GOVERNMENT OF PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF WATER RESOURCES
WATER RESOURCES PLANNING ORGANIZATION

FEDERAL REPUBLIC OF GERMANY

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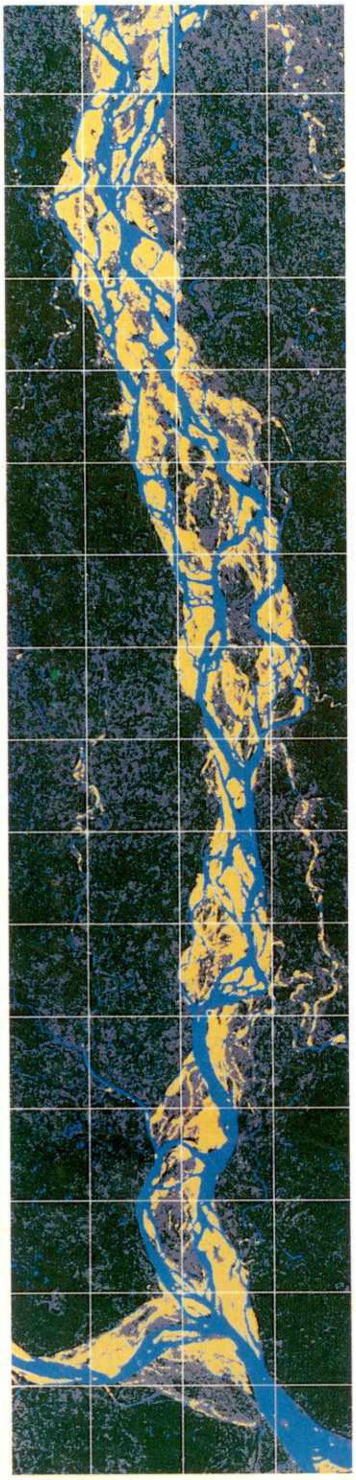
FRENCH REPUBLIC

CAISSE FRANCAISE DE
DEVELOPPEMENT (CFD)



BANK PROTECTION AND RIVER TRAINING (AFPM) PILOT PROJECT FAP 21/22

TEST AND IMPLEMENTATION PHASE

SONAR AND SUBBOTTOM PROFILER SURVEY REPORT

NOVEMBER 1998

JAMUNA TEST WORKS CONSULTANTS, JOINT VENTURE
CONSULTING CONSORTIUM FAP 21/22

RHEIN-RUHR ING.-GES.MBH, DORTMUND/GERMANY

COMPAGNIE NATIONALE DU RHONE, LYON/FRANCE
PROF.DR. LACKNER & PARTNERS, BREMEN/GERMANY
DELFT HYDRAULICS, DELFT/NETHERLANDS

In association with:

BANGLADESH ENGINEERING &
TECHNOLOGICAL SERVICES LTD. (BETS)
DESH UPODESH LIMITED (DUL)

BANK PROTECTION AND RIVER TRAINING
(AFPM) PILOT PROJECT
FAP 21/22

TEST AND IMPLEMENTATION PHASE

SONAR AND SUBBOTTOM PROFILER SURVEY REPORT

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SURVEY REPORT

SONAR and SUBBOTTOM PROFILER SURVEY
TEST SITE II, BAHADURABAD

Prepared by

OSAE

OFFSHORE SURVEY AND ENGINEERING
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FOR

JAMUNA TEST WORKS CONSULTANTS
BANK PROTECTION AND RIVER TRAINING (AFPM) PILOT PROJECT FAP 21/22
WATER RESOURCES PLANNING ORGANIZATION (WARPO)
DHAKA, BANGLADESH

November 1998

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BANK PROTECTION AND RIVER TRAINING/AFPM PILOT PROJECT
FAP 21/22

SONAR AND SUBBOTTOM PROFILER SURVEY REPORT

Table of Contents

1 INTRODUCTION

The Consulting Consortium FAP21/22, Dhaka, Bangladesh contracted OSAE Offshore Survey and Engineering, Gesellschaft für Seevermessung mbH, Bremen to perform measurements using a side scan sonar and subbottom profiler around Test Site II, Bahadurabad.

The main goal of the survey was to determine the spatial distribution of the materials used for construction of the falling and launching aprons on the slope of the structure. This shall enable a comparison of the distribution of construction materials as during the time of construction Test Site II and to measurements to be performed in the future.

All survey operation were carried out in the time period between 3rd and 13th March, 1998.

2 LIST OF PROFILES

In the following tables all side scan sonar and ChirpII subbottom profiler lines are listed.

2.1 Side Scan Sonar

File name	Heading	Start Fix	End Fix	Comment
-20B00	N	1	49	Speed 1.8 - 1.9 m/sec Paper Speed 3 kts, fish depth 1m gain port & starboard: +3 dB
0B00	N	1	52	
20B00	N	1	50	
20B01	N	1	43	
30B00	N	1	44	
-30B00	N	1	49	fish depth 3m, gain: port side : +9dB
50B00	N	1	55	
20B02	N	1	39	
30B01	N	1	40	

2.2 Chirp II Subbottom Profiler

File name *.SEG	File name Masterchart	Comment
Cal	1A02.LOG	Calibration Line
Cal2	1A03.LOG	Calibration Line
Cent3	0B04	Centre Line
10Cent	10B04	
20Cent	20B04	
30Cent3	30B05	
40Cent	40B05	
0B	0A05	Cross profiles
0C	0A06	
0D	0A07	
0E1	0A08	
0E2	0A09	
0F	0A0A	
0G	0A0B	
0H1	0A0C	
0H2	0A0D	
50B	50A0D	X-profiles
30B	30A0D	
10B	10A0D	
-10B2	-10B0D	
-30B	-30A0D	
30C	30A0E	
10C2	10A0E	
-30C	-30A0E	
40D2	40A0E	
20D	20A0E	
-20D	-20A0E	
30E11	30A0F	
10E1	10A0F	
-10E1	-10A0F	
20E2	20A10	
-20E2	-20A10	
30F	30A10	
10F	10A10	
-10F	-10A10	
-30F	-30A10	
50G	50A10	
30G	30A11	
10G	10A11	
-10G	-10A11	
-30G	-30A11	
40H1	40A11	
20H1	20A11	
10H2	10A12	
-10H2	-10A12	
-20H2	-20A12	
-30H2	-30A12	
-40H2	-40A12	
-10E2	-10A13	
10E2	10A13	
-10D	-10A14	
10D	10A14	

3 SURVEY SPREAD DESCRIPTION AND METHOD OF WORKING

The survey spread used during the sonar and subbottom profiler survey at Bahadurabad is displayed on Fig. 1.

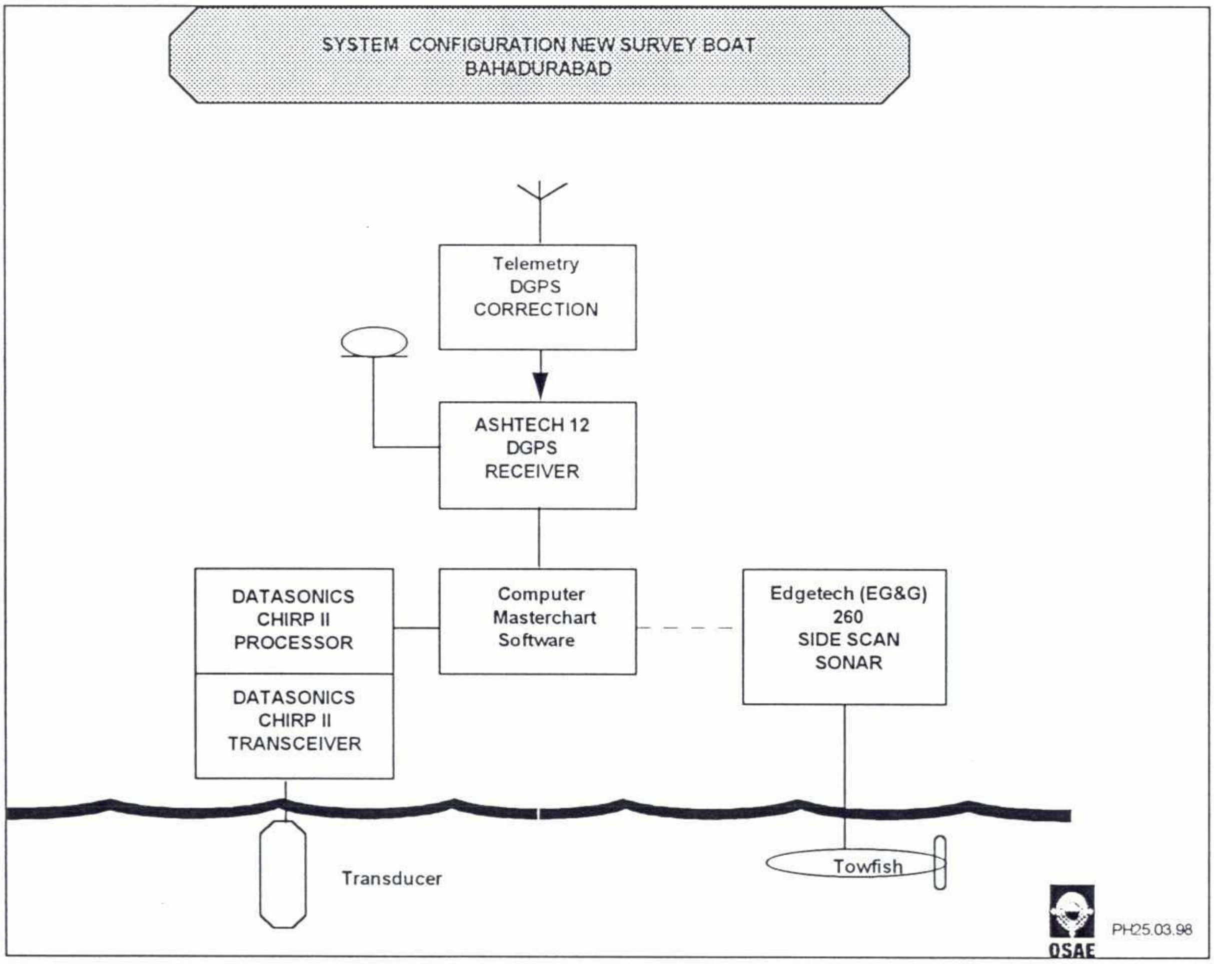

Fig. 1: System configuration during survey operation Bahadurabad 1998

3.1 Navigation

Navigation was based on the Differential GPS (DGPS) Technique. An Ashtech 12 Satellite Receiver was used. For the real-time differential mode, two stations are needed. The base receiver is located at an accurately known position onshore, whereas the remote receiver is located on the survey vessel. Data communication between the two receivers is performed by radio transmission. The differential signal was provided by a reference station located at a known position within the Contractors Camp in Bahadurabad. The DGPS-correction signal was received by a special receiver/modem unit using a VHF-Antenna of the survey boat.

3.2 Sidescan Sonar

An Edgetech (EG&G) 260 TH Sidescan Sonar and 272TD Towfish were used for mapping of surface sediments and structures on the floor of the river. The EG&G Sidescan Sonar System consists of a dual frequency Towfish (100 and 500 kHz), and a shipboard unit with integrated graphic recorder. During the survey we used a working frequency of 500 kHz. Tests were also performed with the 100 kHz frequency transducers. The Towfish was towed off the starboard side of the survey boat. The Towfish was towed at a fixed depth of varying between approximately 1 - 3 m. The layback position relative to the DGPS antenna was 1m to the right and 1m backwards. The height of the fish relative to the bottom is monitored by bottom tracking derived from one of the two channels. A depth profile is displayed on the right side of the sonograph. However, it has to be noted that this profile is just a tool for the operator to monitor the towfish height and bottom tracking and not a depth profile as recorded by echosounders. The side scan sonar records were annotated manually every 10 seconds using the same fixnumbers as generated by the Masterchart navigation computer. A range of 25 m or 50m was selected during the survey. The resolution is 1/400th of the range (i.e. 6.5cm or 13 cm). At this range setting, a swath of 50 m or 100 m was recorded on each line.

Basic Principle

The transducers emit pulses as fan shaped beams on each side of the tow fish. The sound travels away from the sonar until it strikes something such as the seafloor or a target in the water. Some of the outgoing sound is then reflected back to the sonar and arrives at the transducers.

The typical geometry of side scan sonar is presented in Fig. 2.

The Sidescan system provides graphic records showing a two-dimensional plan view of the sea floor. These records are closely analogous to a low-oblique aerial photo. The image characteristics are a function of both bottom topography and sediment property variation. In contrast to conventional sonographs, the records from the EG&G 260 do not have scale distortions as microprocessors in the signal processor apply an automatic amplitude correction to the received data such that they relate directly and consistently to the back scattering characteristics of the sea floor. True horizontal scale is represented, as derived from fish height and angular slant range to the bottom targets. Ship speed is used to correct sonar data for along-track compressional distortion.

