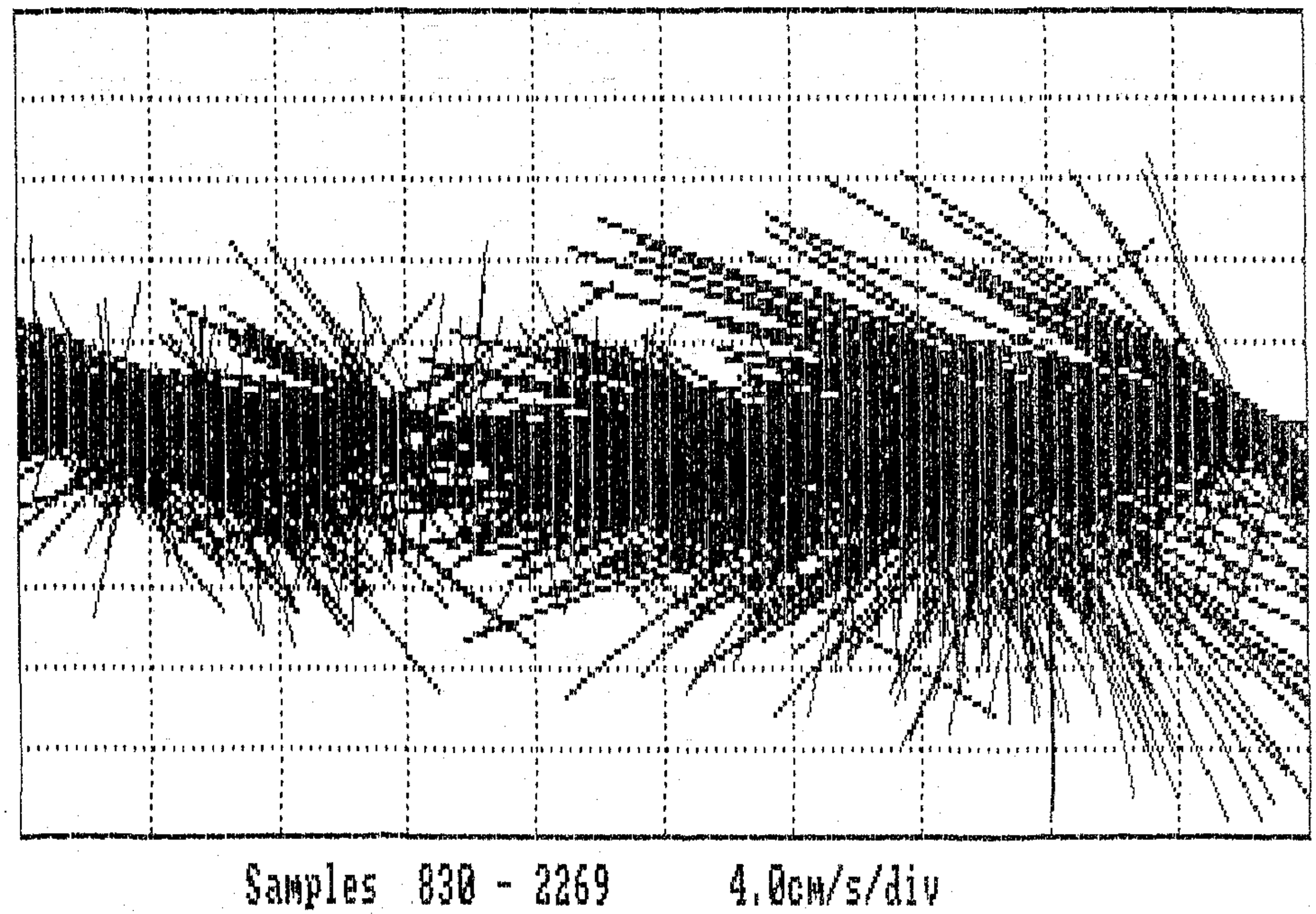
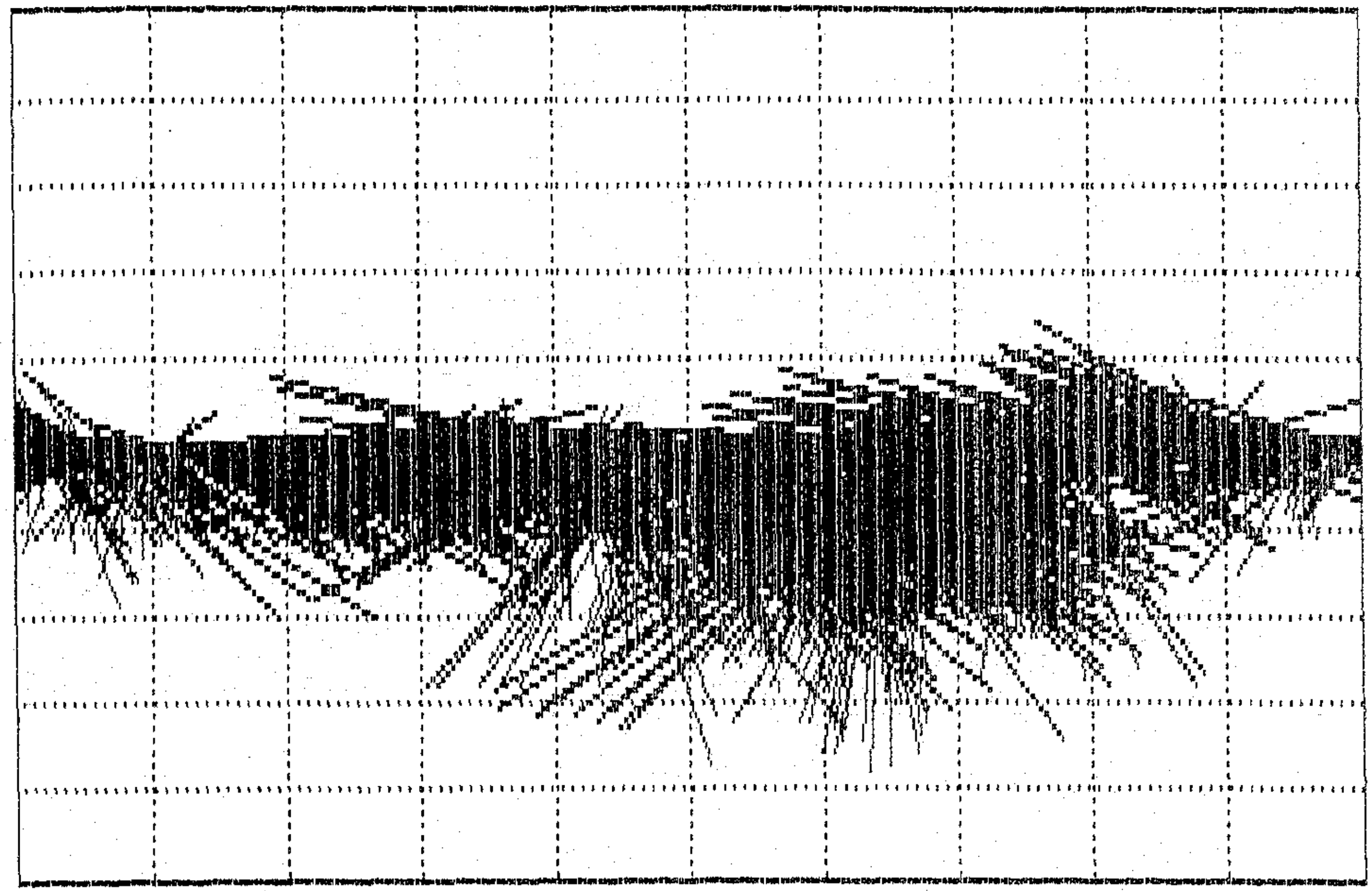


Fig 2.4.3.28

Straw



Samples 2270 - 3757 5.0cm/s/div

Fig 2.4.3.29

Straw

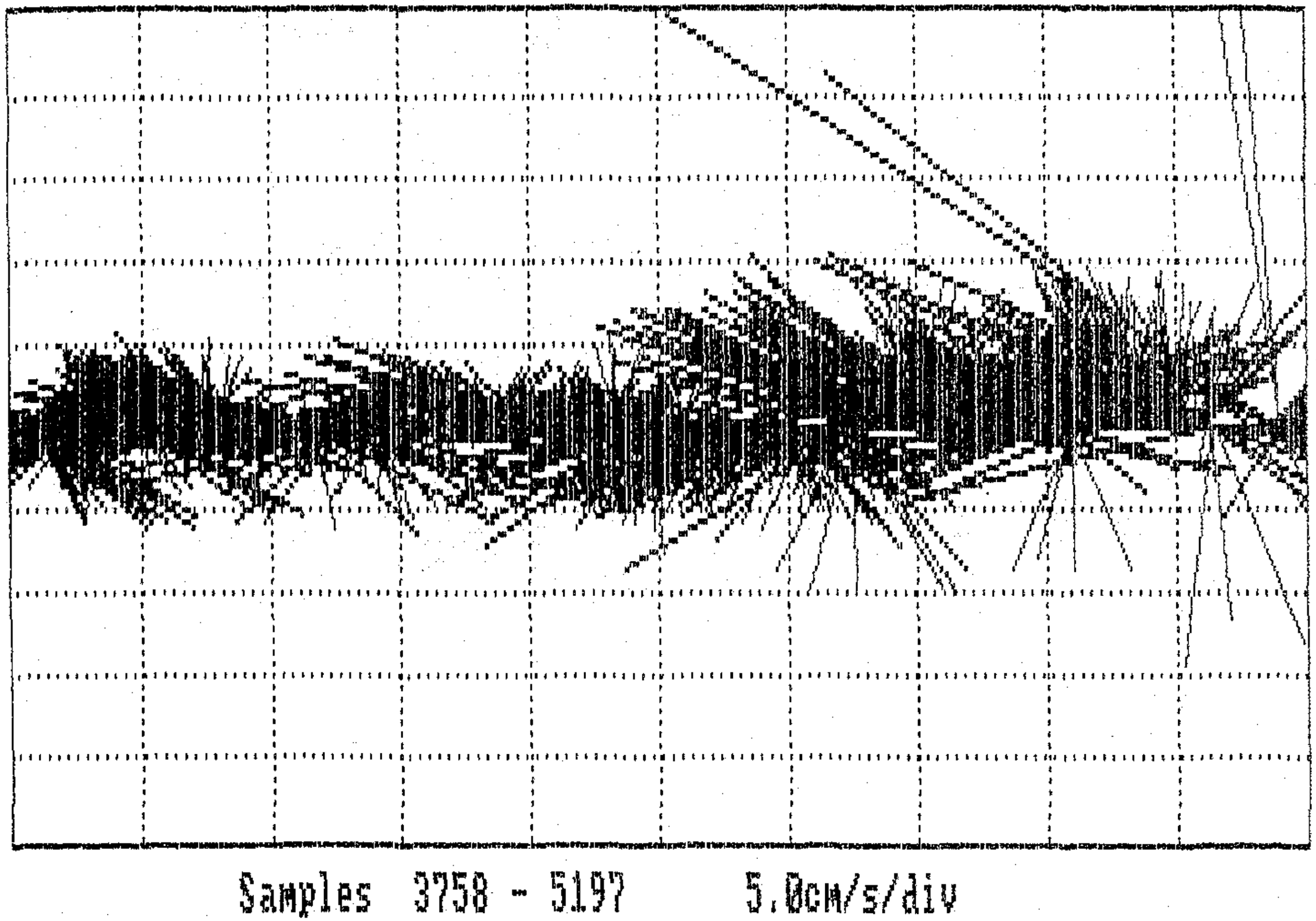
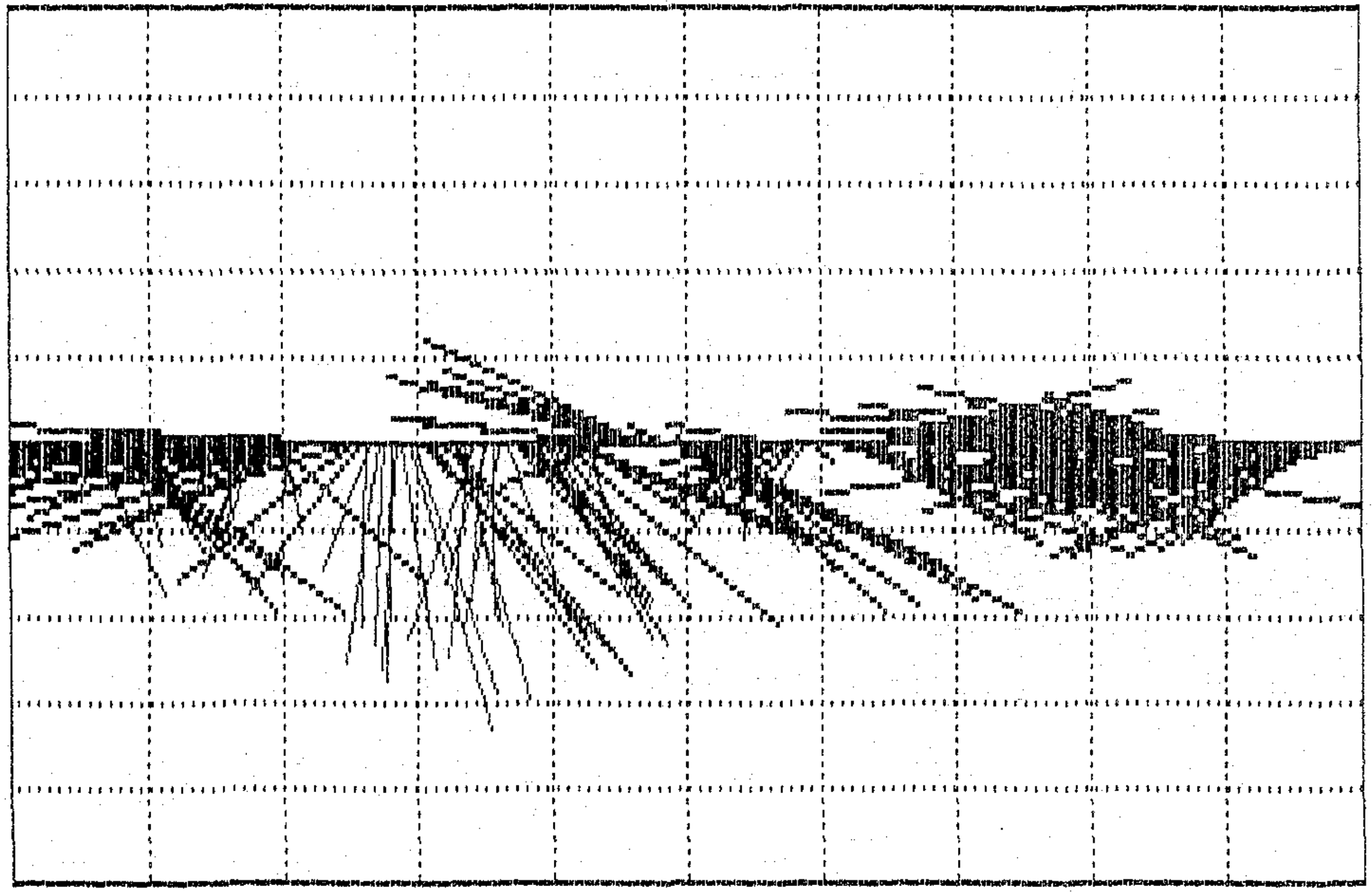