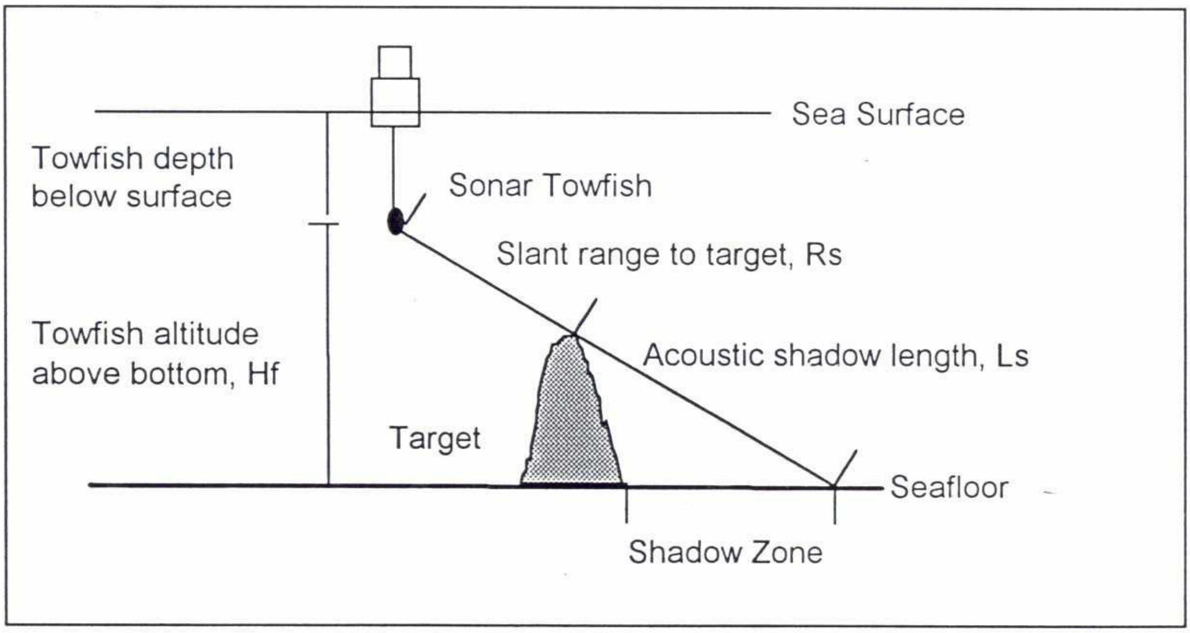

Fig. 2: Side Scan Sonar Geometry

Knowing the geometry (see Fig. 2) enables us to determine the height of targets using following relation:

$$Ht = (Ls \times Hf)/(Rs \times Ls)$$

where

Ht	=	height of target;
Ls	=	acoustic shadow length;
Rs	=	slant range to target, and
Hf	=	height of towfish above seafloor.

3.3 CHIRP II Subbottom Profiler

The Subbottom Profiler used during the survey was a Datasonics Model CAP 6600 system. The system consists of the following components:

- Model 6600 Transceiver
- Model 6600 Processor
- Model AT 472 transducer

Basic Principle

The subbottom profiler generally uses the reflection seismic method. A seismic pulse is generated at a seismic source and transmitted into the water column. At the sea floor and at subbottom layers the energy is reflected and received by a special receiver. After amplification the data are displayed on a graphic recorder or monitor.

Fig. 3 schematically shows the path of the emitted and reflected beams generating the bottom and multiple reflection.

Point reflectors, like single boulders or other targets are characterized by hyperbolic reflections. This hyperbolae are side lobes generated by the changing distance between transmitter and target. The geometry of point reflections are shown in Fig. 4 .

In contrast to conventional subbottom profilers the Chirp II system transmits a broadband FM sweep (Fig. 5). Each return echo is processed through a digital signal processing based receiver (Fig. 5), resulting in high resolution images of subbottom structure. The advantage is a higher resolution of signals and deeper penetration into the seafloor. The signal to noise ratio is increased by the application of the Chirp technology.

A low frequency (2-7 kHz) Chirp system was used for the survey at Bahadurabad in order to acquire substantial subbottom penetration into the sediments of the Jamuna river. The system was internally triggered at a repetition rate varying between 4 shots per second (250 ms) and 8 shots per second (125 ms). Data were recorded at a rate of 1024 or 2048 samples per shot. Therefore the resolution of digital data varied between 0.12 ms and 0.06 ms. At a speed of sound of 1500 m/s the resolution varies between 4.5 cm and 9 cm. The data were recorded in the SEGY data format on Magneto-Optical Disks for replay and further postprocessing operations at home.

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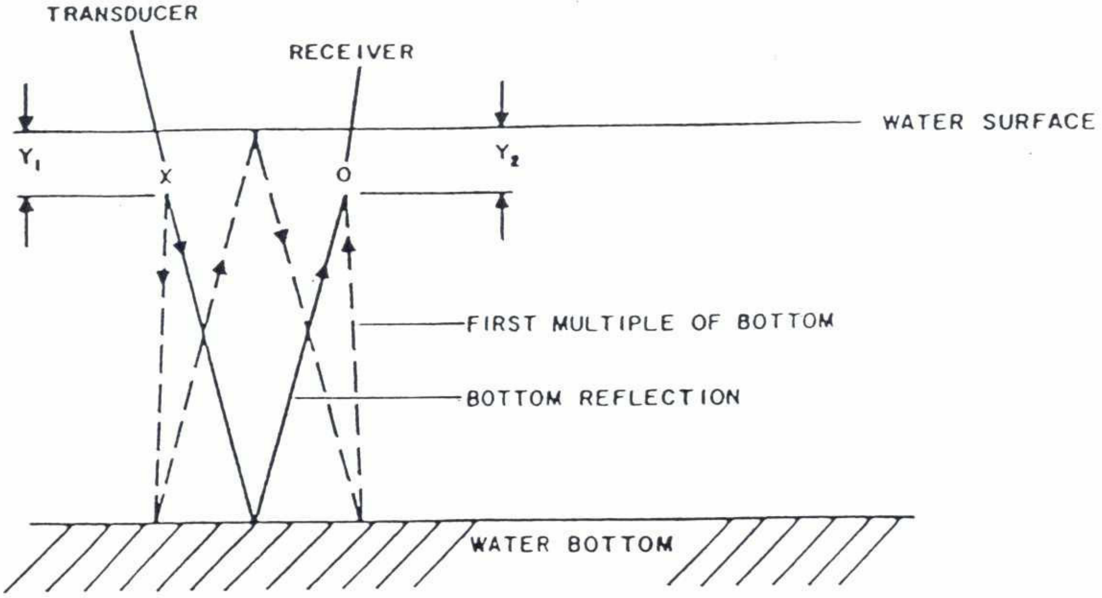

DIAGRAM OF RECORD OF REFLECTION AND MULTIPLE

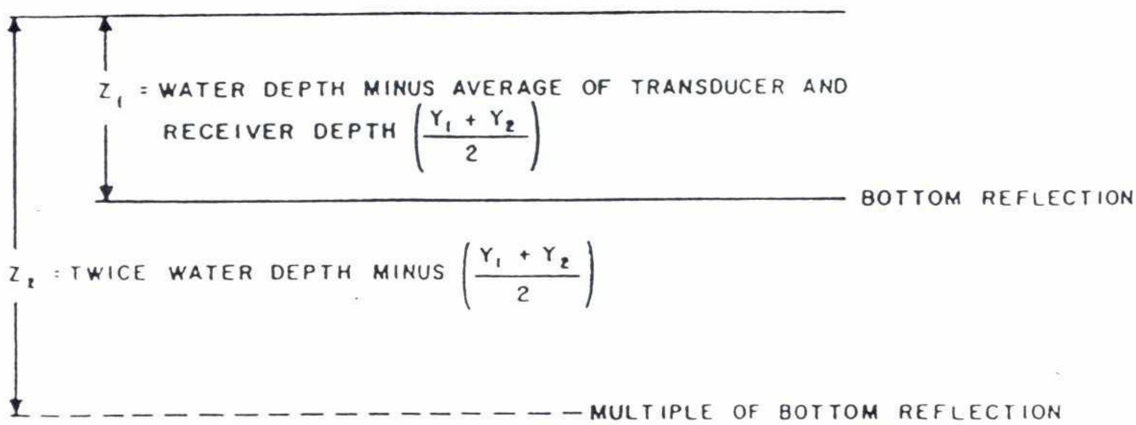

Figure 3

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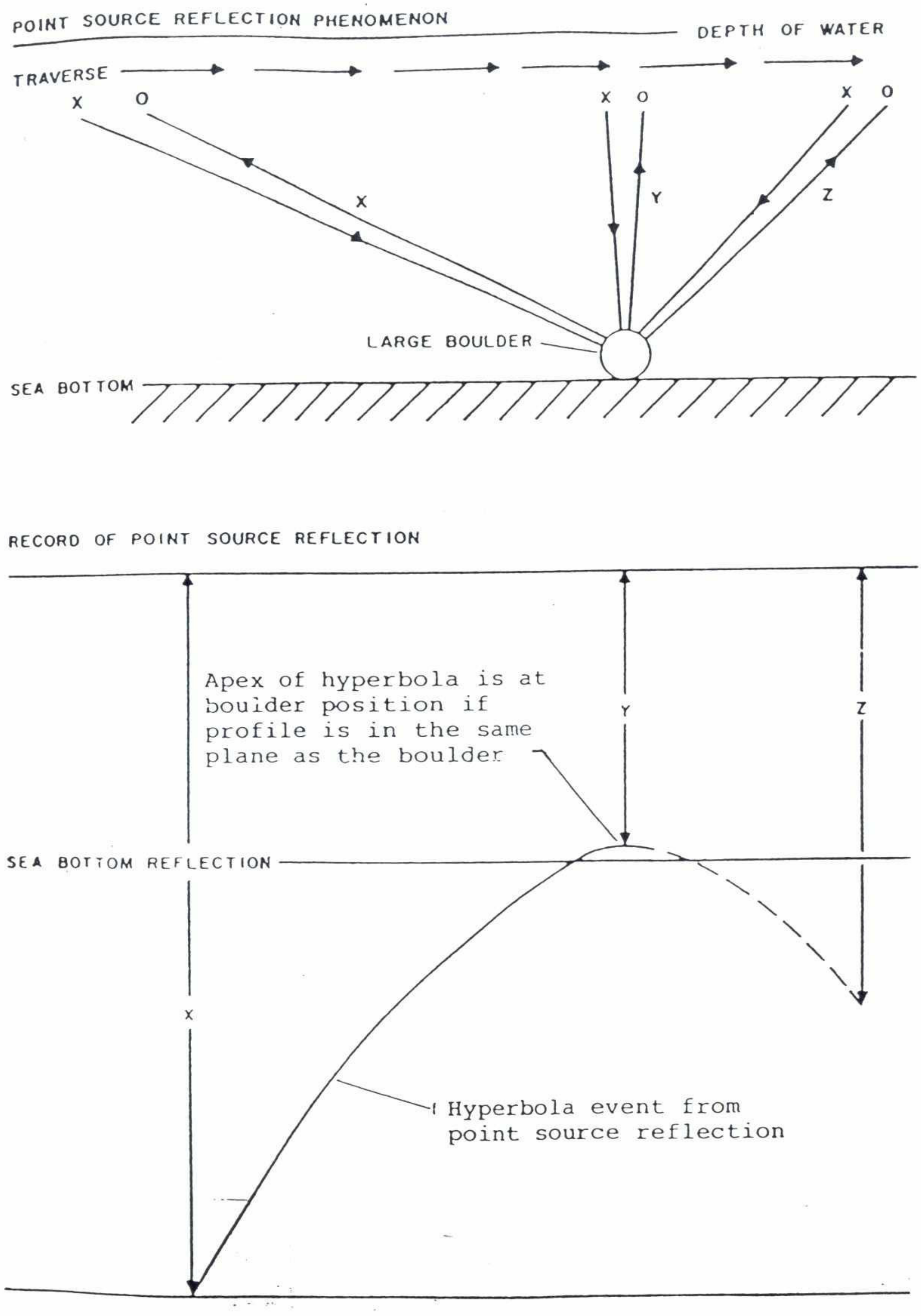
POINT SOURCE REFLECTION PHENOMENON
DEPTH OF WATER
TRAVERSE
X O
X
X O
Y
X O
Z
LARGE BOULDER
SEA BOTTOM
RECORD OF POINT SOURCE REFLECTION
Apex of hyperbola is at boulder position if profile is in the same plane as the boulder
Y
Z
SEA BOTTOM REFLECTION
X
Hyperbola event from point source reflection