Fig 2.4.3.30

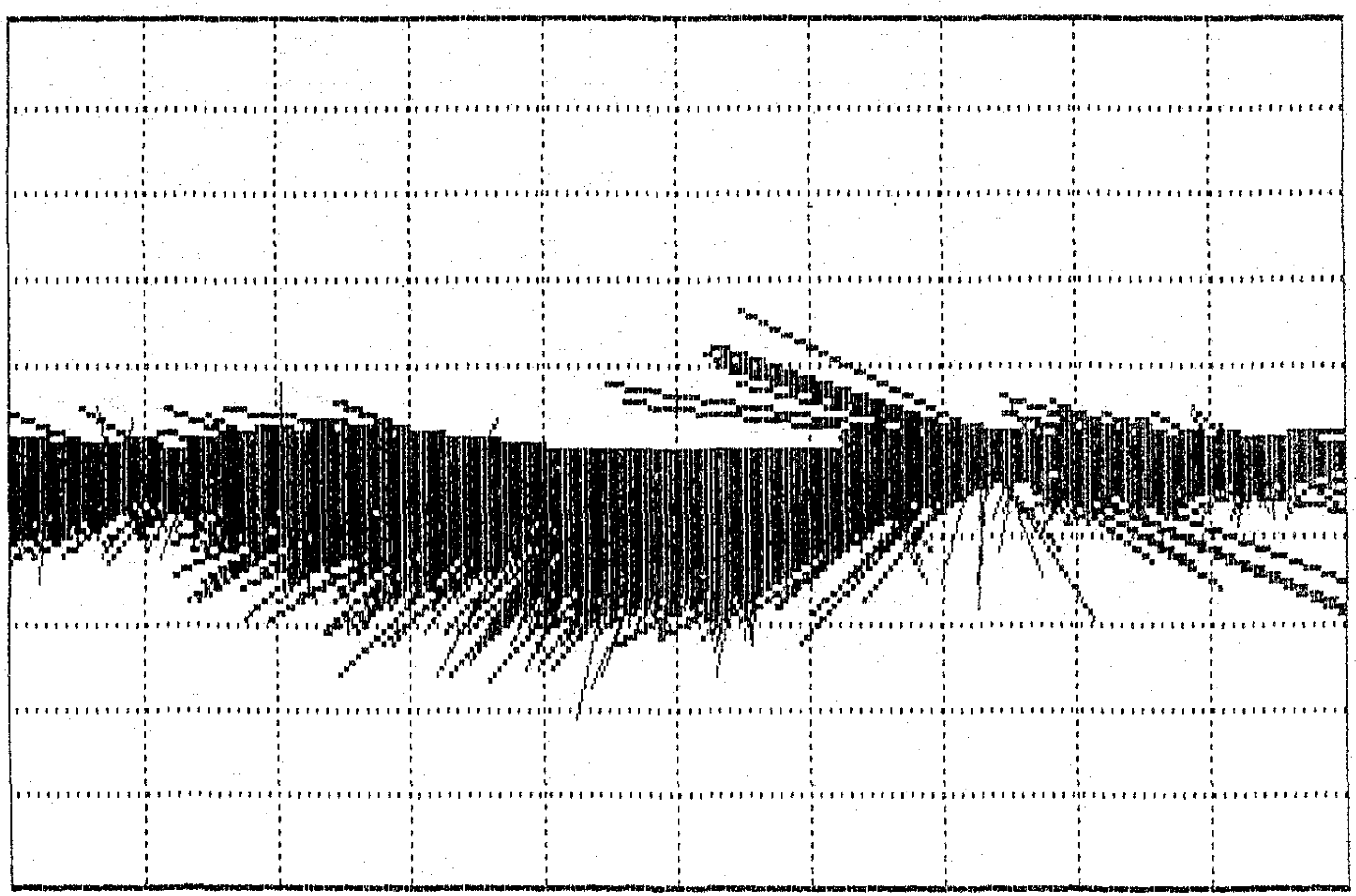
Straw



Samples 188 - 409   5.0cm/s/div

Fig 2.4:3.31

Straw



Samples 410 - 1897 5.0cm/s/div

Fig 2.4.3.32

Straw

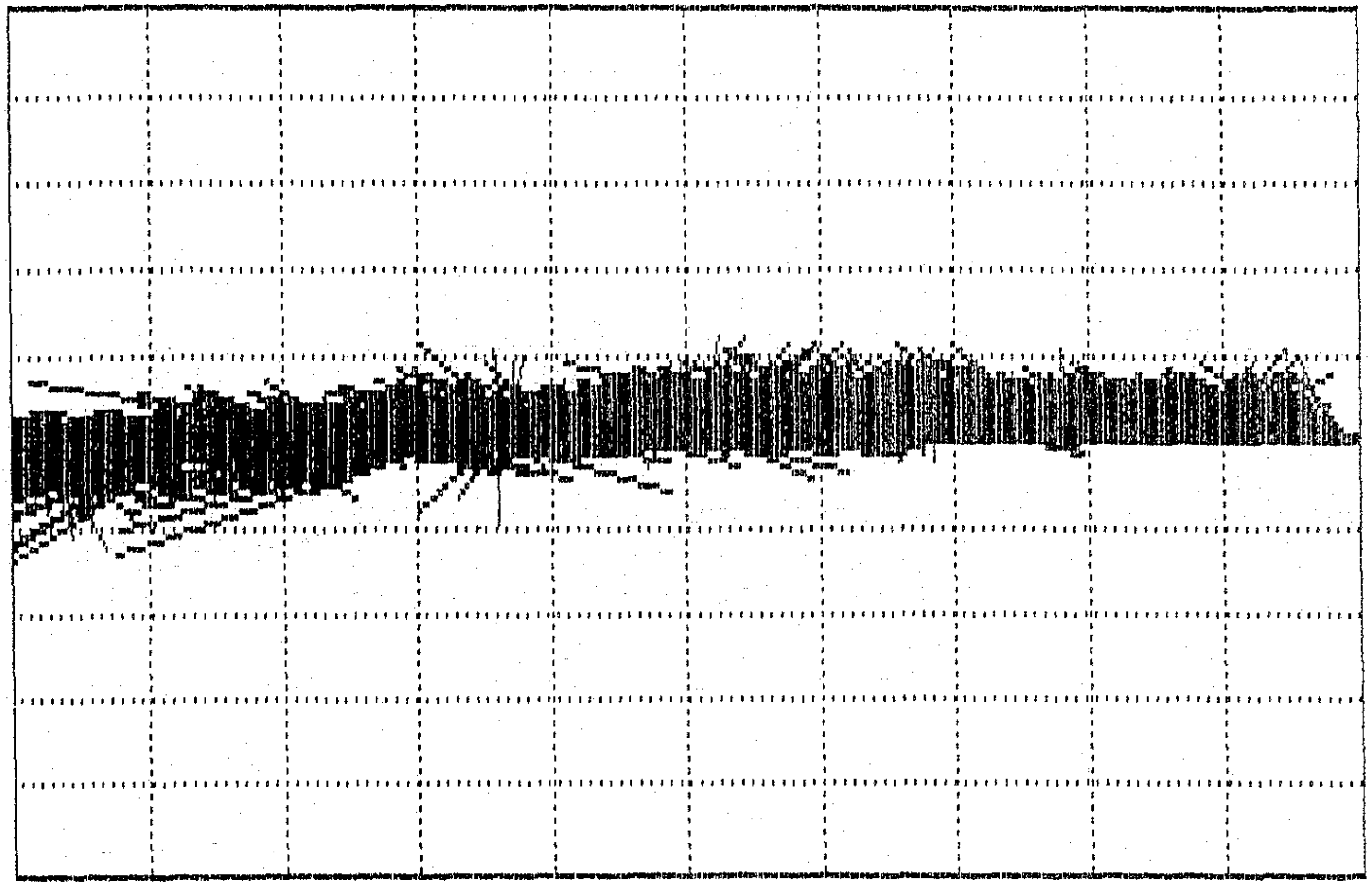
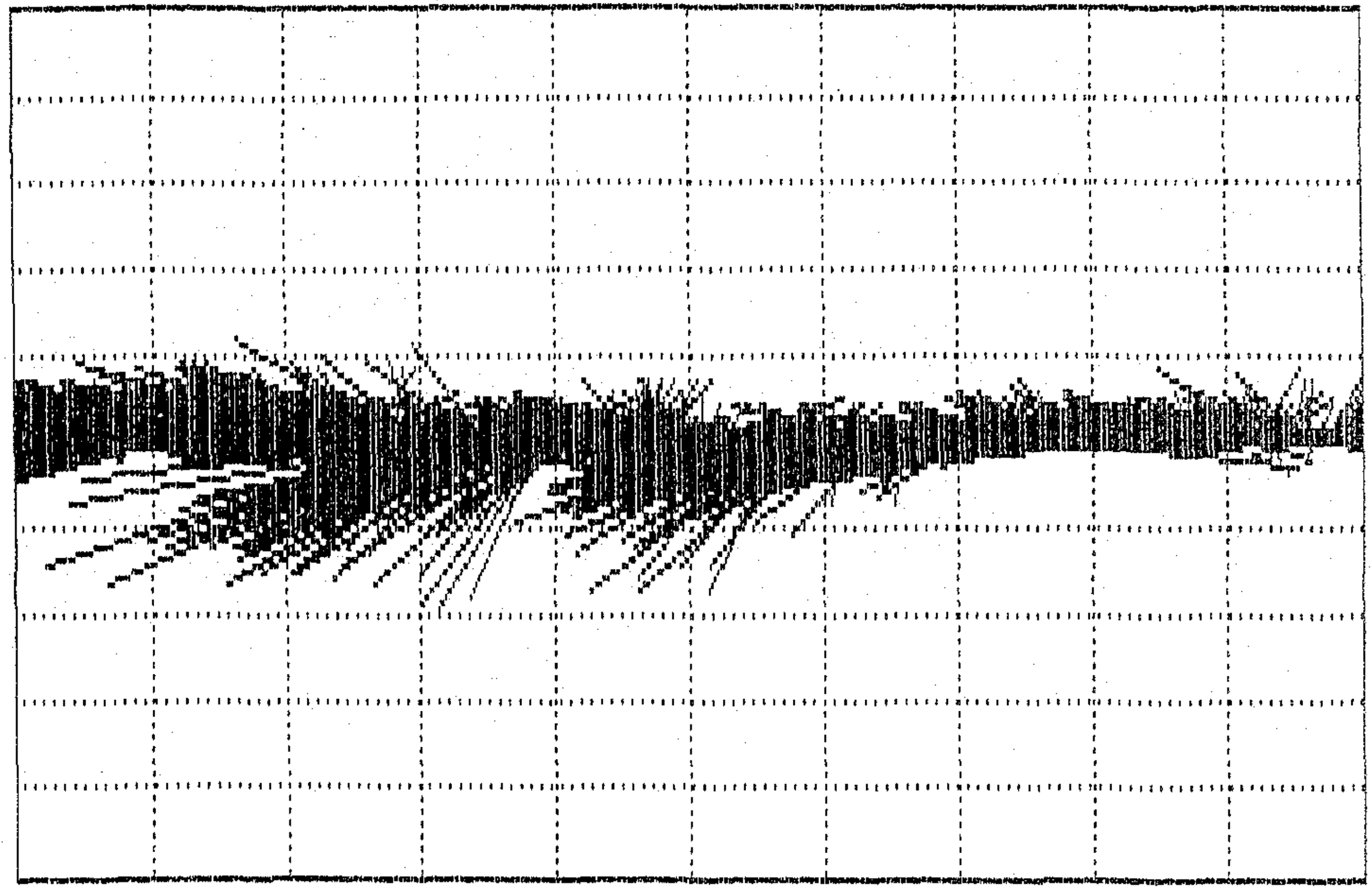


Fig 2.4.3.33

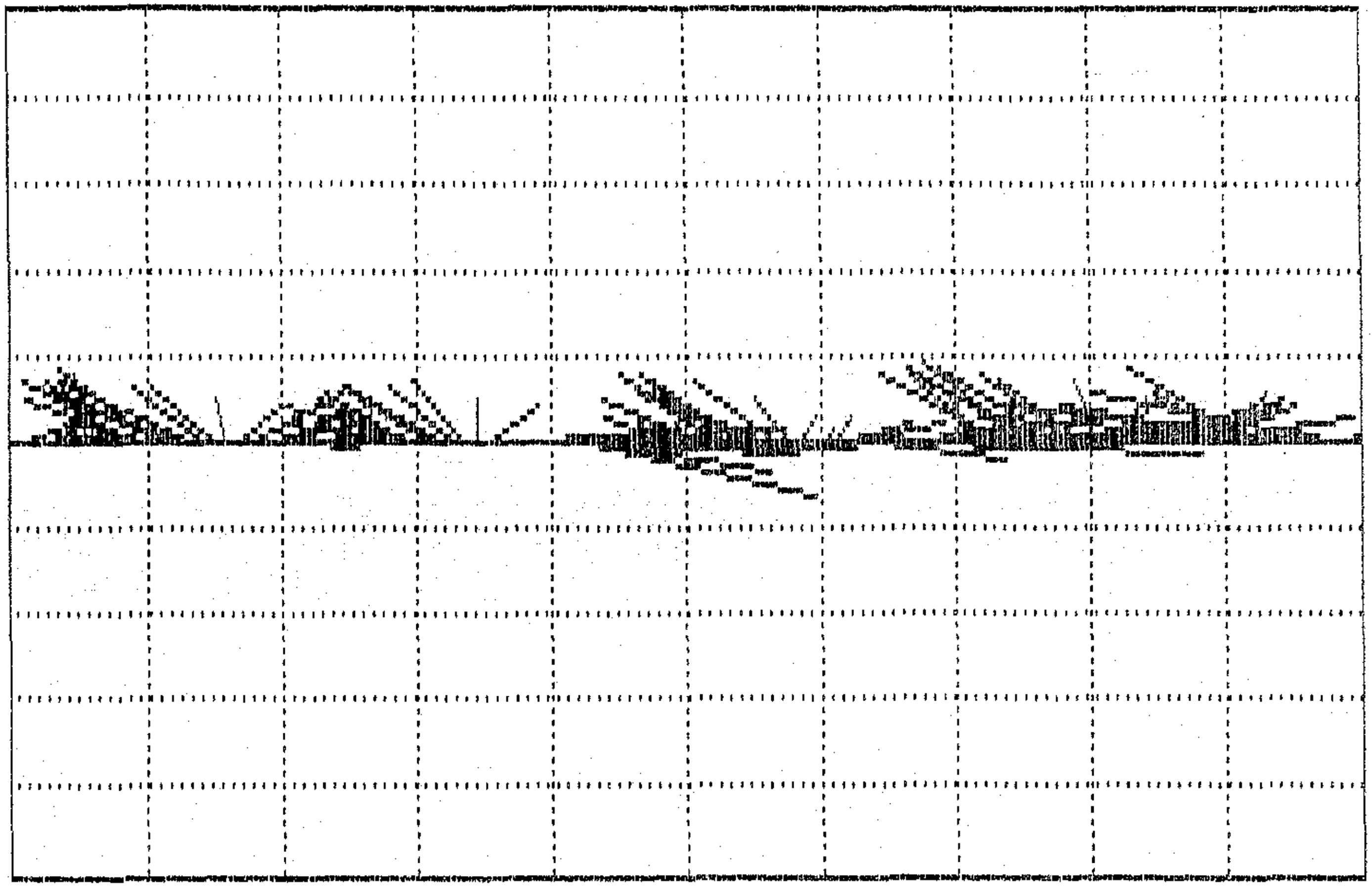
Straw



Samples 3338 - 4825 5.0cm/s/div

Fig 2.4.3.34

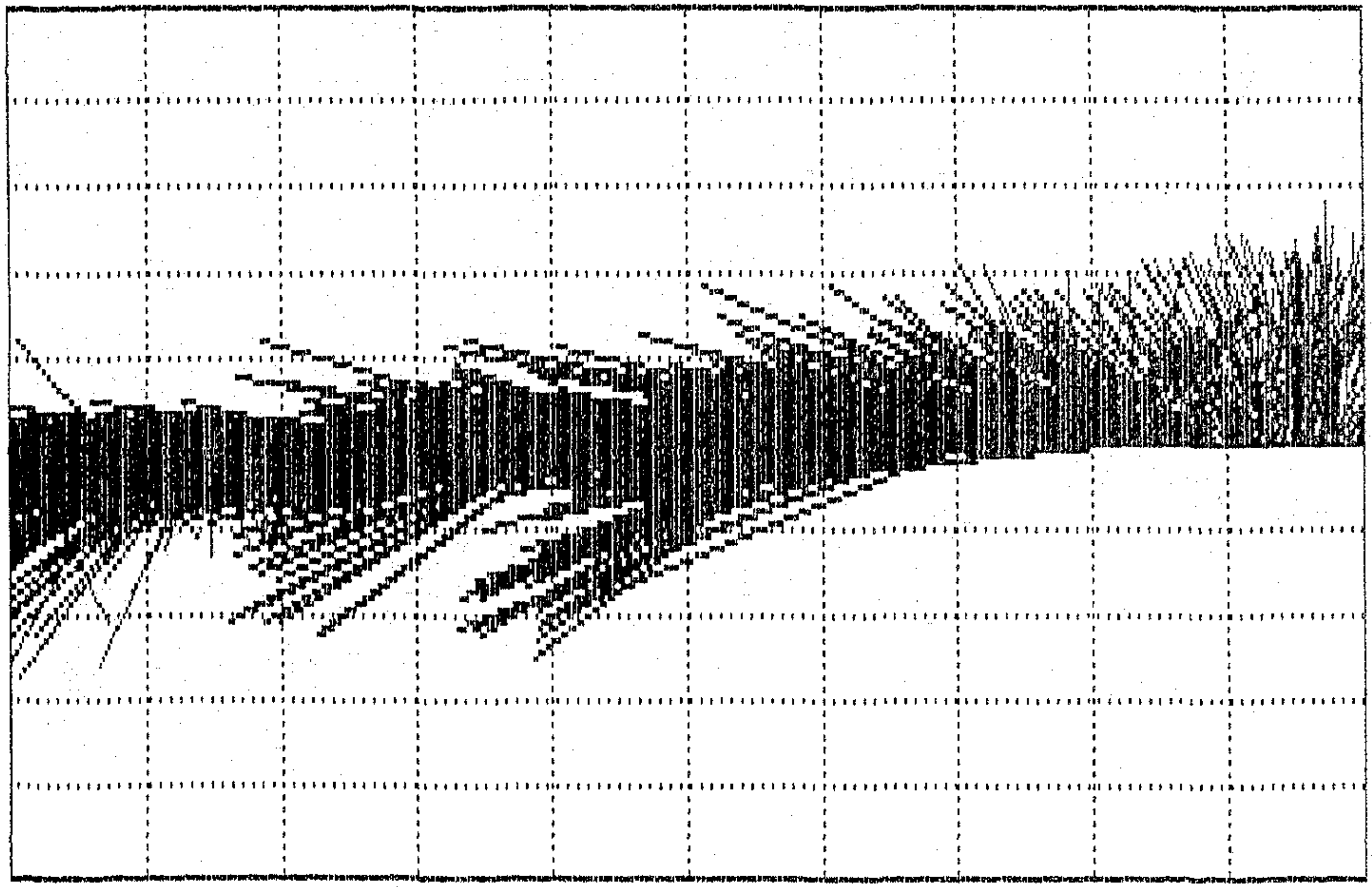
Straw



Samples 4826 - 4939 5.0cm/s/div

Fig 2.4.3.35

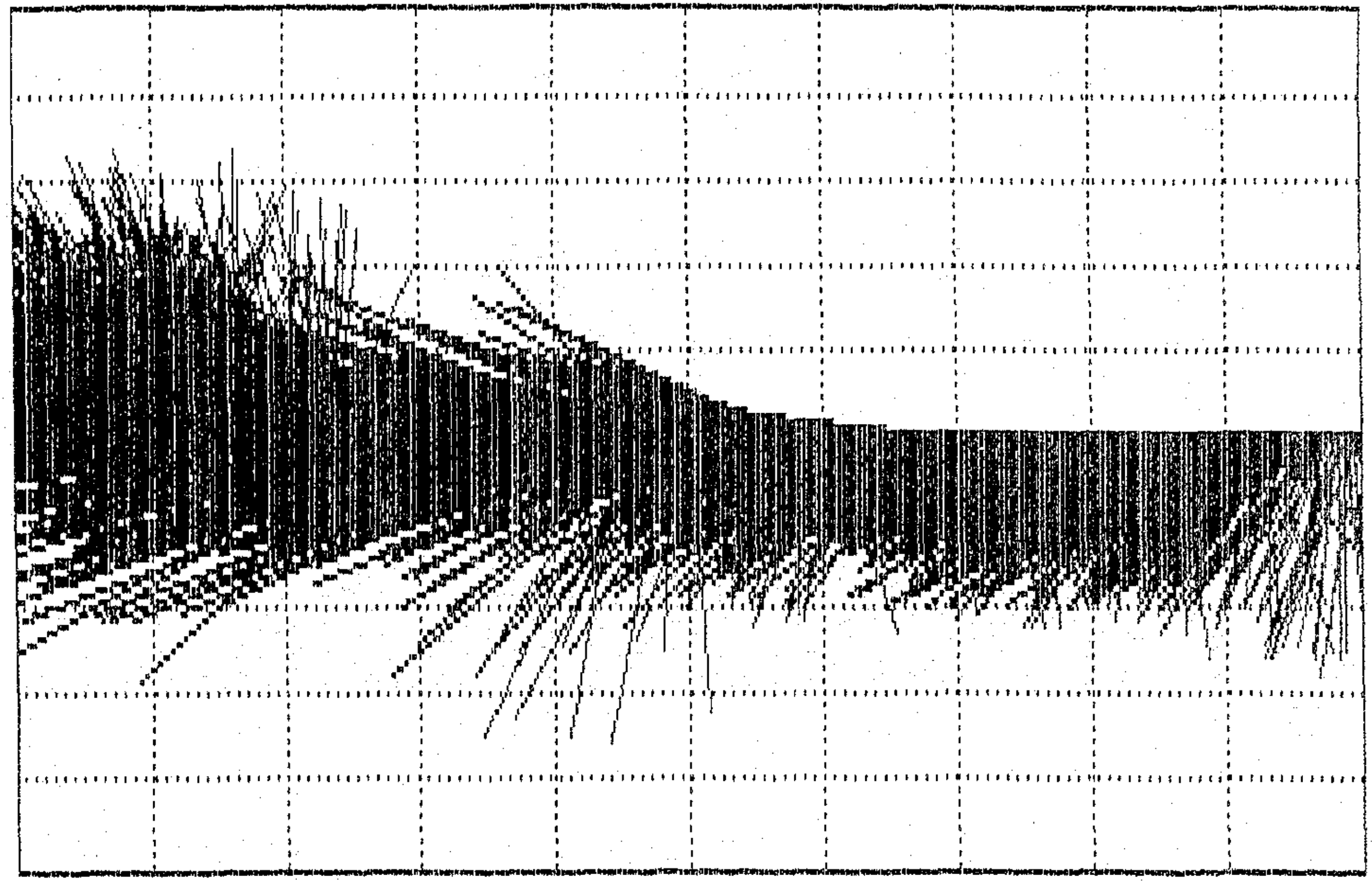
Straw



Samples 42 - 1123   5.0cm/s/div

Fig 2.4.3.36

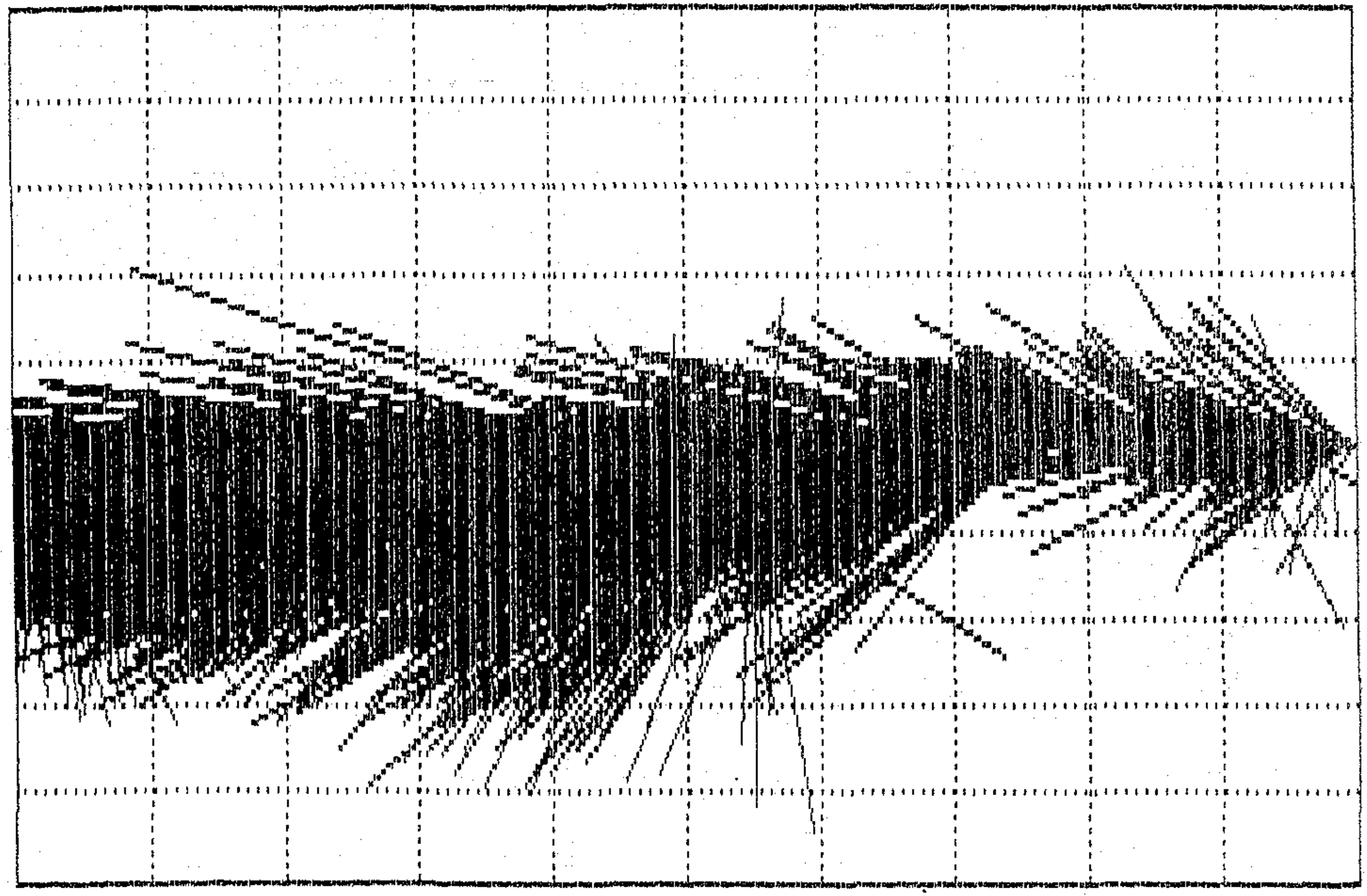
Straw



Samples 1124 - 2611 6.0cm/s/div

Fig 2.4.3.37

Straw



Samples 2612 - 4099 6.0cm/s/div

Fig 2.4.3.38

Straw

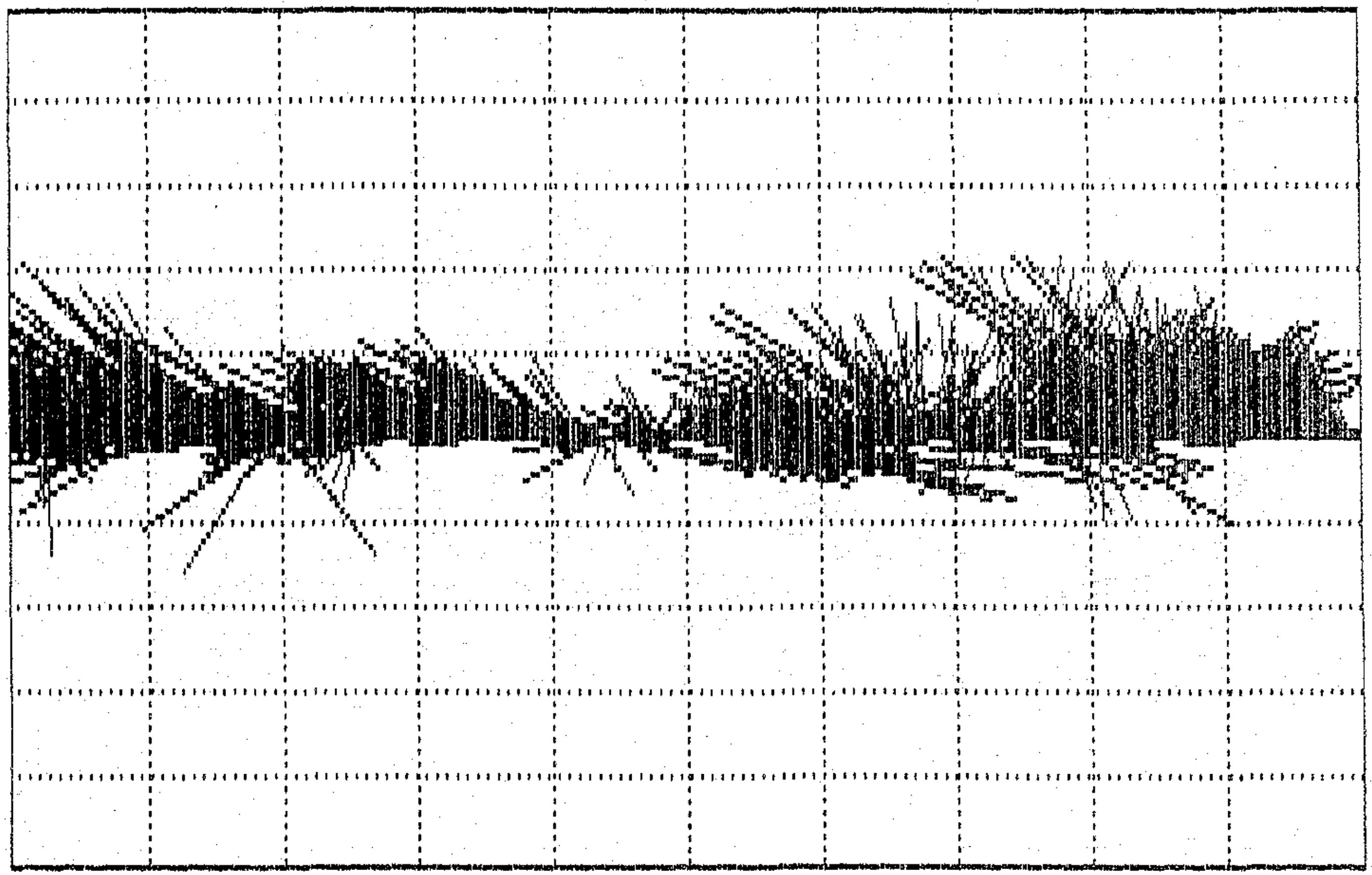
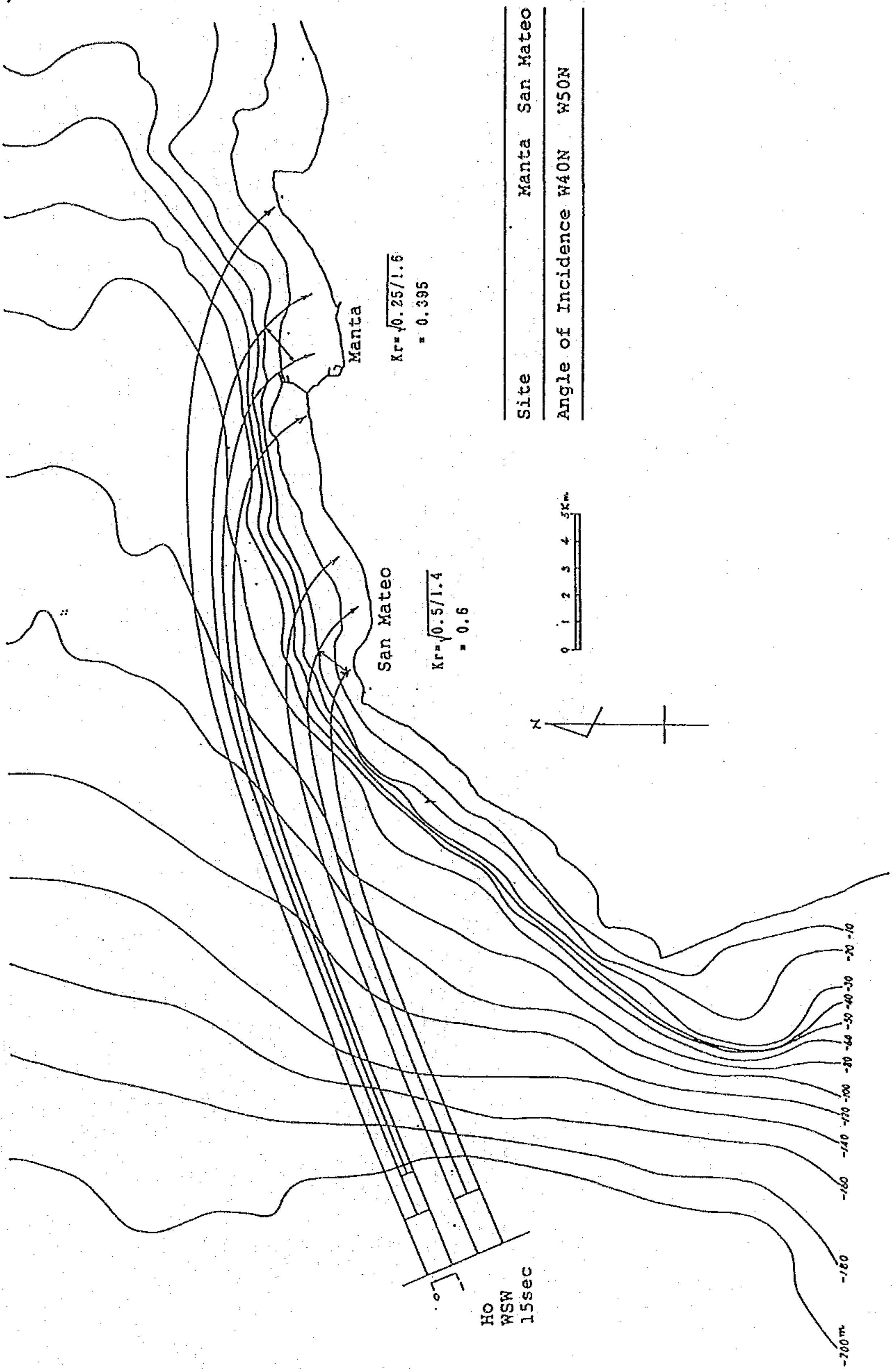