Figure 4

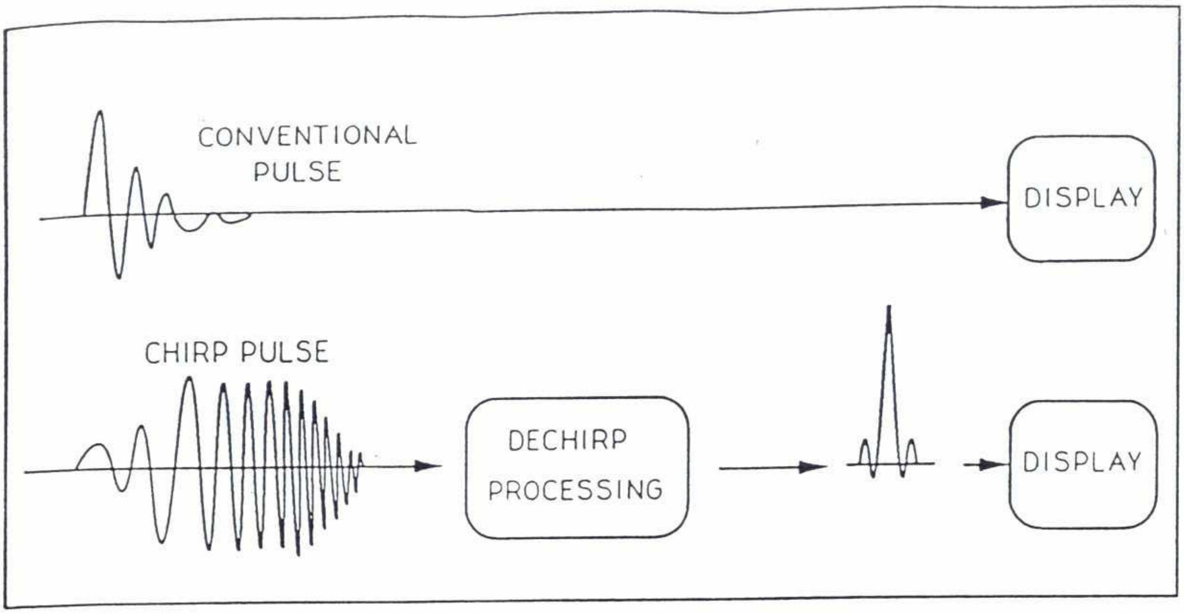

Figure 1 Comparison of chirp to a conventional system

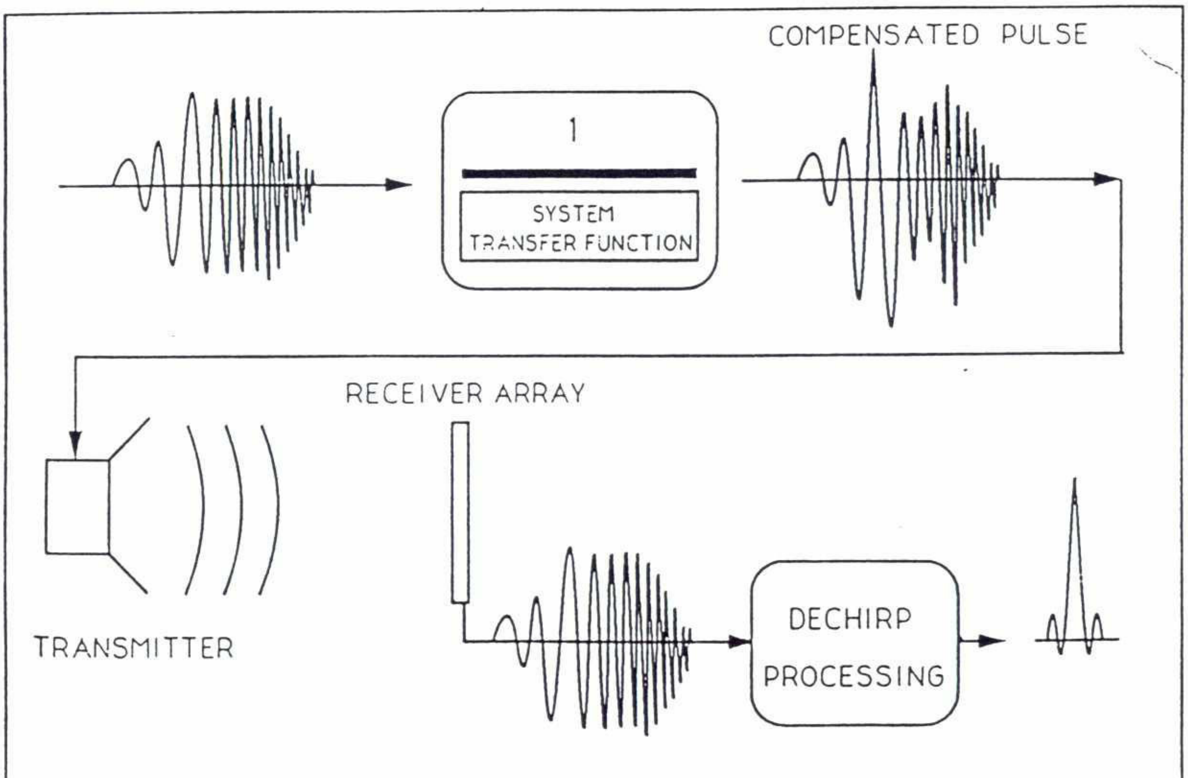

Figure 2 Chirp processing system

Figure 5

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A single transducer was used for the survey at Bahadurabad. The transducer was mounted at the portside of the survey vessel well in front of the wake in order to reduce ships noise interference as much as possible. The transducer depth was 0.45 m below the water level. The transducer was mounted 1m to the left of the DGPS antenna.

Postprocessing of Chirp II data

Postprocessing of the ChirpII data was done in OSAE's processing center in Bremen. The REFLEX data acquisition and processing system was used for postprocessing. The hardware of the system consists of a Pentium based personal computer with Magneto-Optical Disk drive (MOD). The special REFLEX software allows to increase the signal/noise-ratio of the seismograms by applying a wide variety of processing steps (e.g. filters, gain, etc.). The SEGY data were transferred to the special REFLEX data format and processed. In order to show the data graphically, the files were converted to HPGL files and plotted on a HP Designjet plotter. The depth scale on Subbottom Profiler records refers to depth below transducer. No correction for transducer depth or water level was applied to SBP-data. Therefore the depth values displayed on the SBP -records are not in accordance to the bathymetric charts, which is common practice, since the SBP is not a dedicated depth sounder but a seismic device.

4 RESULTS AND INTERPRETATION

4.1 Side Scan Sonar

4.1.1 Results

In the following section side scan sonar profile 20B02 will be described in more detail. This line is located 30m away from the edge of the original structure. All in all three different types of reflection/backscattering intensity can be distinguished on the records. Type 1 is characterized by a continuous dark backscatter pattern. Generally stronger reflection/backscattering of the acoustic energy is displayed by darker graytones on the recording paper., whereas weak reflection/backscattering leads to lighter graytones. Backscattering type 1 occurs near the water line on the right channel of the sonogram between fixnumbers #1 to ca. #32. The spatial distribution of this type can be seen on the chart (scale: 1:750). An internal structure within this type can be seen between fixes #13 and #32. Here streaks parallel to the test site structure are visible.

The second reflection/backscattering type is also characterized by strong reflections. However, type 2 is not as continuous as type 1. A typical example of this type can e.g. be found on the attached sonogram between fixnumbers #26 and #32 at a distance between 5 - 25m on the right hand sonar channel. The spatial distribution of this type is also displayed on the 1:750 charts. This reflection pattern shows two variations. The typical appearance of variation 1 can be seen between the above mentioned fixpoints (#26 - #32). The second variation of this type of reflection/backscattering can be found between fixnumbers # 23 and #25 from the center to 15m on the right channel.

The third typical reflection/backscattering type is characterized by generally weak returning energy. Typical sections on the sonogram are between fixnumbers #3 and #6 on the right hand side of the record. The recording paper shows light graytones within these zones.

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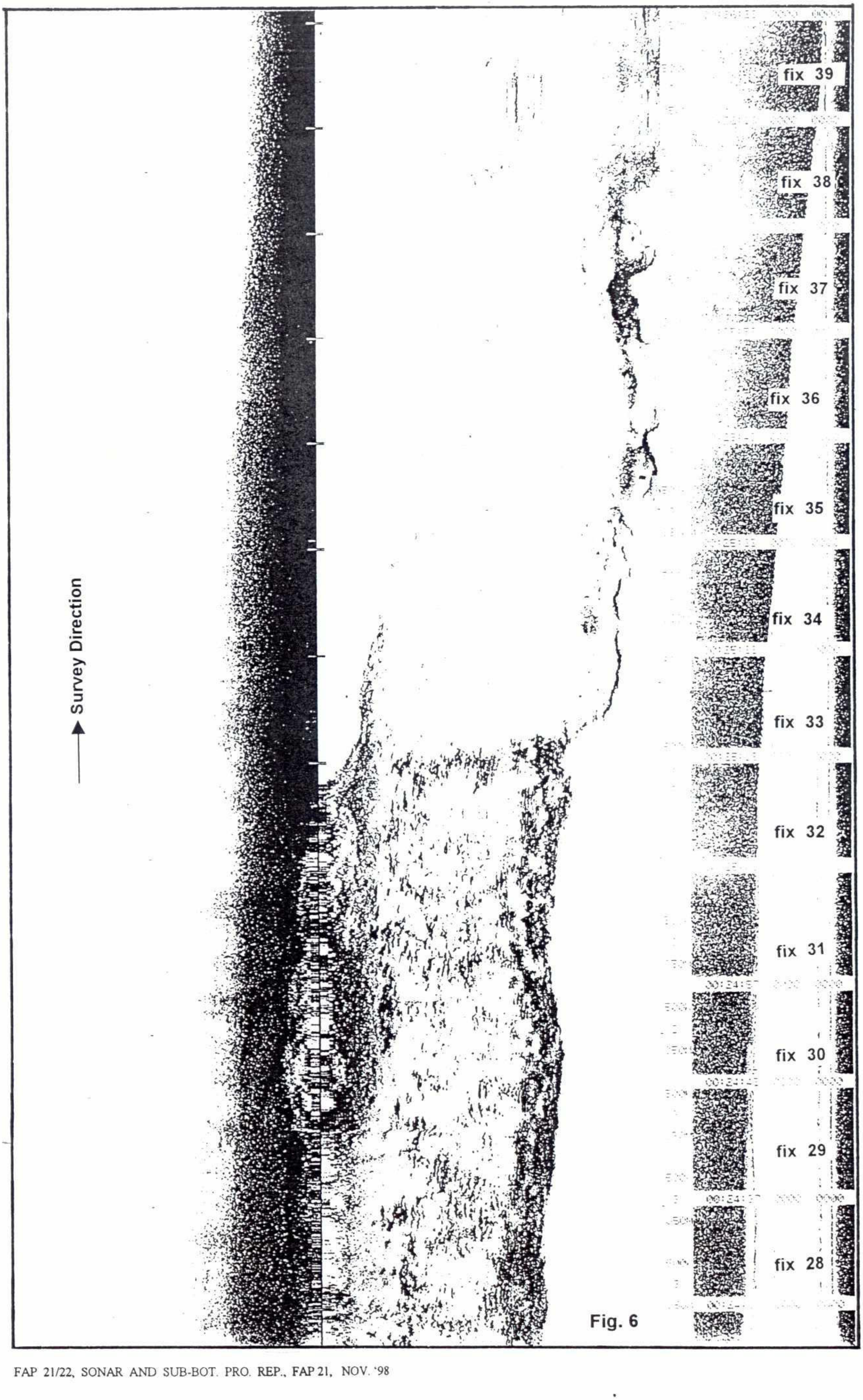
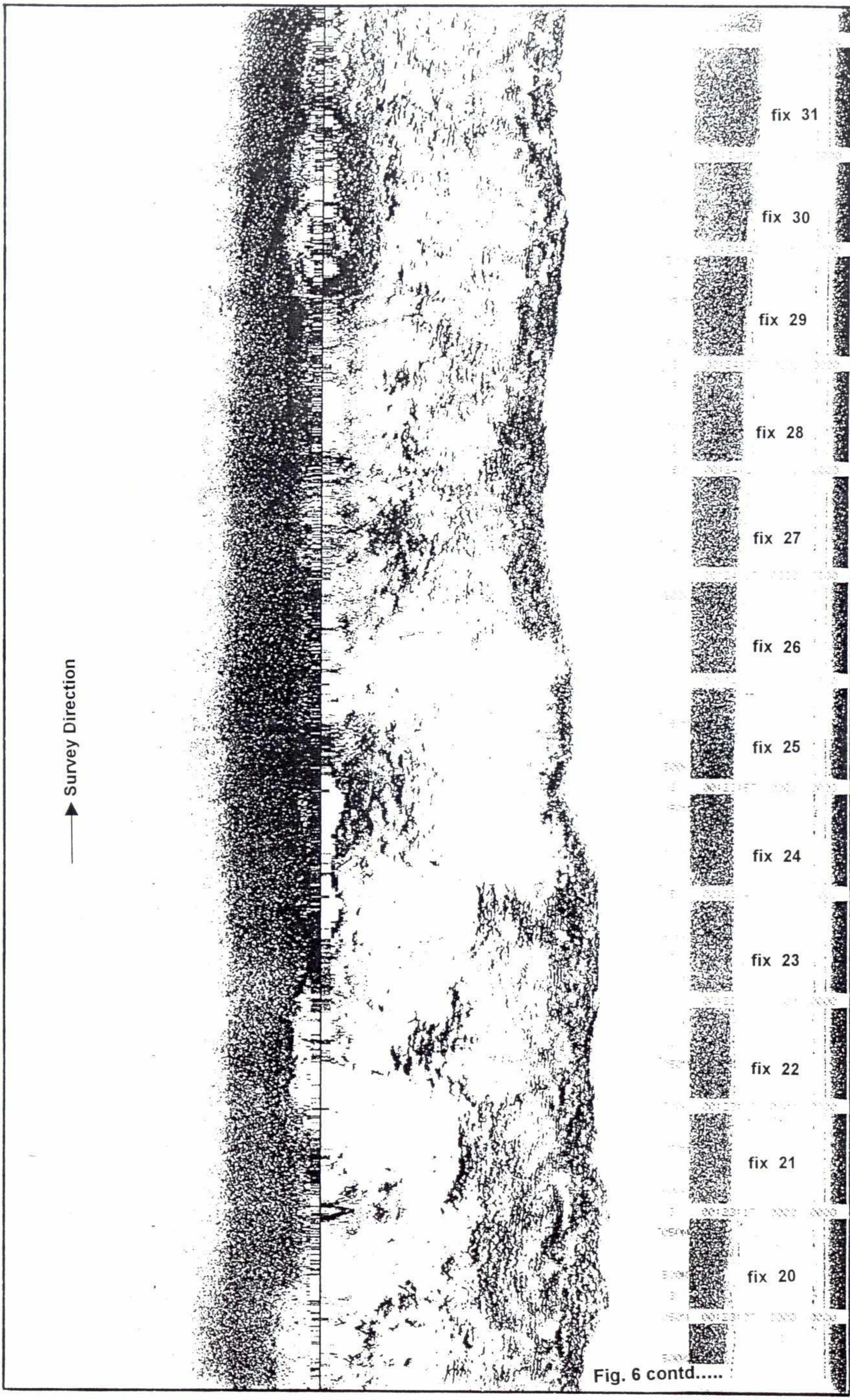