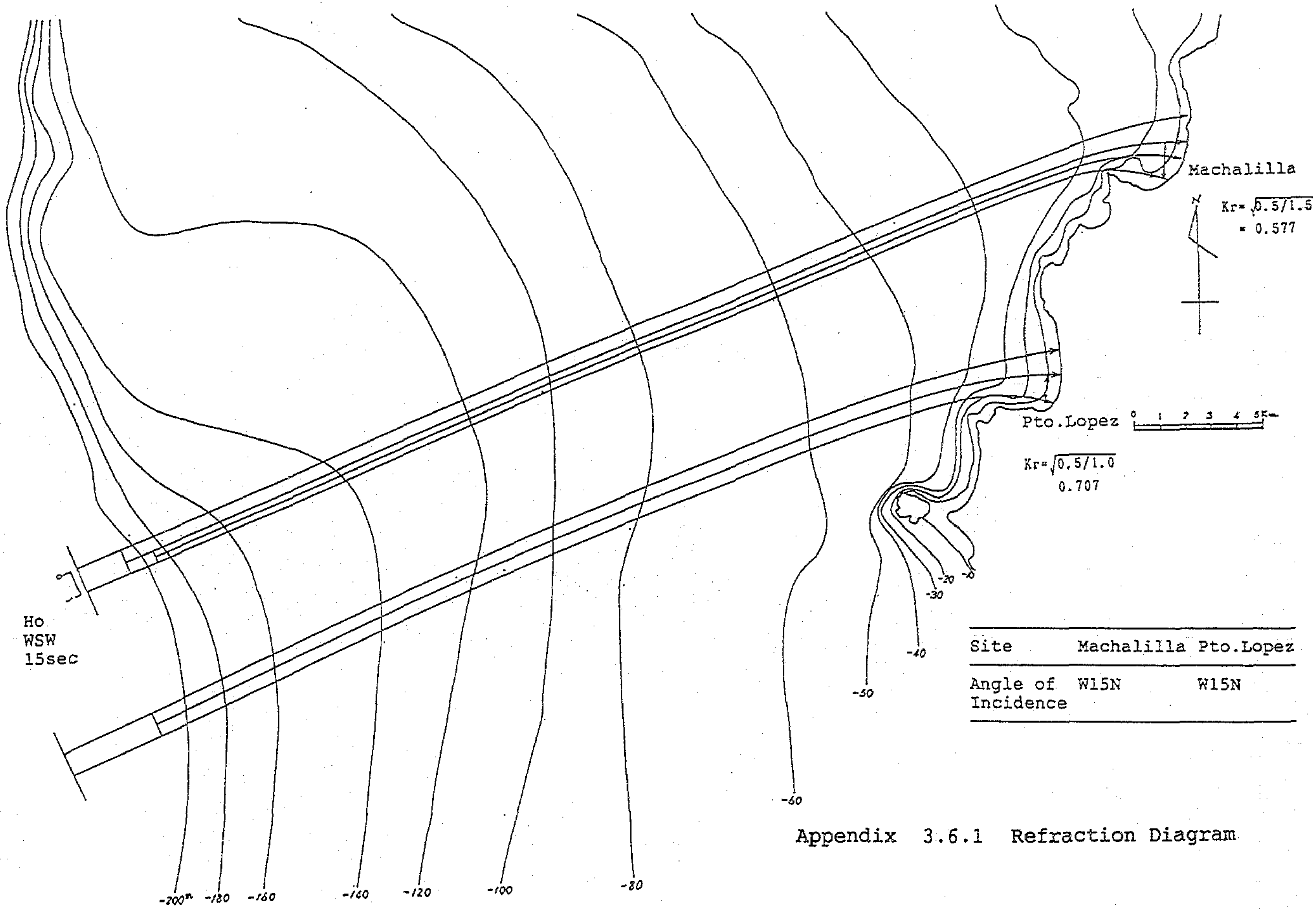
Fig 2.4.3.39

(5) Refraction Diagram

1) Refraction Diagram made by the JICA Study Team

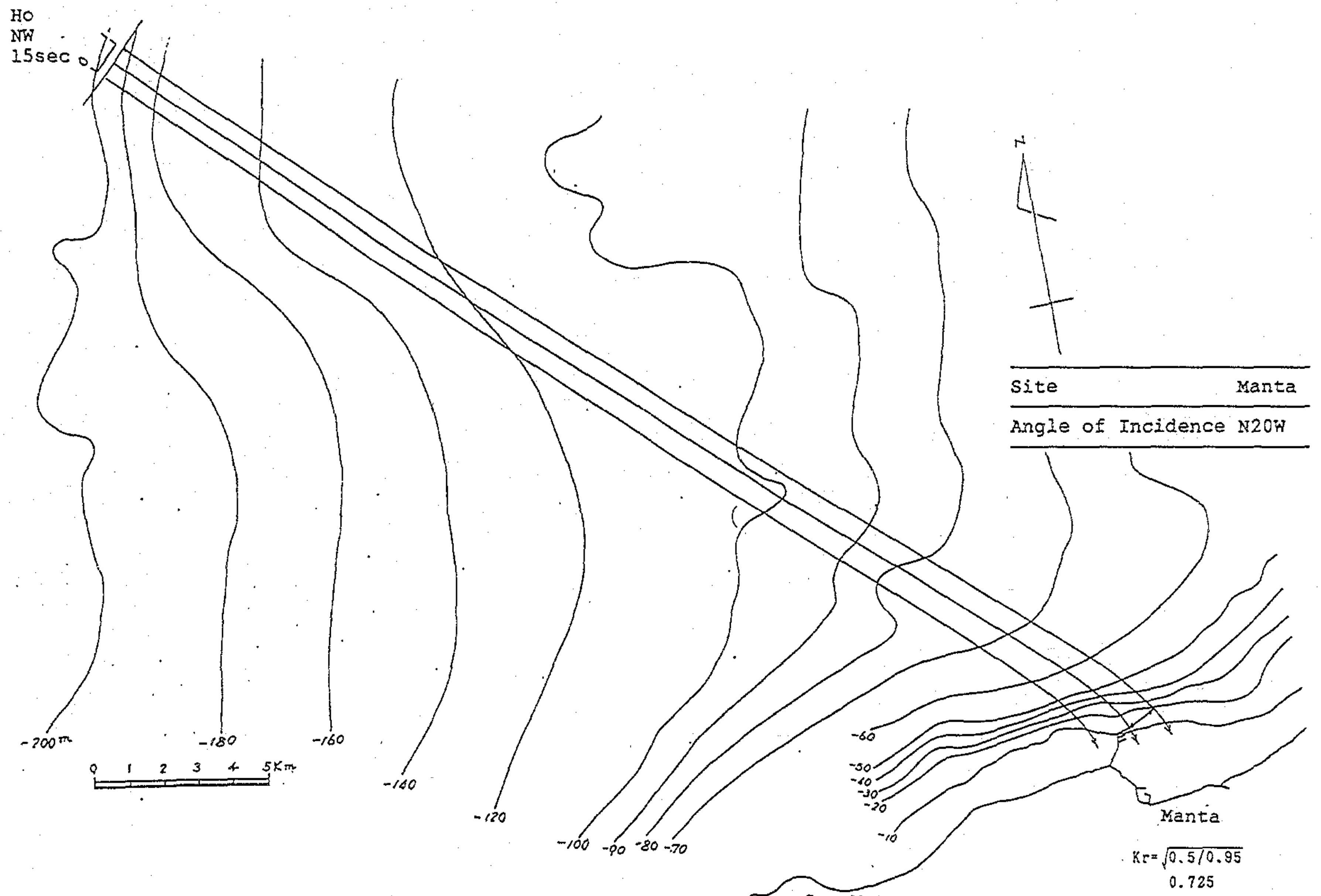


Appendix 3.6.1 Refraction Diagram

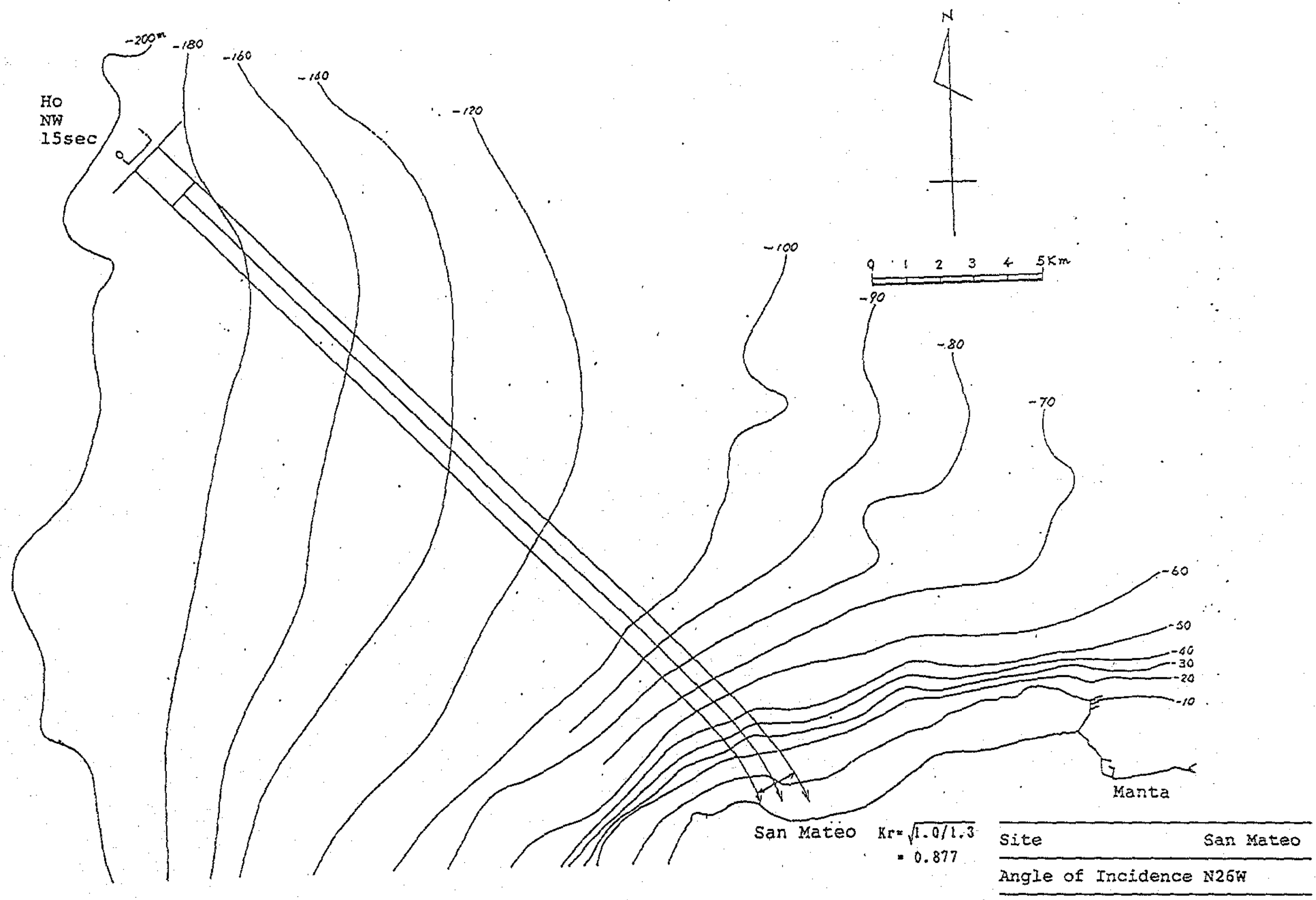


Site	Machalilla	Pto.Lopez
Angle of Incidence	W15N	W15N

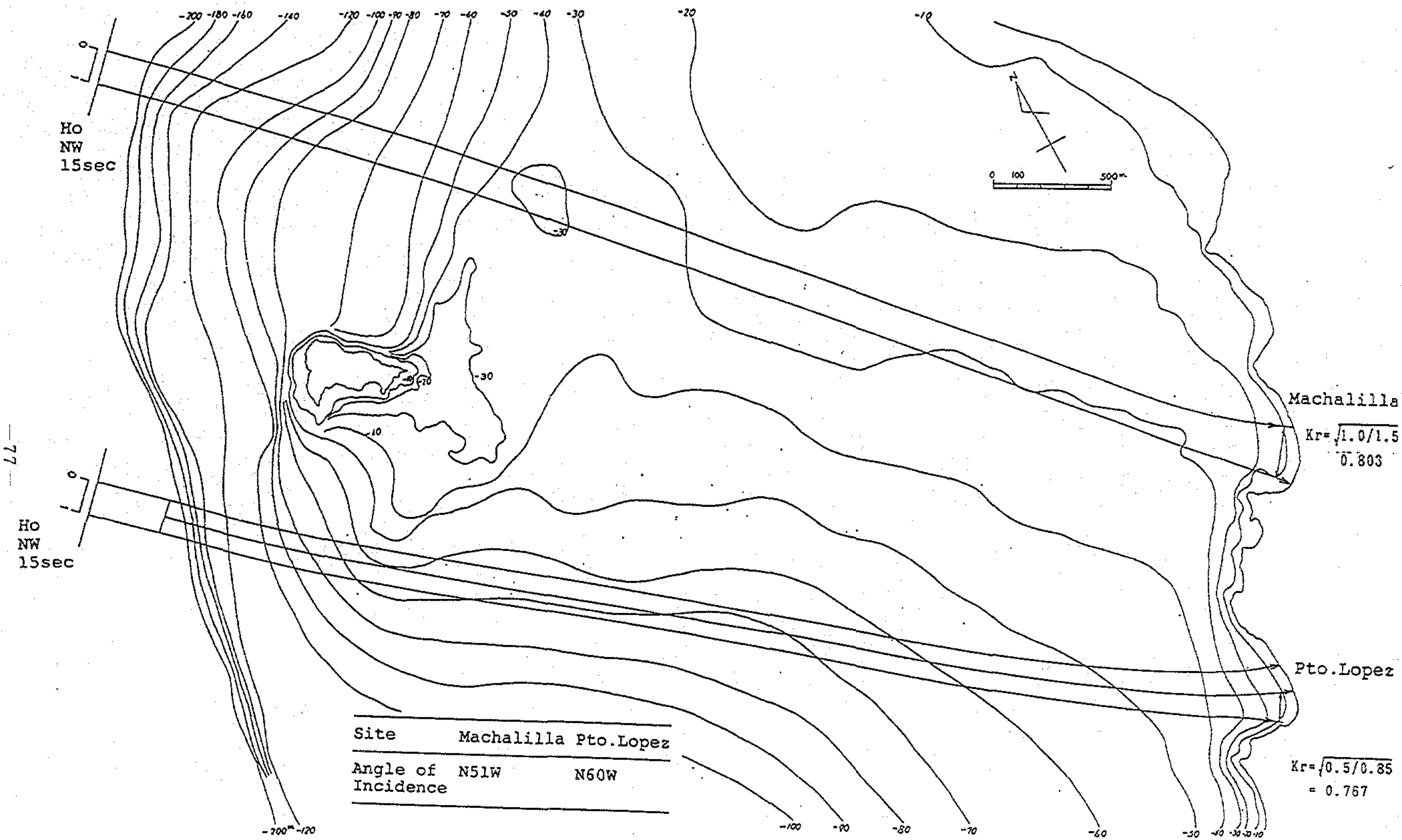
Appendix 3.6.1 Refraction Diagram



Appendix 3.6.1 Refraction Diagram



Appendix 3.6.1 Refraction Diagram

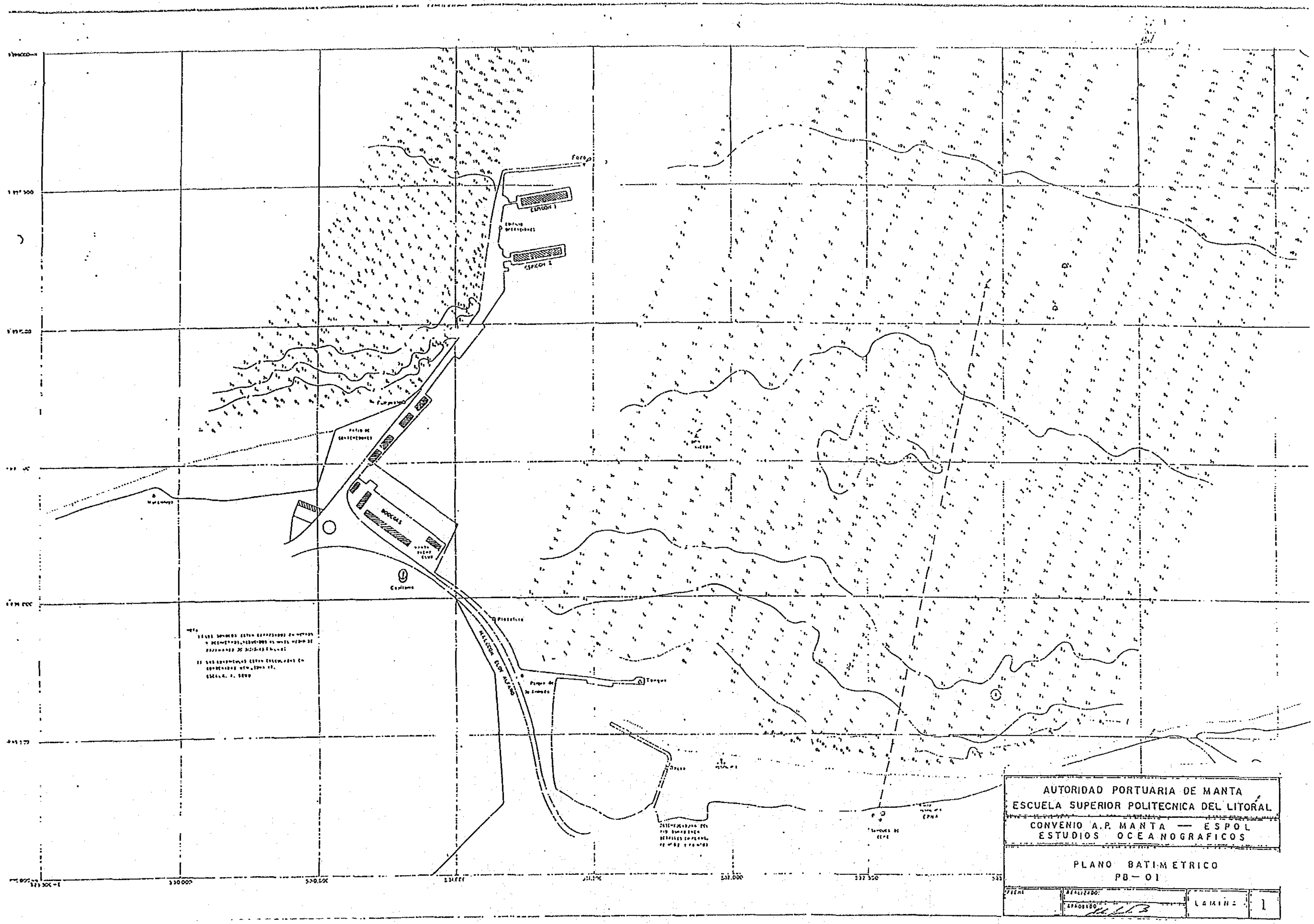


Site	Machalilla	Pto.Lopez
Angle of Incidence	N51W	N60W

Appendix 3.6.1 Refraction Diagram

2) Previous Study on the Refraction Diagram

1	PLANO BATIMETRICO PB - 01			
16	REFRACCION DE OLAS	θo = 270°	T = 14 seg	Kr = 0.449
17	REFRACCION DE OLAS	θo = 270°	T = 16 seg	Kr = 0.454
18	REFRACCION DE OLAS	θo = 270°	T = 18 seg	Kr = 0.502
19	REFRACCION DE OLAS	θo = 270°	T = 20 seg	Kr = 0.502
20	REFRACCION DE OLAS	θo = 315°	T = 14 seg	Kr = 0.739
21	REFRACCION DE OLAS	θo = 315°	T = 16 seg	Kr = 0.793
22	REFRACCION DE OLAS	θo = 315°	T = 18 seg	Kr = 0.7278
23	REFRACCION DE OLAS	θo = 315°	T = 20 seg	Kr = 0.7516
24	REFRACCION DE OLAS	θo = 0°	T = 14 seg	Kr = 0.5642
25	REFRACCION DE OLAS	θo = 0°	T = 16 seg	Kr = 0.5275
26	REFRACCION DE OLAS	θo = 0°	T = 18 seg	Kr = 0.3527
27	REFRACCION DE OLAS	θo = 0°	T = 20 seg	Kr = 0.6344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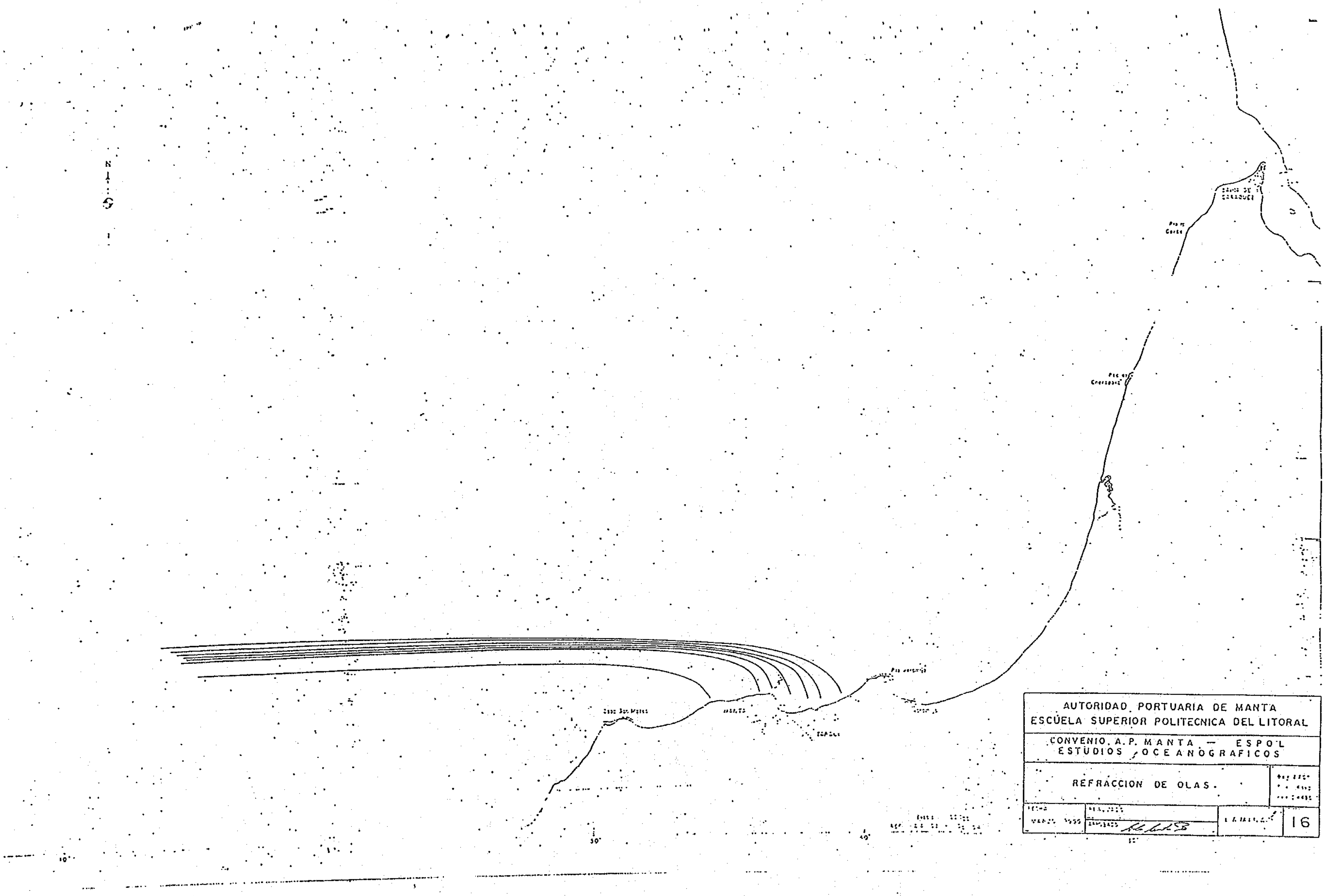
ESCUELA SUPERIOR POLITECNICA DEL LITORAL