Survey Direction
fix 39
fix 38
fix 37
fix 36
fix 35
fix 34
fix 33
fix 32
fix 31
fix 30
fix 29
fix 28

Fig. 6



Survey Direction
fix 31
fix 30
fix 29
fix 28
fix 27
fix 26
fix 25
fix 24
fix 23
fix 22
fix 21
fix 20

Fig. 6 contd.....

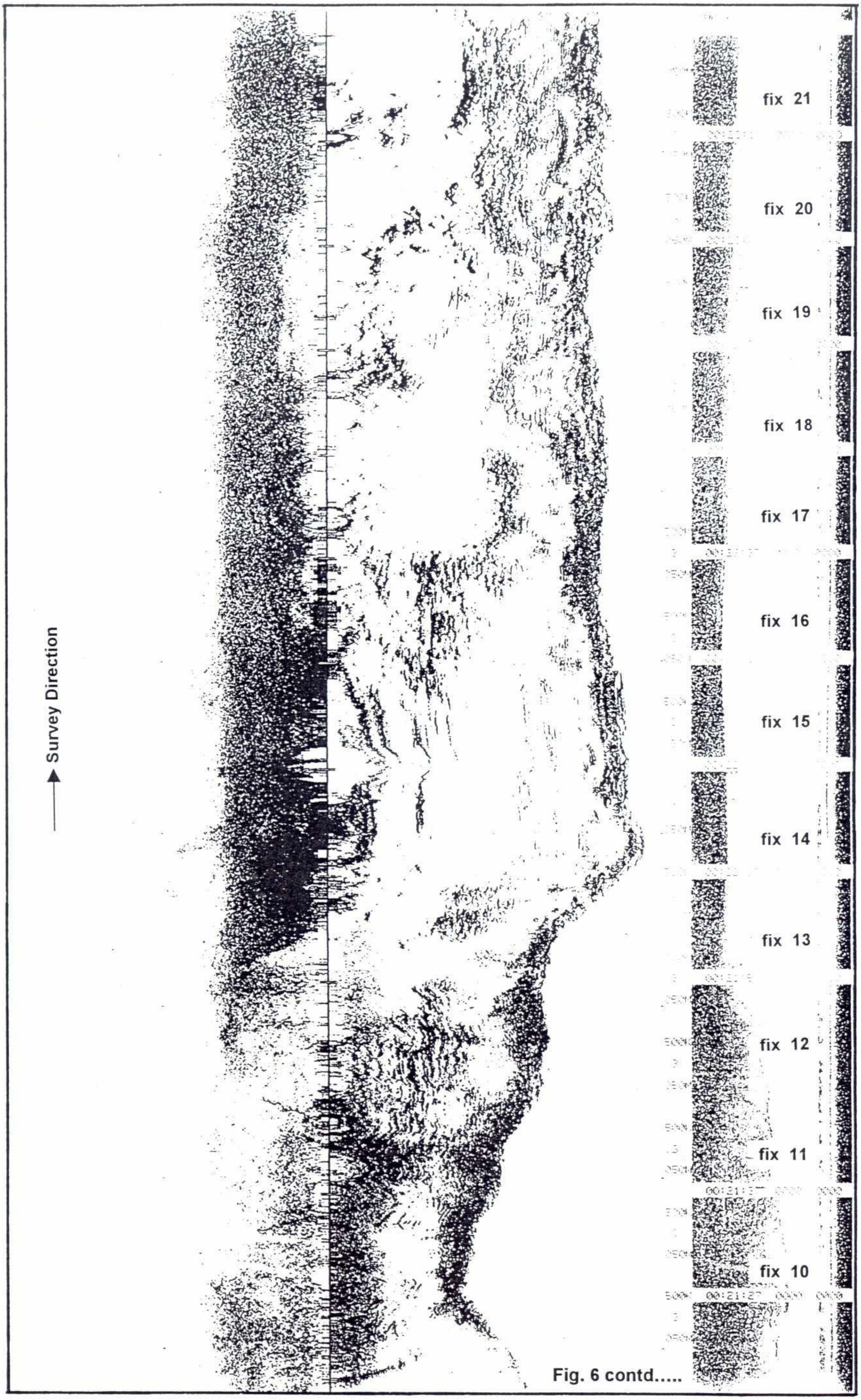

Survey Direction
fix 21
fix 20
fix 19
fix 18
fix 17
fix 16
fix 15
fix 14
fix 13
fix 12
fix 11
fix 10

Fig. 6 contd.....

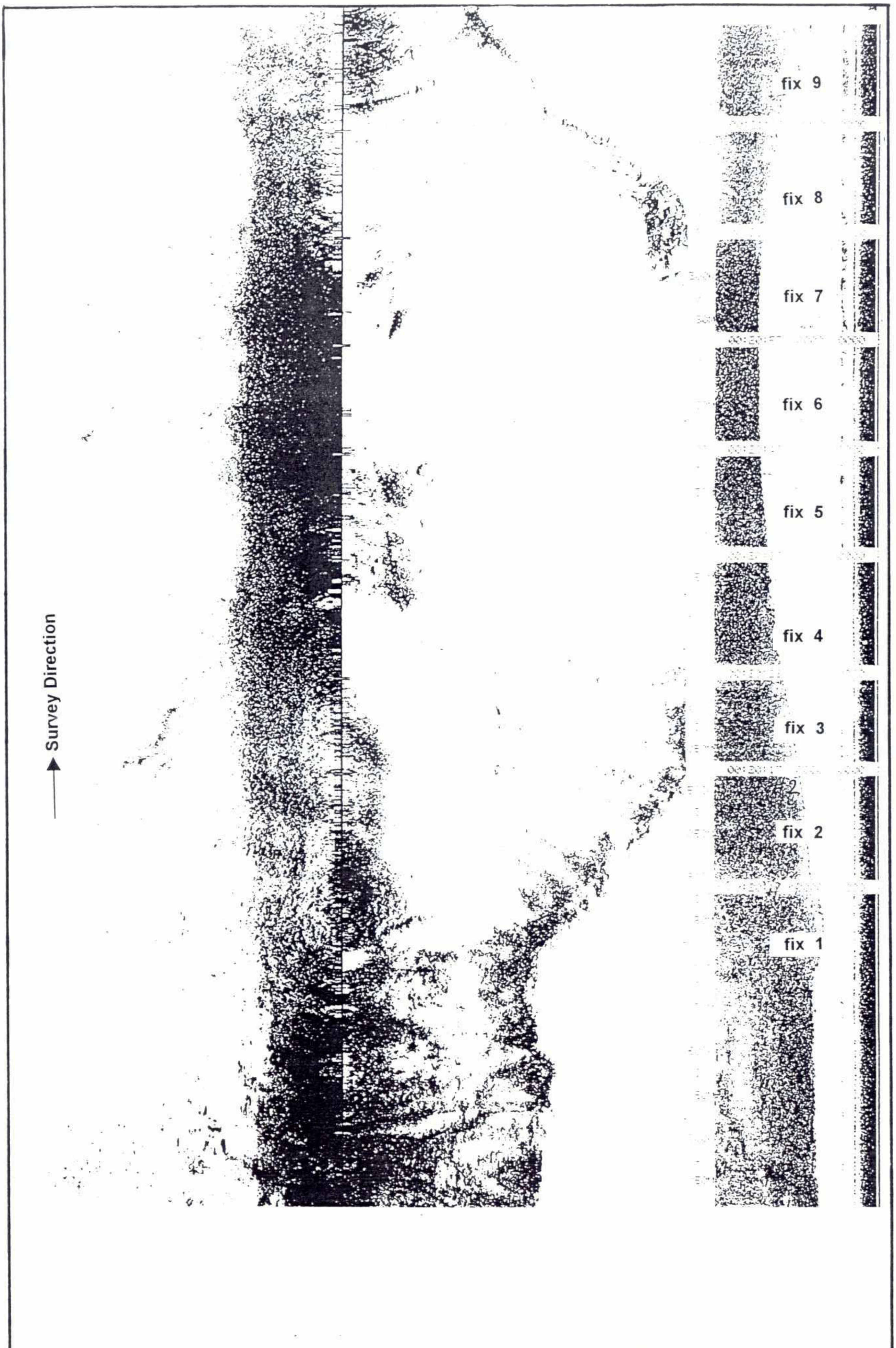


Fig. 6 contd./end

The left hand channel of the sonogram shows a continuous dark reflection/backscattering pattern. However, in this case the darker graytones are not due to harder sediments. The amplification gain for this channel was set to +9 dB instead of +3 dB (right hand channel) in order to record at least some pattern. Tests using the +3 dB amplification on the left hand channel showed that a totally white record. However, this indicates that the river floor recorded on the left hand channel can also be classified as type 3.

The distribution of the type 3 reflection/backscattering pattern is shown on the transparent 1:750 chart.

4.1.2 Interpretation

For the interpretation of the side scan sonar records, the engineering information regarding the materials used for the launching apron and the falling apron were compared with the distribution of the reflection/backscattering types as described above.

Type 1

The strong reflection/backscattering pattern is generated by generally hard material. This statement is trivial as we know that the materials used for construction are concrete or boulders. However, the spatial distribution on the 1:750 chart shows a more or less continuous occurrence of this reflection type. This indicates that the materials are covering the upper slope of the river totally from section H2 to section D. The horizontal streak pattern is visible to fixnumber #32, except for fixes # 23 to # 25. This zones coincide with falling aprons constructed of concrete blocks.

Type 2

Type 2 also shows a strong reflection/backscattering characteristic. However, this type is not as continuous as type 1. As shown on the 1:750 chart, the distribution is characterized by patches. Fig. 7 shows a part of the side scan sonar line 30B01 (range: 25m, frequency: 500 kHz). In the vicinity of fixnumber #25 a patch of reflection type 2. The rounded form of the elements building this patch indicates, that the Geo-Bags(200/900 kg) of section E are responsible for the reflection/backscattering pattern.

Another area characterized by a similar reflection pattern is found between fixnumber # 33 to fixnumber # 36 on side scan sonar line 30B00 (Fig. 8). The engineering chart show that within this area also Geo-Bags were used as falling apron.

Type 3

Reflection/backscattering type 3 is found in the remaining parts of the area. This weak reflection/backscattering indicates a lack of large or coarse material. The zones are interpreted to consist of sandy or even finer material sedimented by the Jamuna river.