CONVENIO A.P. MANTA — ESPOL
ESTUDIOS OCEANOGRAFICOS
PLANO BATIMETRICO
PB — 01
LAMINA
1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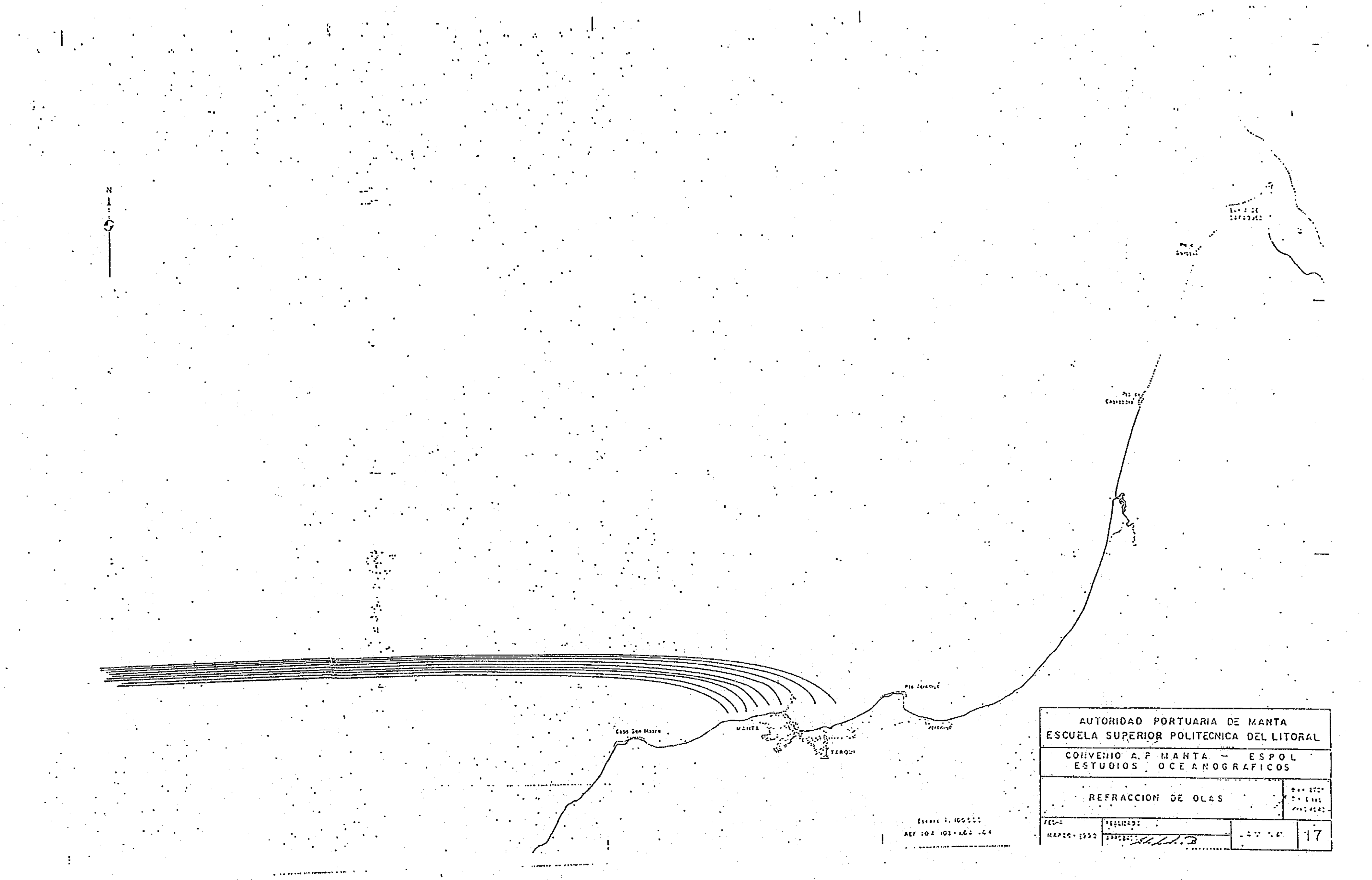
REFRACCION DE OLAS.
16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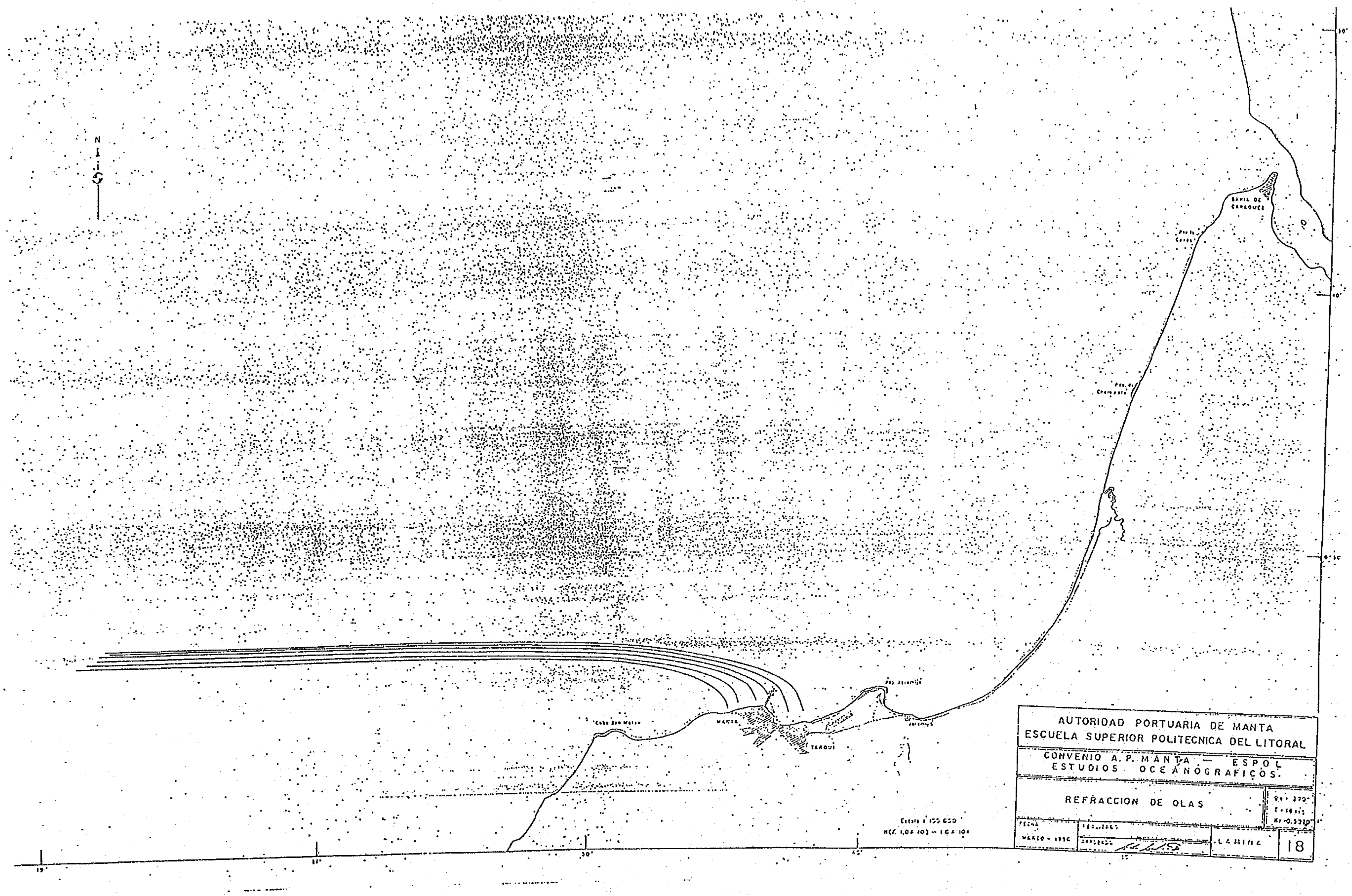
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LAMINA
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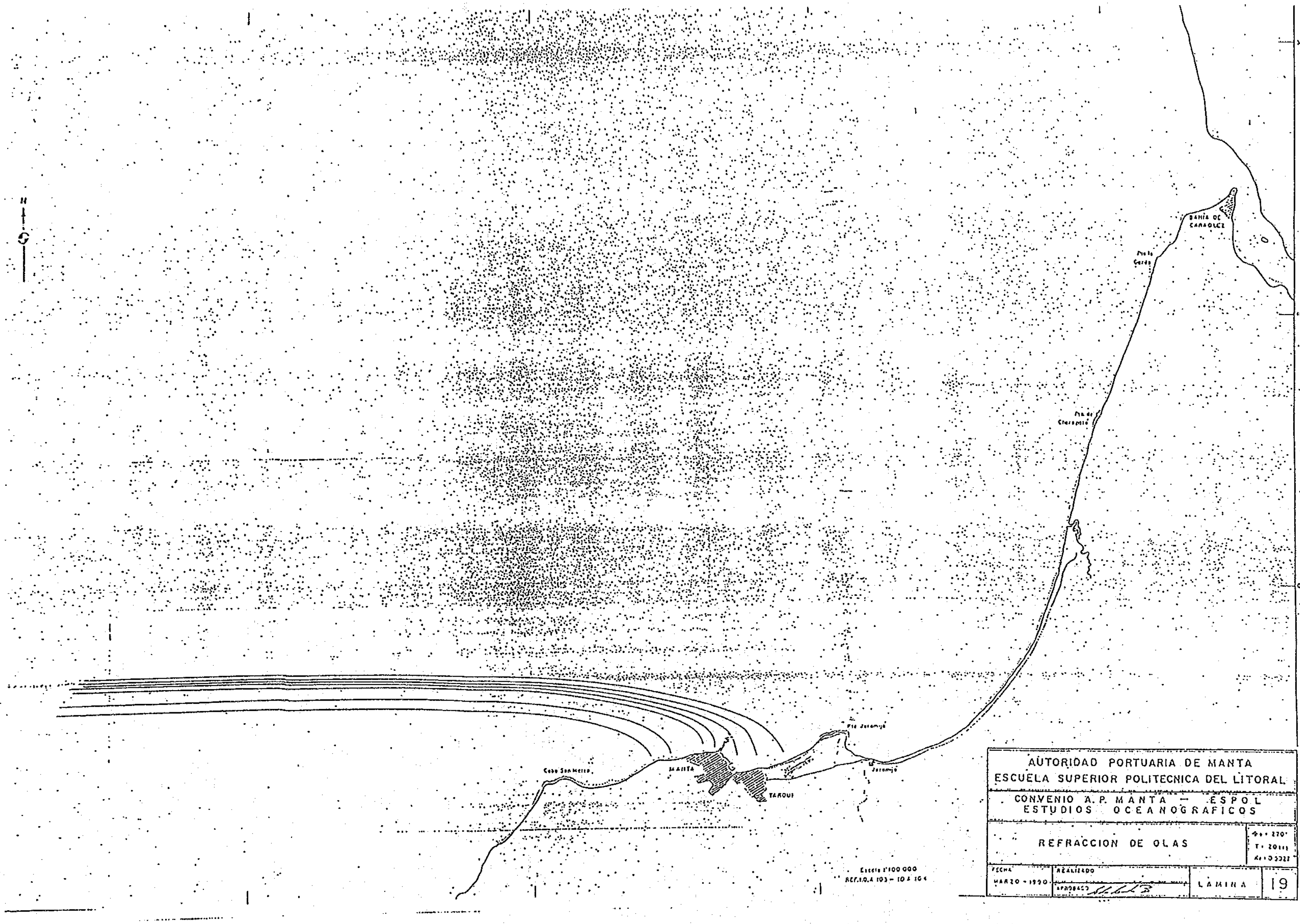
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Jaramijó
Escala 1:100 000
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FECHA
MARZO - 1990
REALIZADO
APROBADO
LAMINA
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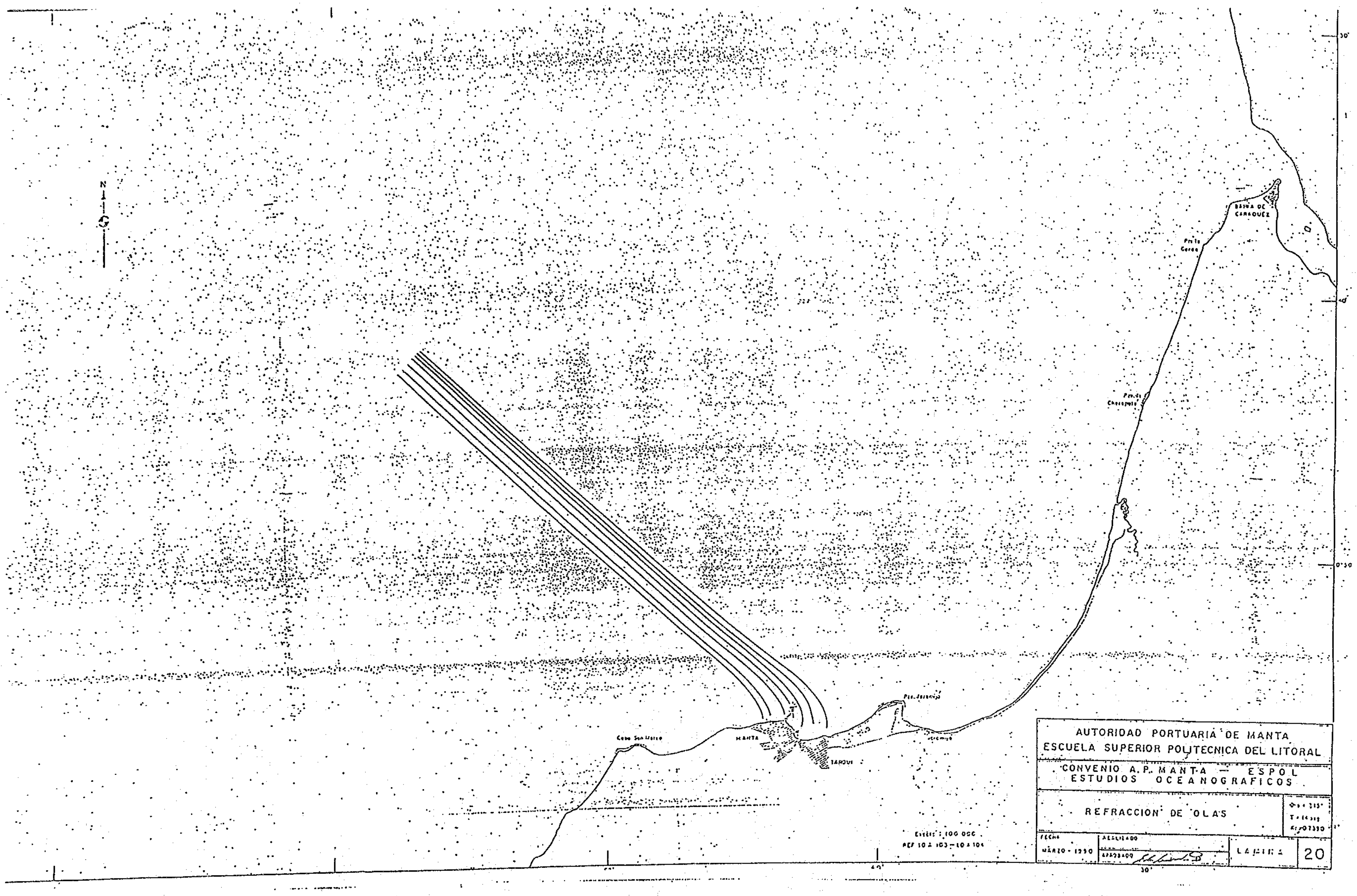