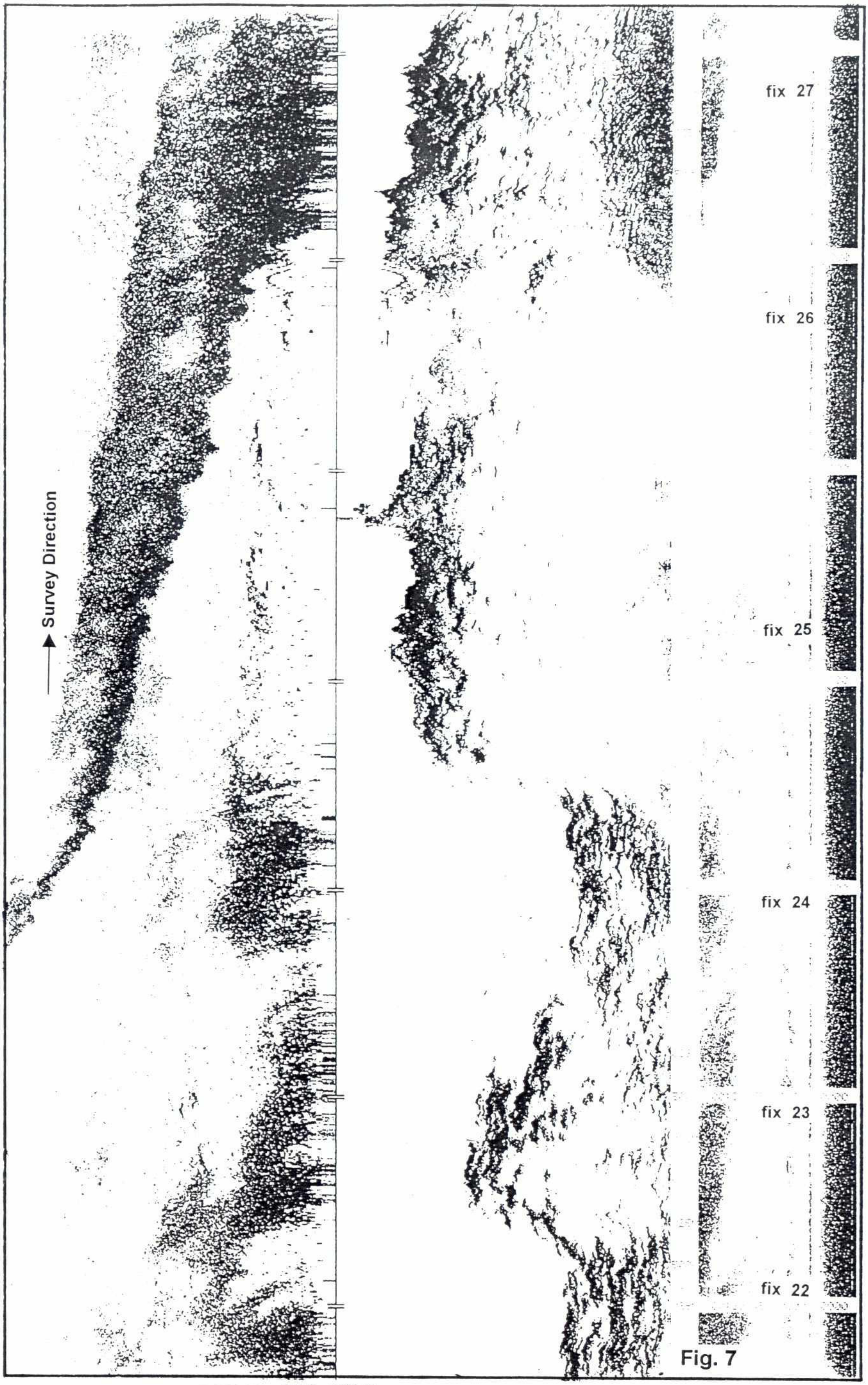


Fig. 7

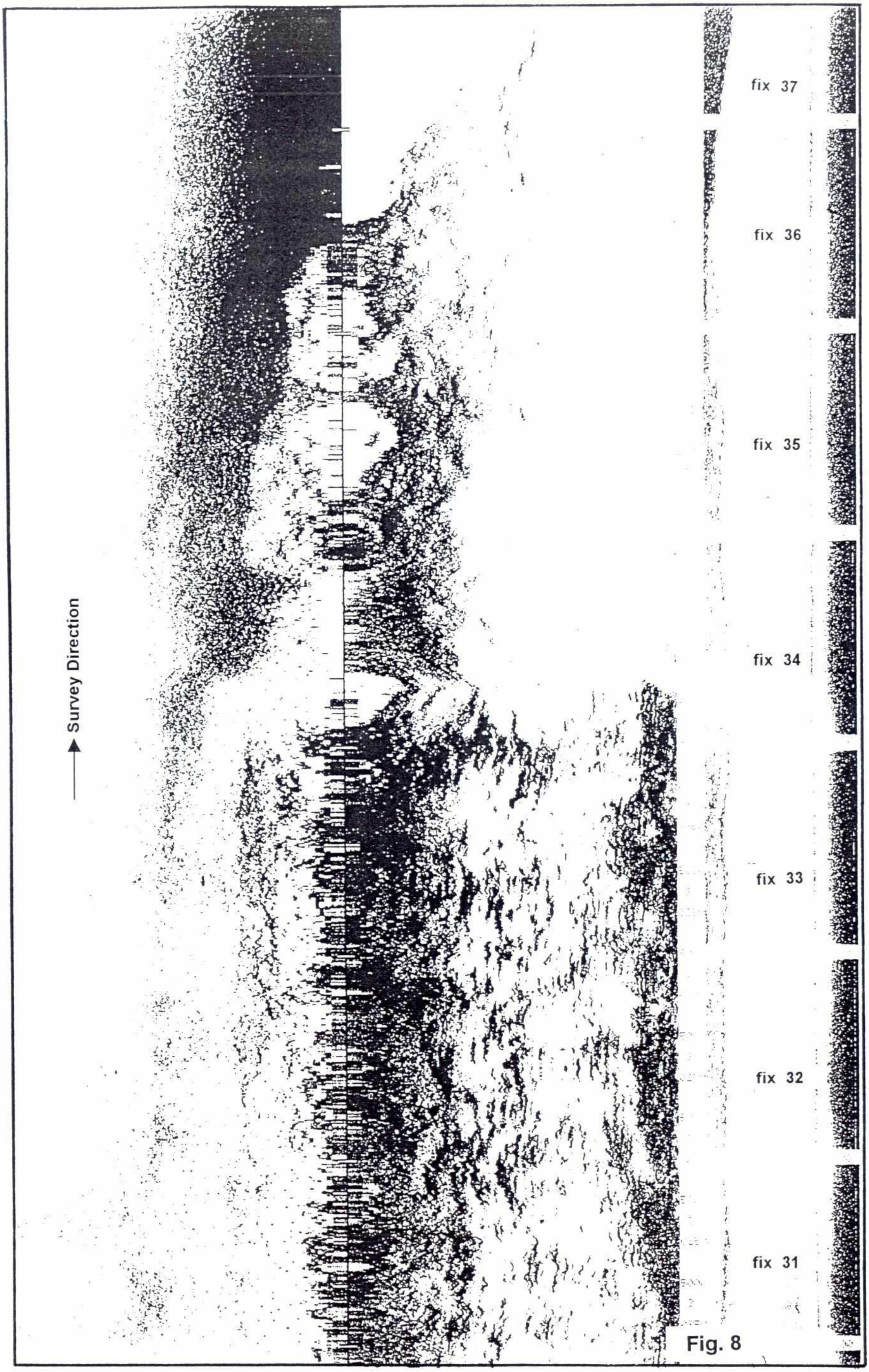

Survey Direction
fix 37
fix 36
fix 35
fix 34
fix 33
fix 32
fix 31

Fig. 8

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4.2 Chirp II Subbottom Profiler

4.2.1 Results

The processed ChirpII profiles were plotted on A4 sheets and are attached to this report. The left side of the profile is towards the Jamuna river. The right side is towards Test Site II, Bahadurabad. Both shot number i.e. numbering at every seismic trace and station i.e. progressive distance from the top of the embankment are shown in the horizontal scale, whereas distance (meters below transducer) is shown in the vertical scale. The original raw data will be stored at OSAE´s processing center.

In the following section the ChirpII profiles on the position of the monitoring profiles (B, C, D, E1, E2, F, G, H1, H2) will be described and interpreted in brief.

Section B

The depth of the river floor smoothly decreases towards the Test Site II. A water depth of ca. 10 m is measured near the start of the profile. In the vicinity of shotnumber 200 depth decreases to ca. 7m and stays that deep. Near shotnumber 400 depth further decreases towards Test Site II.

A subbottom penetration of more than 5 m can be observed between shotnumbers 0 and 150. Strong parallel subbottom reflectors can be seen at this interval. Between shotnumbers 150 and the end of the profile bottom penetration is less than 5 m. In this part no continuous parallel reflectors occur.

Section C

Water depth starts with ca. 12 m and decreases to roughly 11m near shotnumber 250. Water depth then increases to the maximum value of ca. 15m near shotpoint 390. From the last mentioned shotnumber depth decreases continuously towards the end of the record (shotnumber 500).

This seismogram shows generally two different reflection patterns. Reflection pattern 1 starts at shotnumber 0 and is visible to shotnumber 390. The second reflection pattern occurs from shotnumber 390 to shotnumber 500. Reflection pattern 1 is characterized by generally weaker reflection intensities and subbottom reflectors, whereas reflection pattern 2 generally shows stronger reflection amplitudes and no subbottom continuous reflectors.

Neat shotnumber 0 a subbottom reflector can be seen at a depth of ca 5 m. This reflector decreases to ca. 2.5 m at shotnumber 220. At shotnumbers >390 no subbottom reflectors are visible.

Section D

Water depth smoothly increases from shotnumber 0 to shotnumber 250 (ca 13 - 14m). From shotnumber 250 to shotnumber 380 water depth further increases to the maximum value of ca. 18 m. From here on a decreasing water depth can be seen towards the end of the record (shotnumber 500).
Basically 2 reflection types can be seen on this record. Reflection type 1 shows subbottom reflectors and a subbottom penetration of >5 m. This reflection type is visible from the start of the record to shotnumber 380.

Reflection type 2 shows a subbottom penetration of less than 5m, no internal continuous reflection can be seen, the reflection intensity is generally higher than the reflections of type 1. This reflection type can be found from shotnumber 380 to the end of the record (shotnumber 500).

Beside this 2 reflection types some stronger reflections can be seen near shotpoint 60 at a subbottom depth of ca. 2.5m and close to the river floor near shotnumbers 120 and 200.

Section E1

The bathymetric profile starts with a waterdepth of ca. 13m at shotnumber 0. depth increases very smoothly to shotnumber 110 (13.5m) and then increases to the max. depth of roughly 20m near shotnumber 350. From here on water depth rapidly decreases to the end of the record (shotnumber 500).

There exist also the two reflection patterns as described above. Reflection pattern 1 is visible to shotnumber 350, whereas reflection pattern 2 can be seen on the slope between shotnumbers 350 and 500.

Section E2

The depth profile of this section shows a very smooth increasing water depth between the start of the line (shotnumber 0) and shotnumber 210. A stronger increase of water depth occurs between shotnumbers 210 and 370. At the last mentioned shotnumber the maximum water depth is recorded (20.5m). From shotnumber 370 to shotnumber 500 depth decreases rapidly.

The subbottom reflection characteristics are as described earlier. Reflection pattern 1 can be found between the start of the profile and shotnumber 370. The steep slope towards the Test Site II is characterized by reflection pattern 2.

Section F

The bathymetric profile shows a very smooth increase of water depth from the start of the record to shotnumber 170 (14.5 - 15m). A steeper slope is recorded between shotnumber 170 and shotnumber 240 (15-20m). From the last mentioned shotnumber to shotnumber 330 water depth is increasing smoothly to ca. 21m. From here on the profile decreases towards the end of the record (shotnumber 430).

The two typical reflection patterns are visible again. Reflection type 1 from the start of the profile to shotnumber 330, and reflection type 2 to the end of the profile. In addition to the two reflection patterns some special subsurface reflections are found. near shotnumber 245 a stronger reflection occurs at a depth of ca. 1m below the floor of the river. A second target was found near shotnumber 270. Here a typical hyperbolic echo caused by refraction can be seen at a subbottom depth of ca. 2.5 m. Between shotnumbers 240 and 330 there also exists a strong reflector at a depth of ca. 0.7m below the floor of the river.

Section G

Water depth starts with 11m near shotnumber 0 and then increases. Between shots 100 and ca. 180 a hump with a depth of ca. 15 m is visible. Maximum water depth is more than 20m (near shotnumber 300). From shotnumber 340 on water depth decreases towards the end of the line (shotnumber 500).

The subbottom reflection pattern as described above are also visible along this profile. From shotnumber 0 to shotnumber 340 reflection type 1 occurs. Reflection type 2 is found on the steep slope between shotnumbers 340 and 500.

Between shotnumbers 280 and 340 there exists a strong subbottom reflector at a depth of ca. 1m. At shotnumber 250 there an object is located close to the floor of the river.

Section H1

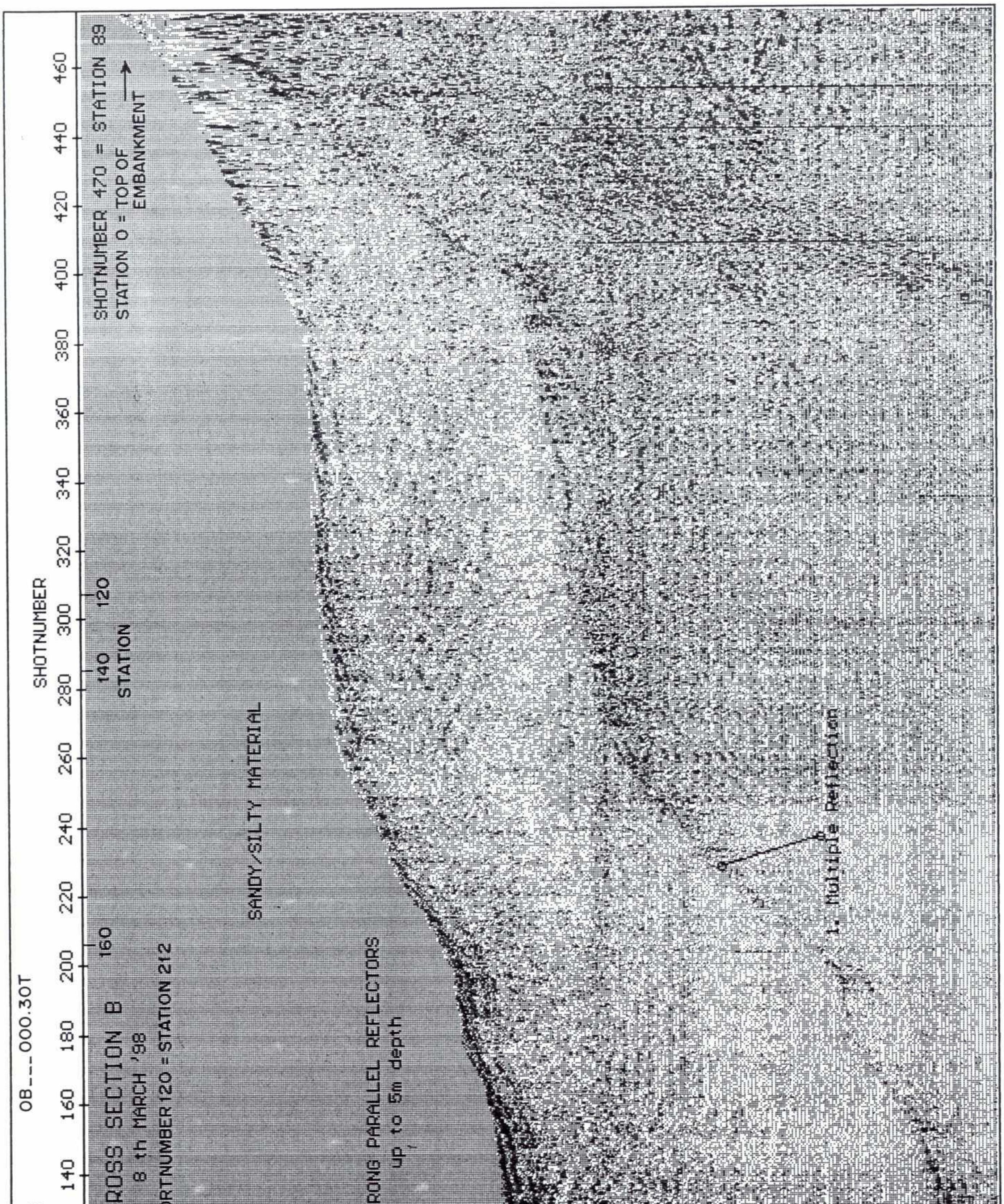
The depth profile increases from ca. 8m water depth near shotnumber 0 to more than 20m waterdepth near shotnumber 390. From shotnumber 390 to the end of the profile (shotnumber 500) water depth decreases. On the gentle slope (shotnumber 0-390) the surface shows a wavy structure.

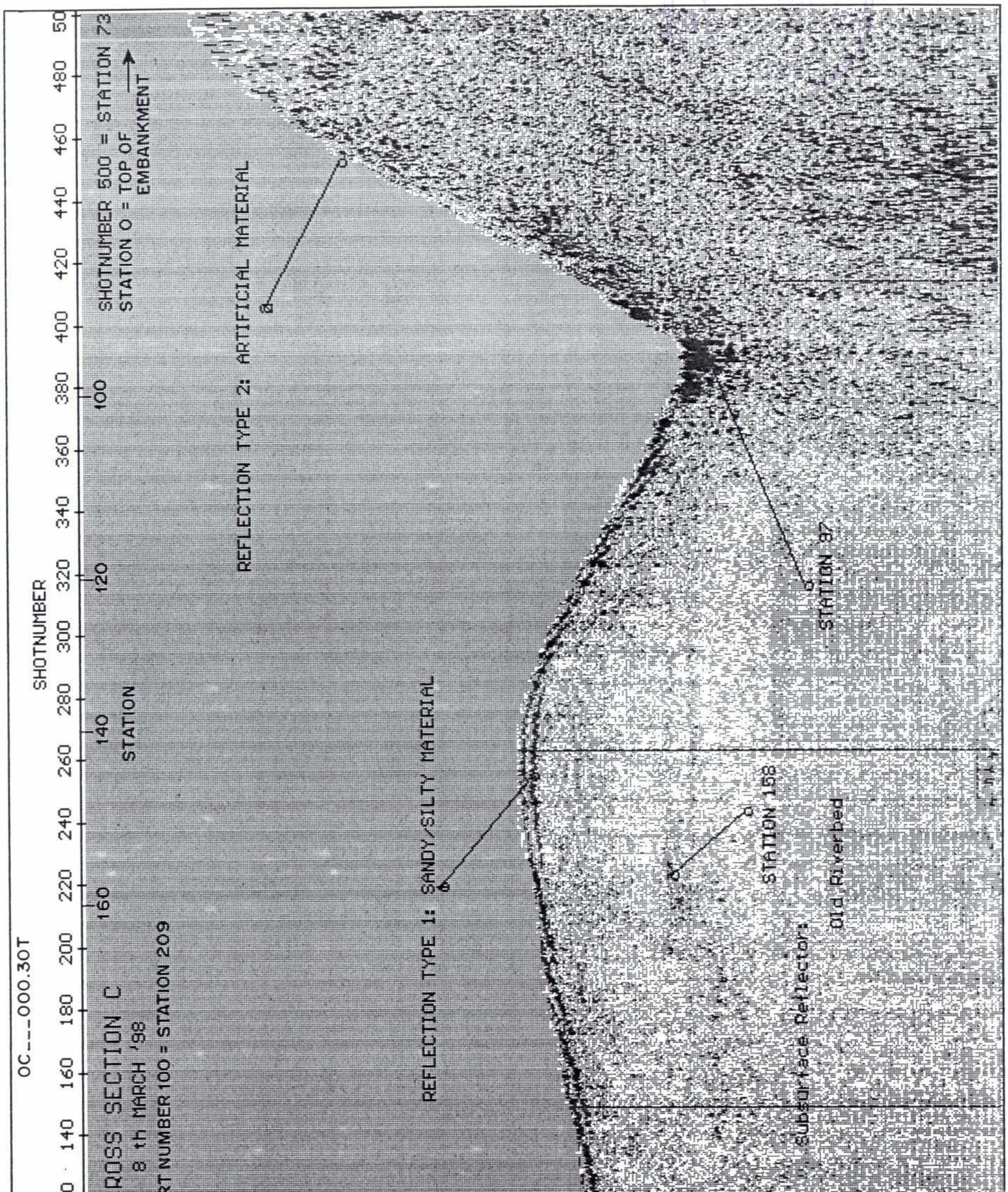
The two typical reflection patterns are also found on this line. Reflection type 1 is visible on the gentle slope between shotnumber 0 and 390, whereas the steep slope (shotnumber 390 to shotnumber 500) is characterized by reflection type 2.