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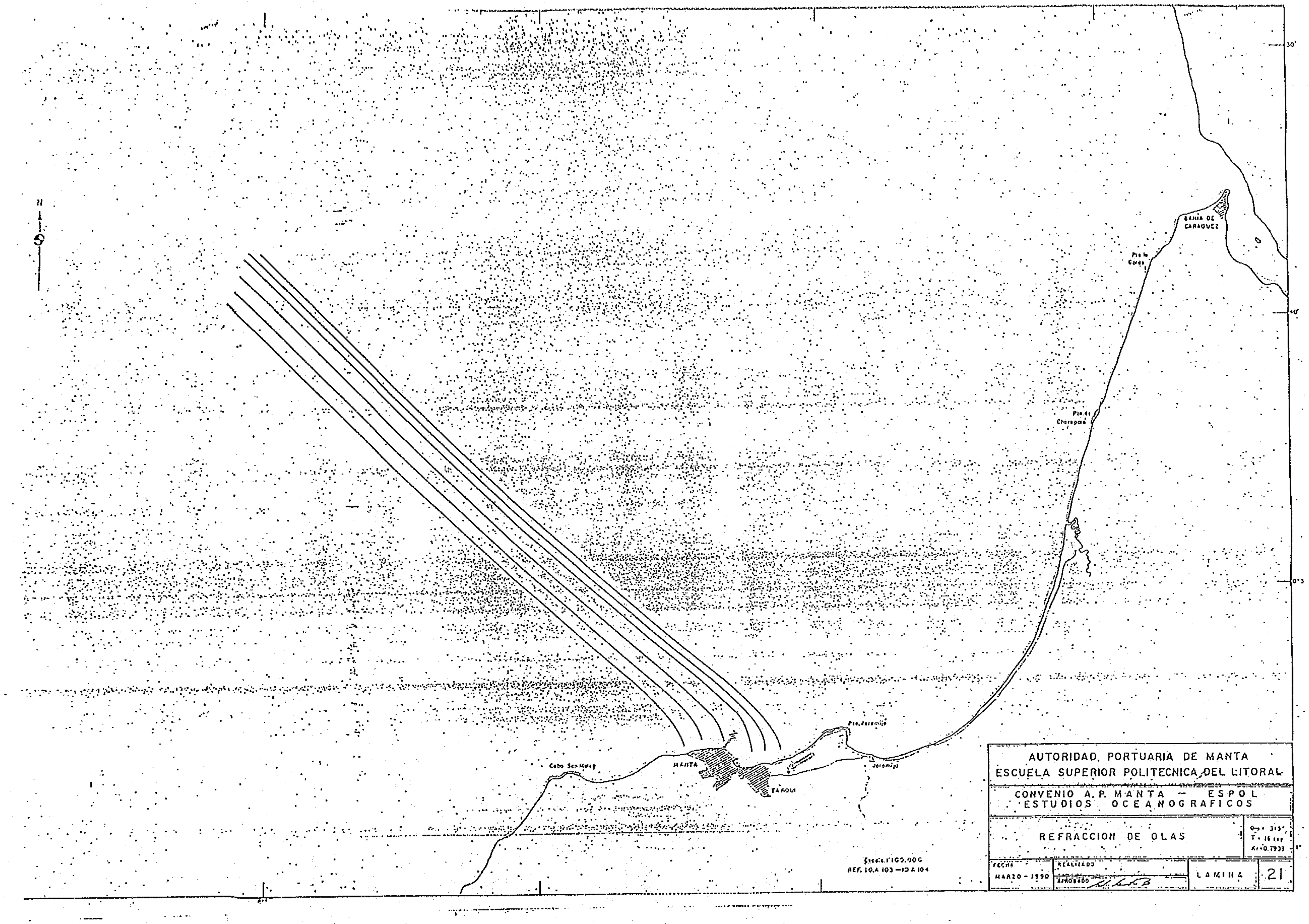
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Cabo San Mateo
MANTA
TARQUI
Jaramijó
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REALIZADO
APROBADO
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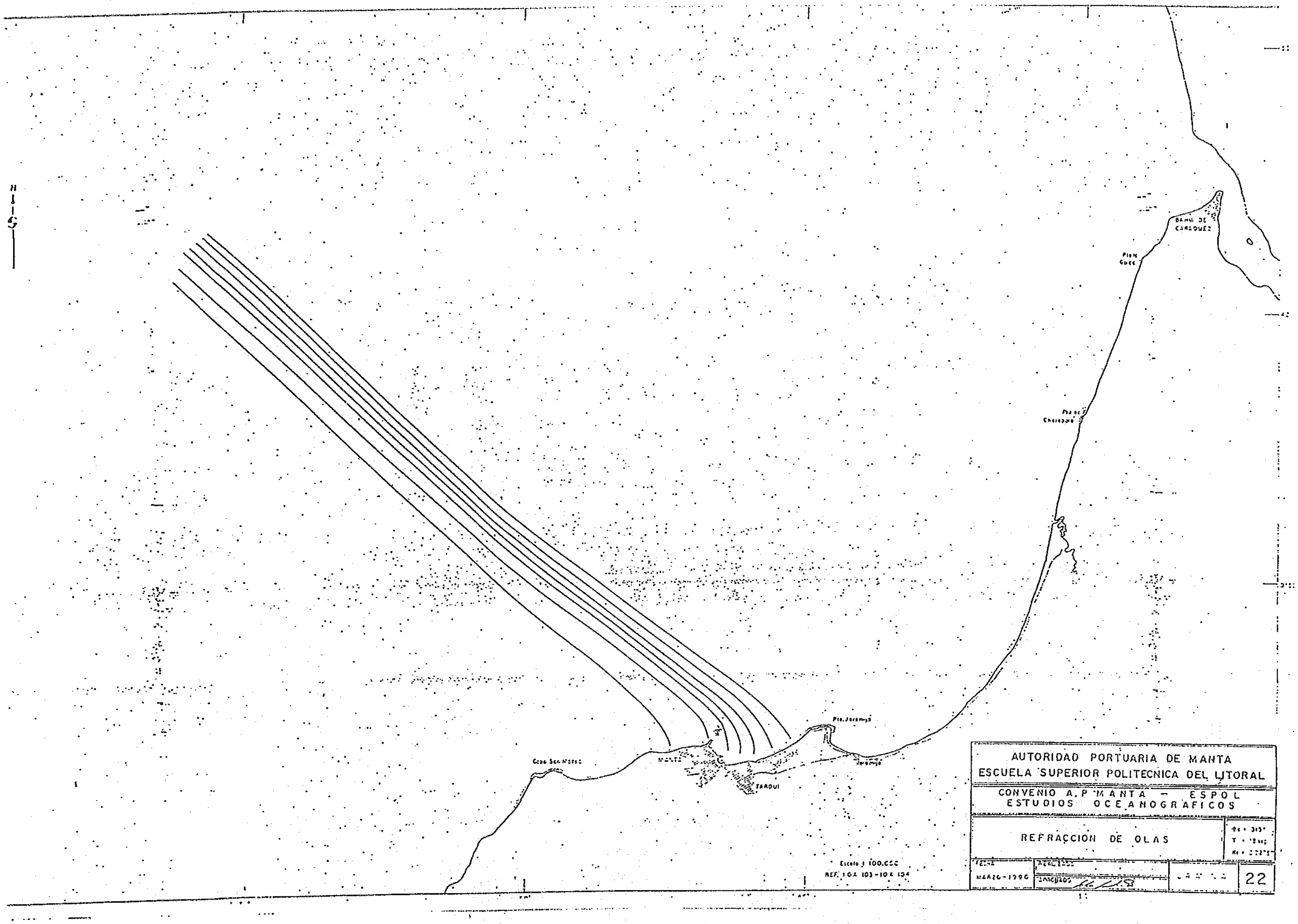
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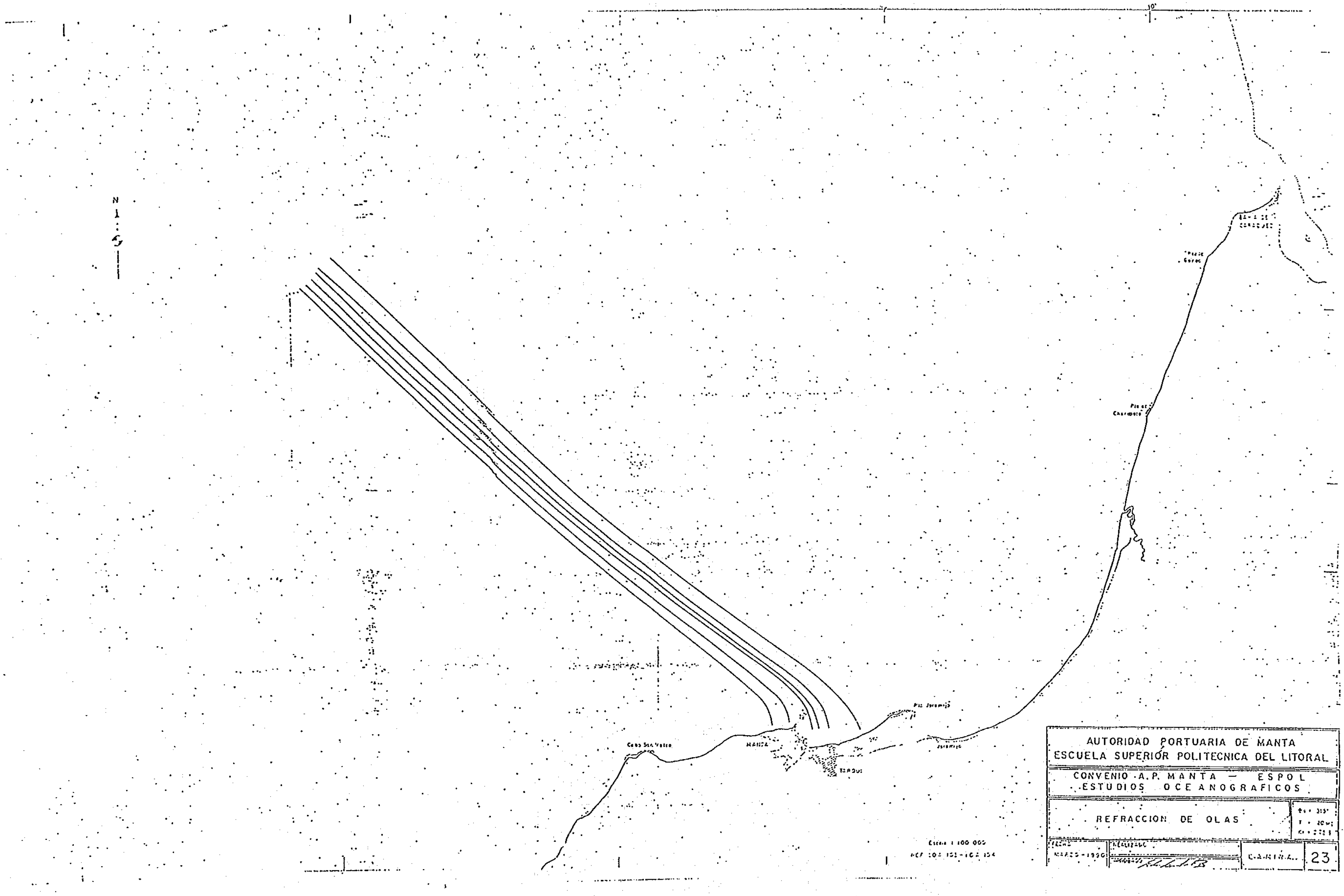

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CARTA
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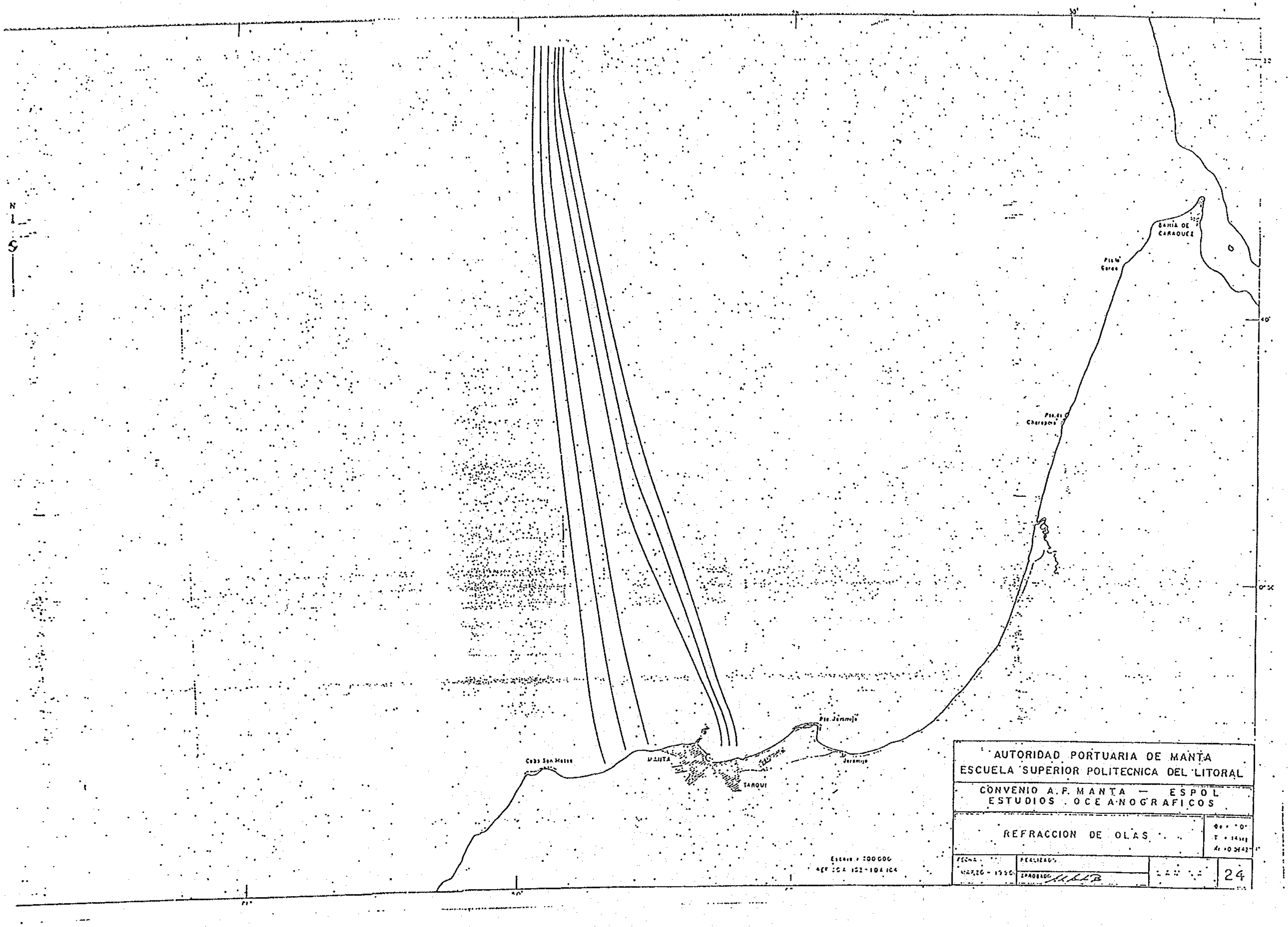

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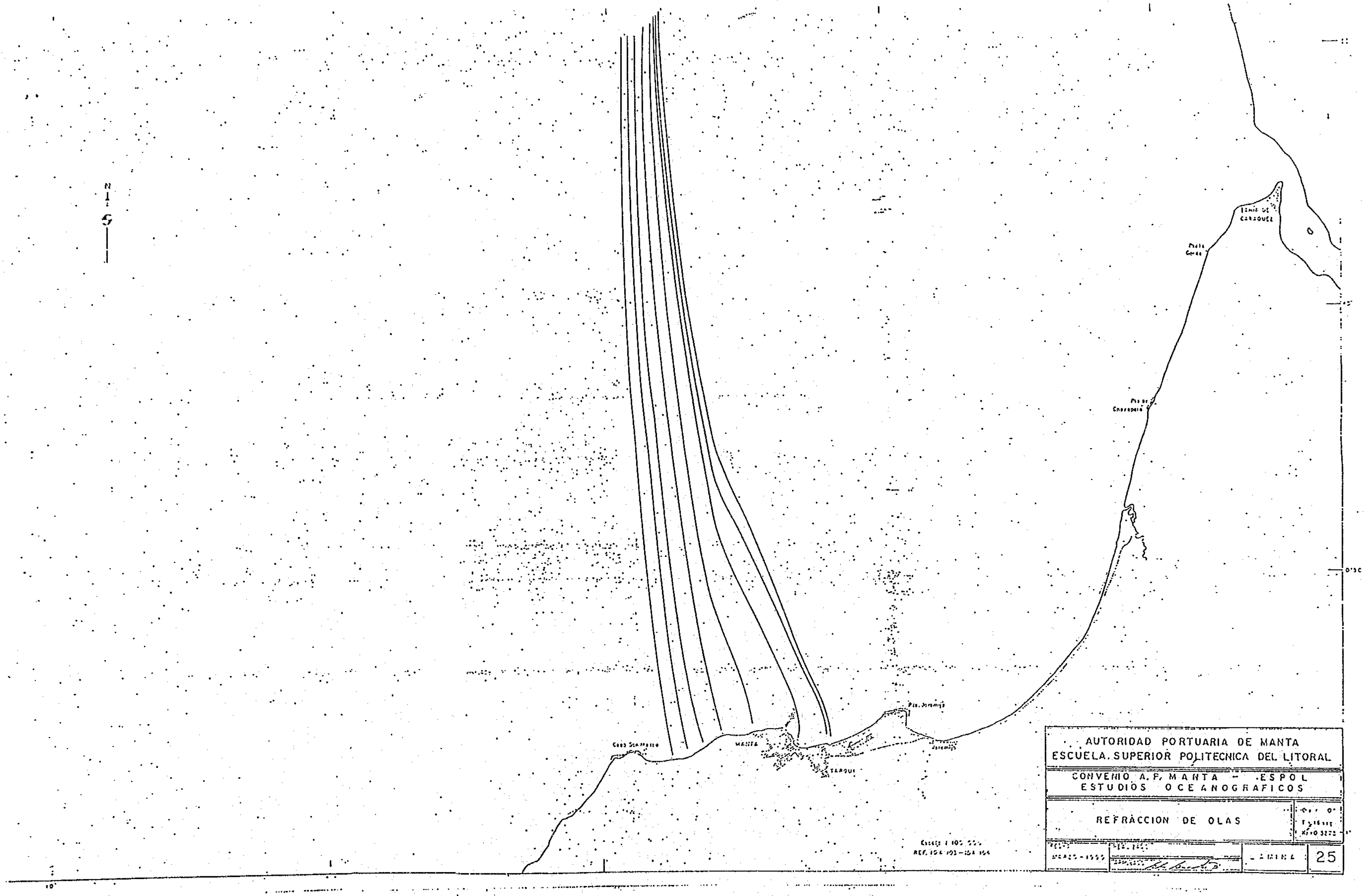

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