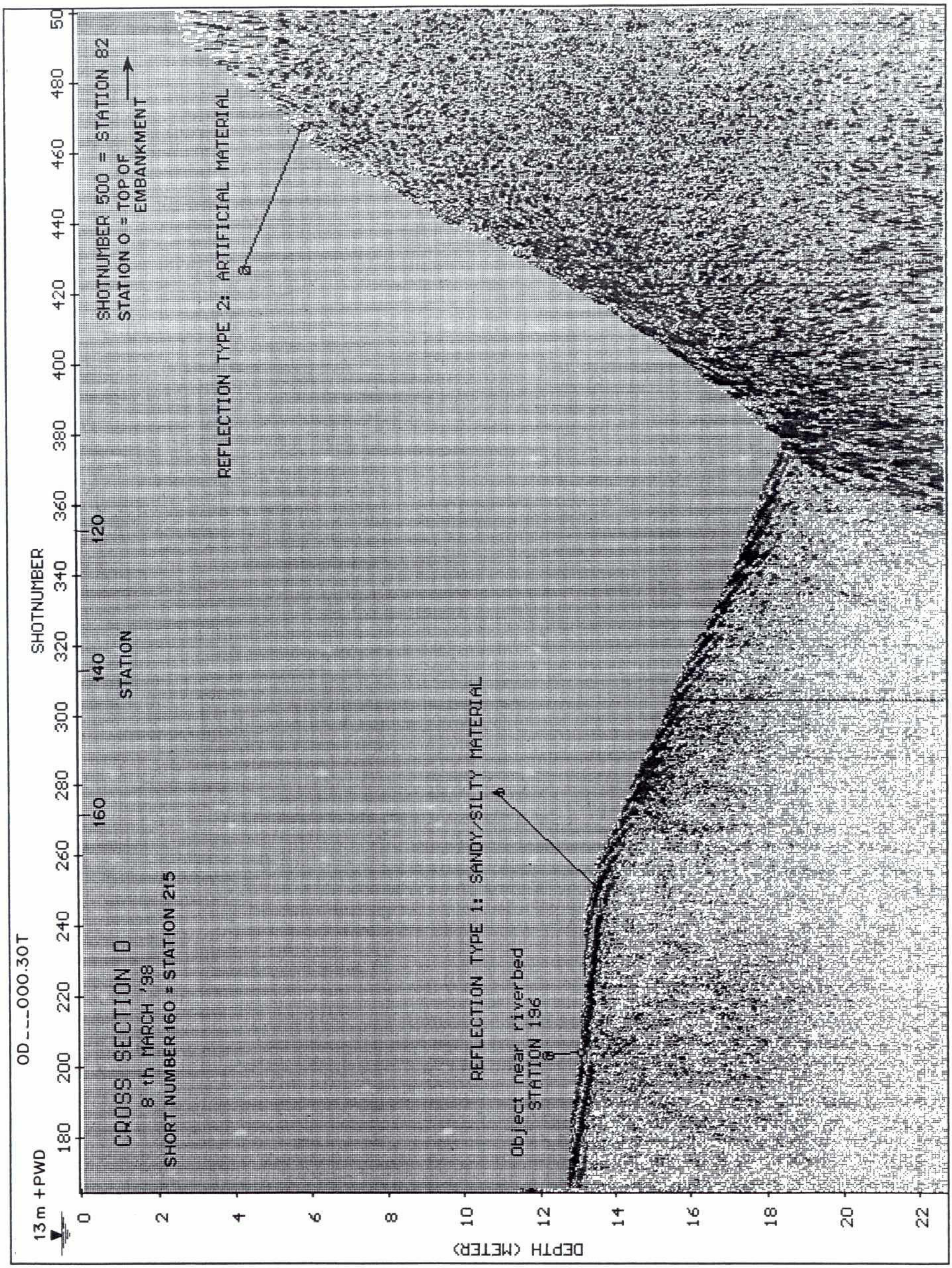
Section H2

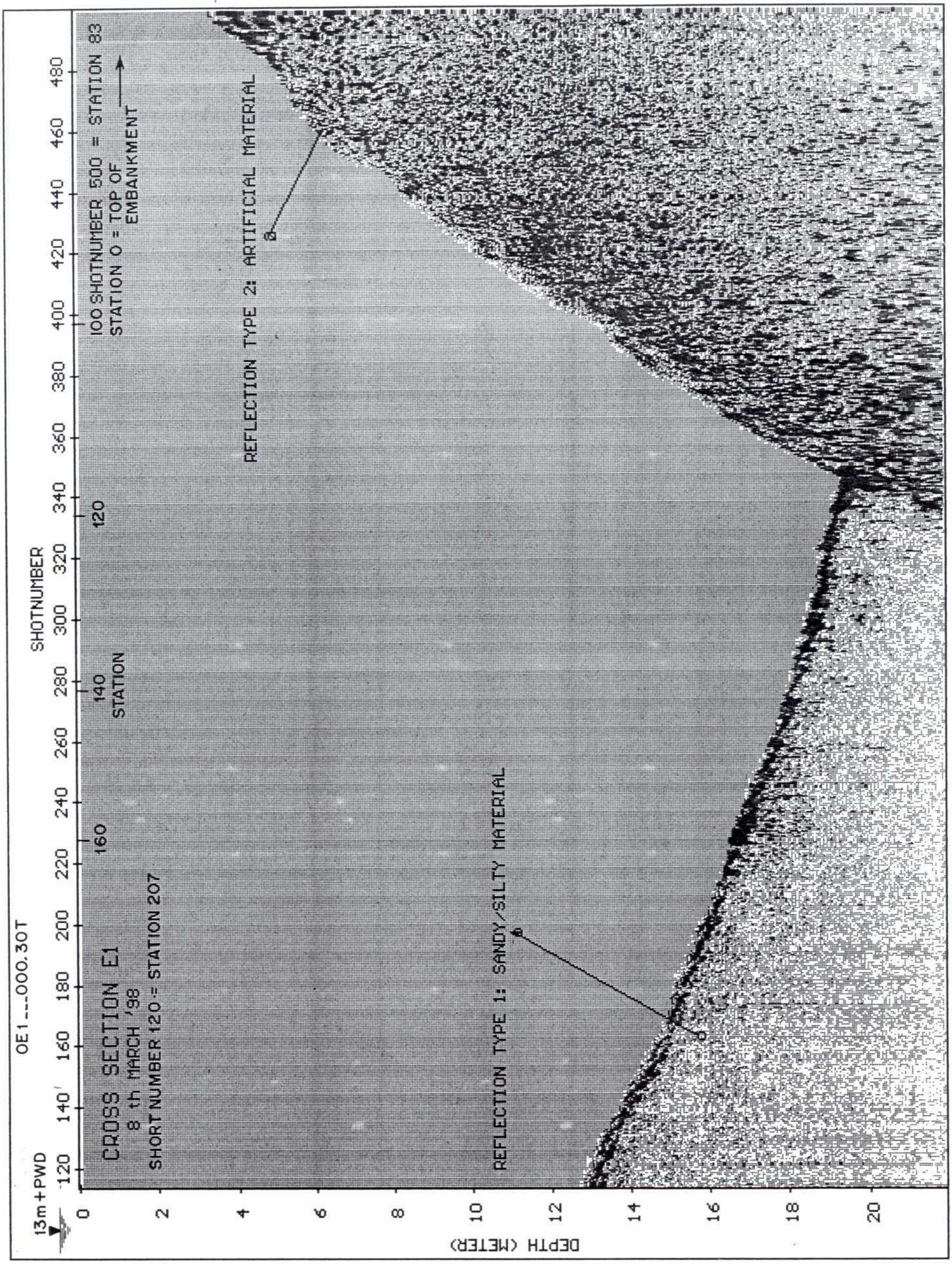
The depth profile of this line is characterized by a water depth of ca. 14 at shotnumber 150 (here the line starts) and then increases to a depth >20 m at shotnumber 350. From here on depth decreases. Between shot numbers 400 and 420 the water depth is ca. 16m. The steep gradient is visible between shotnumbers 420 and the end of the line at shotnumber 500.

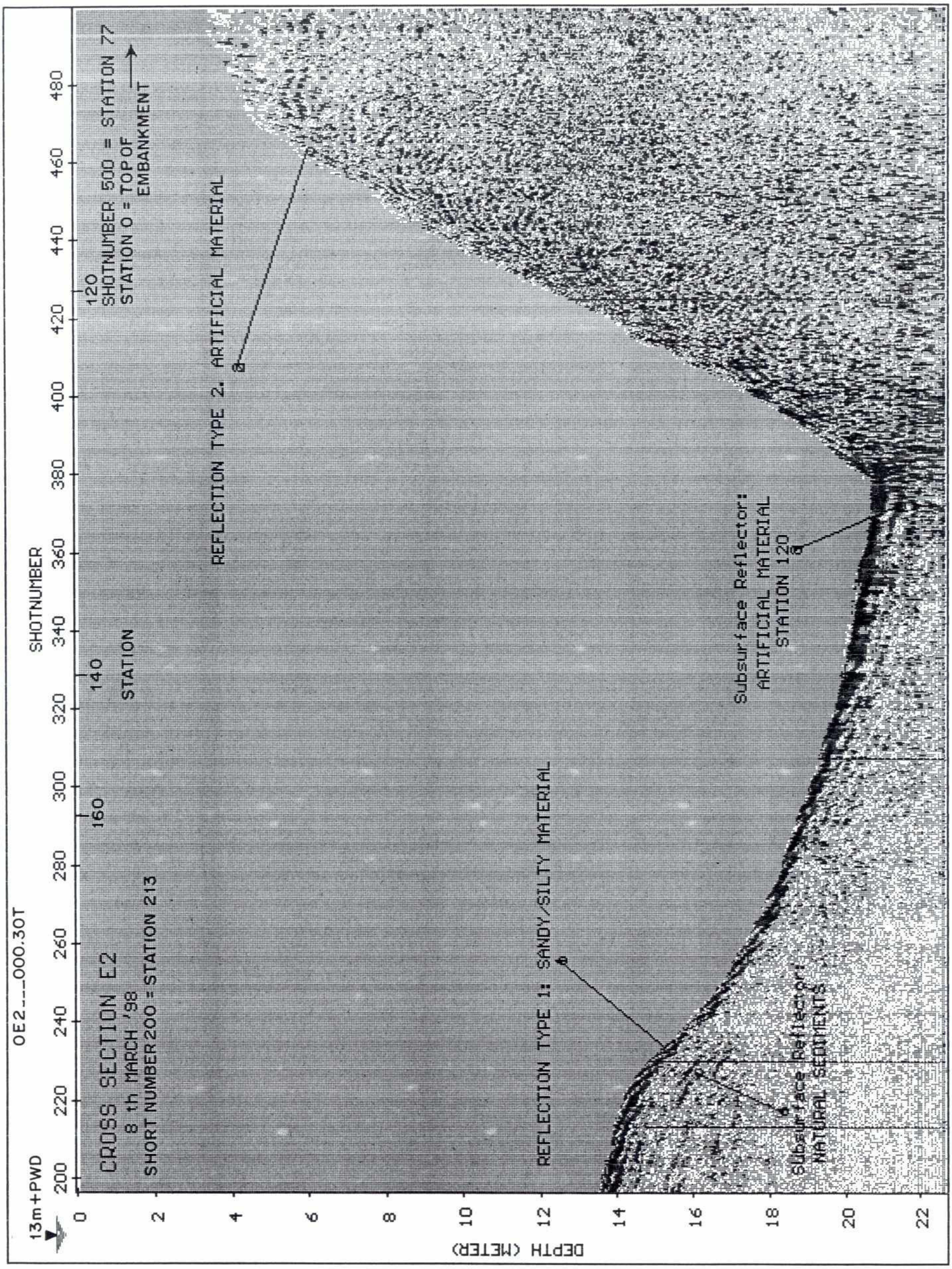
On this line the two typical reflection patterns are also visible. Reflection type 1 is visible on the gentle slope between shotnumber 0 and 420, whereas the steep slope (shotnumber 420 to shotnumber 500) is again characterized by reflection type 2.

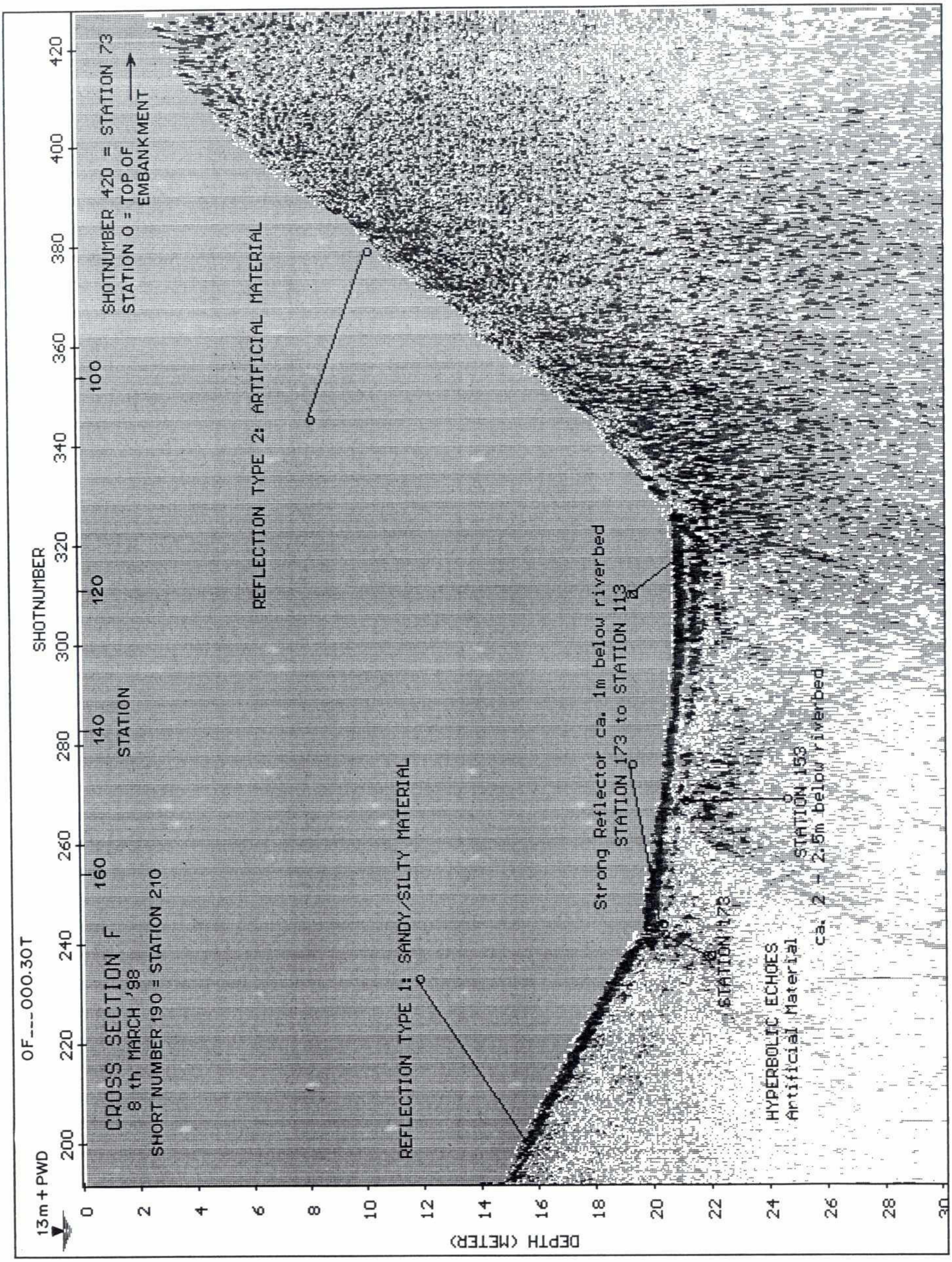

13 m + PWD
OB___000.30T
SHOTNUMBER
120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420 440 460
CROSS SECTION B
8 th MARCH '98
SHORTNUMBER 120 = STATION 212
160
140
STATION
120
SHOTNUMBER 470 = STATION 89
STATION 0 = TOP OF EMBANKMENT
SANDY/SILTY MATERIAL
STRONG PARALLEL REFLECTORS
up to 5m depth
1. Multiple Reflection
DEPTH (METER)
0 2 4 6 8 10 12 14 16 18 20 22


CROSS SECTION C
8 th MARCH '98
SHORT NUMBER 100 = STATION 209
SHOTNUMBER 500 = STATION 73
STATION 0 = TOP OF EMBANKMENT
OC___000.30T
SHOTNUMBER
STATION
REFLECTION TYPE 1: SANDY/SILTY MATERIAL
REFLECTION TYPE 2: ARTIFICIAL MATERIAL
STATION 97
STATION 158
Subsurface Reflector
Old Riverbed
13m + PWD
DEPTH (METER)

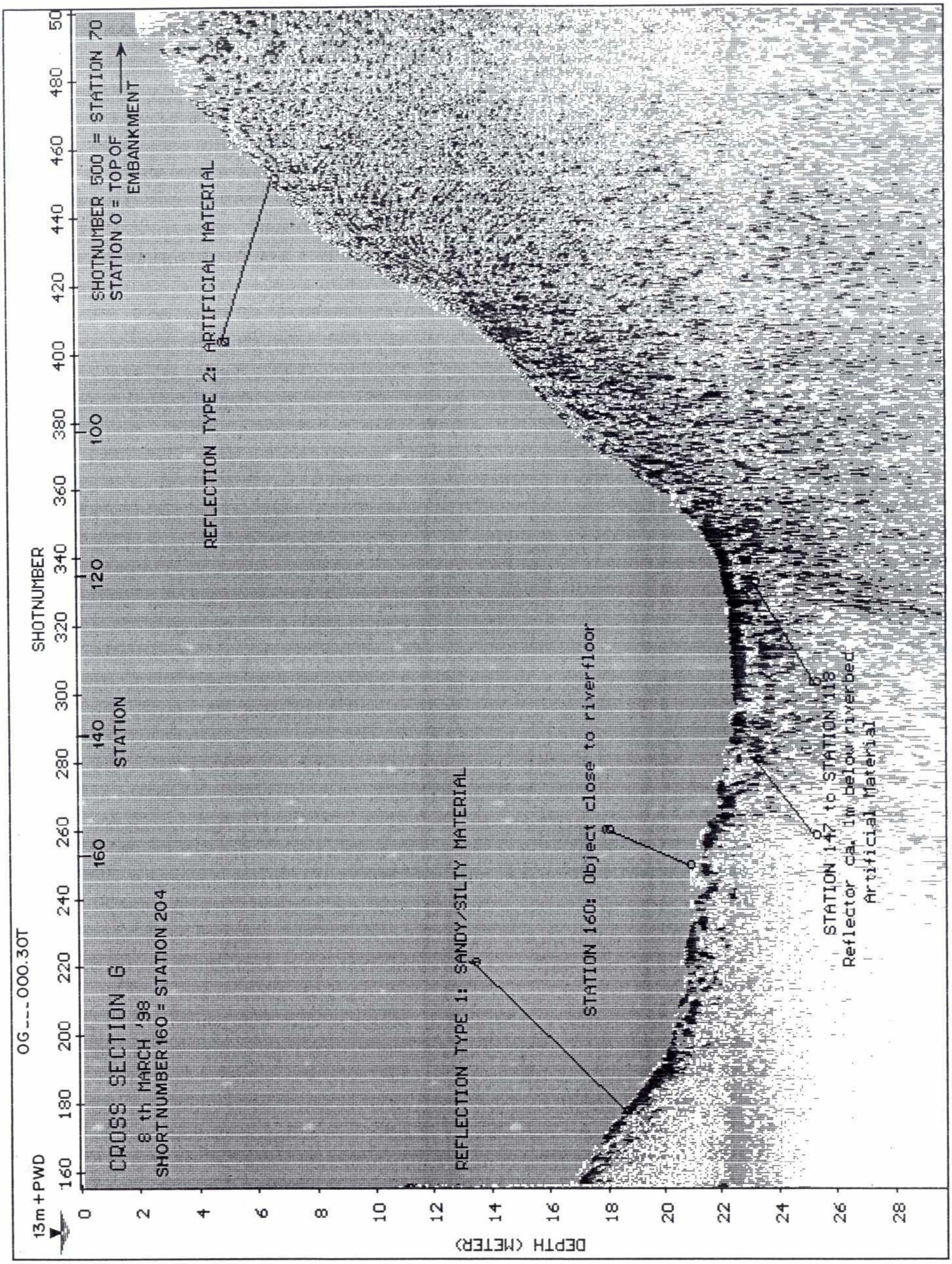

CROSS SECTION D
8 th MARCH '98
SHORT NUMBER 160 = STATION 215
SHOTNUMBER 500 = STATION 82
STATION 0 = TOP OF EMBANKMENT
OD___000.30T
SHOTNUMBER
STATION
120
140
160
REFLECTION TYPE 2: ARTIFICIAL MATERIAL
REFLECTION TYPE 1: SANDY/SILTY MATERIAL
Object near riverbed STATION 196
13 m +PWD
DEPTH (METER)
0
2
4
6
8
10
12
14
16
18
20
22
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500


CROSS SECTION E1
8 th MARCH '98
SHORT NUMBER 120 = STATION 207
OE1 ...000.3OT
SHOTNUMBER
100 SHOTNUMBER 500 = STATION 83
STATION 0 = TOP OF EMBANKMENT
STATION
160
140
120
REFLECTION TYPE 2: ARTIFICIAL MATERIAL
REFLECTION TYPE 1: SANDY/SILTY MATERIAL
13m+PWD
DEPTH (METER)
120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420 440 460 480
0 2 4 6 8 10 12 14 16 18 20

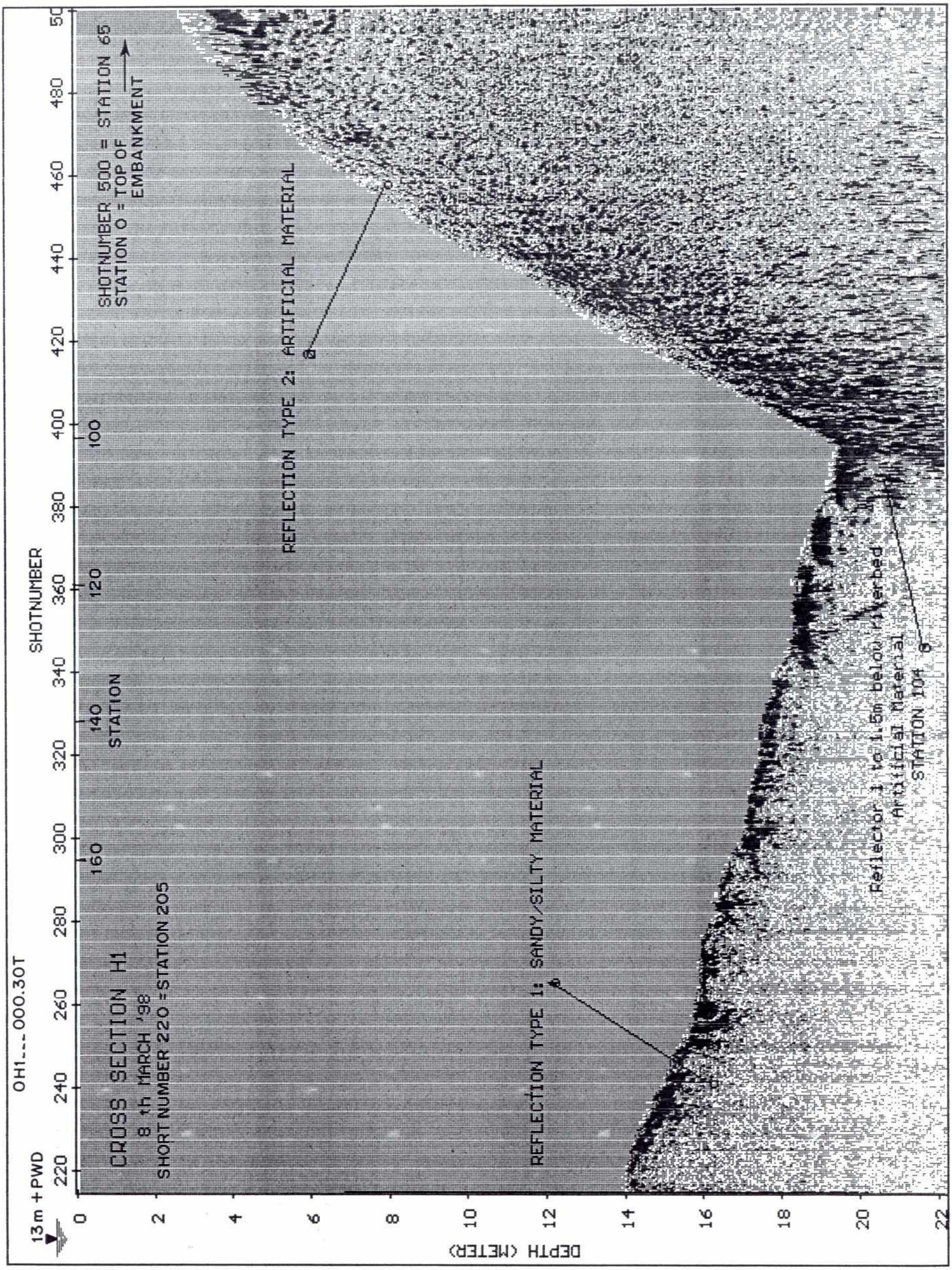

13m+PWD
OE2___000.30T
SHOTNUMBER
200 220 240 260 280 300 320 340 360 380 400 420 440 460 480
CROSS SECTION E2
8 th MARCH '98
SHORT NUMBER 200 = STATION 213
STATION
160
140
120
SHOTNUMBER 500 = STATION 77
STATION 0 = TOP OF EMBANKMENT
REFLECTION TYPE 2. ARTIFICIAL MATERIAL
REFLECTION TYPE 1: SANDY/SILTY MATERIAL
Subsurface Reflector: ARTIFICIAL MATERIAL STATION 120
Subsurface Reflector: NATURAL SEDIMENTS
DEPTH (METER)
0 2 4 6 8 10 12 14 16 18 20 22

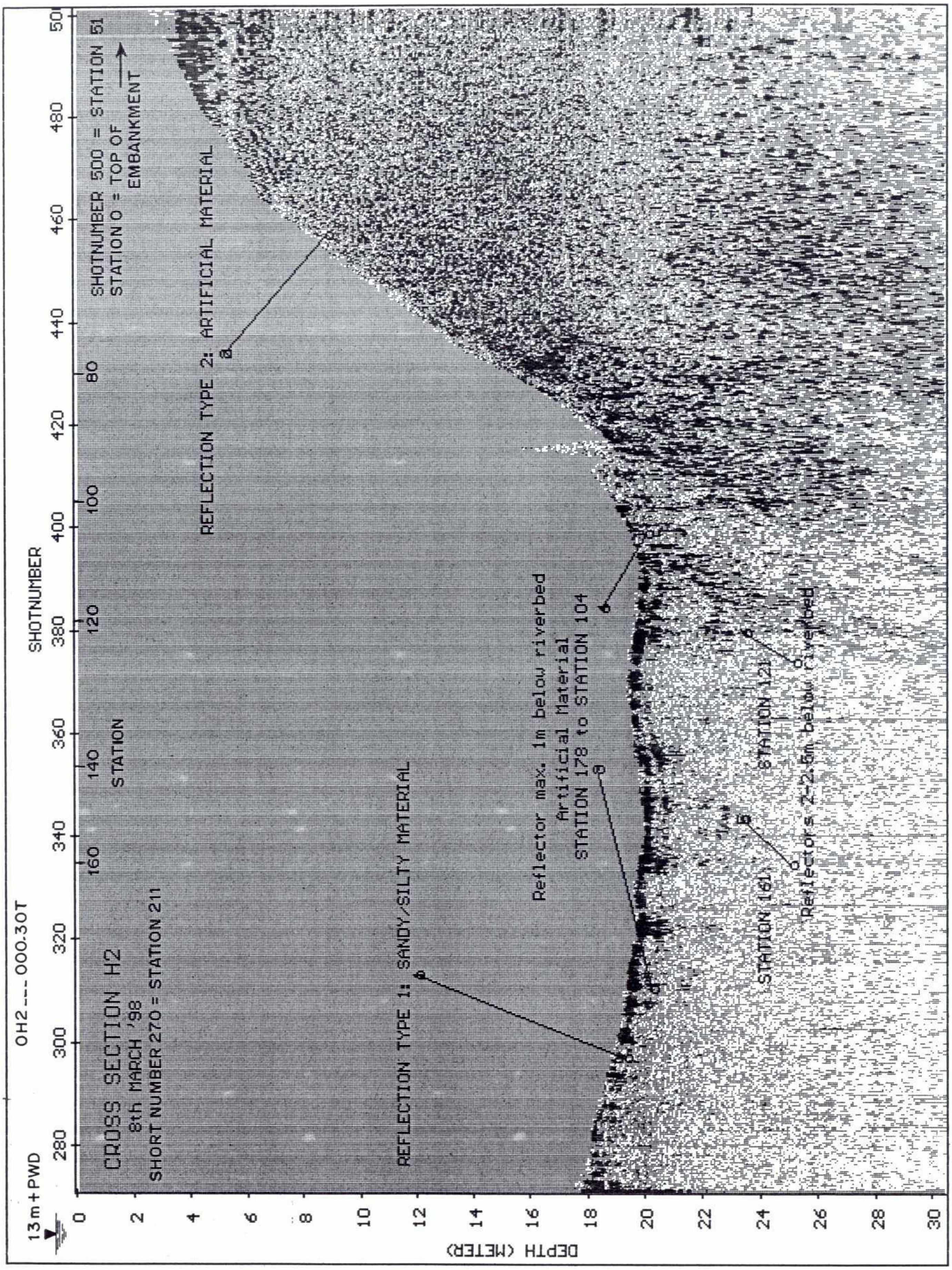


OF___000.30T
SHOTNUMBER
CROSS SECTION F
8 th MARCH '98
SHORT NUMBER 190 = STATION 210
SHOTNUMBER 420 = STATION 73
STATION 0 = TOP OF EMBANKMENT
STATION
160
140
120
100
REFLECTION TYPE 1: SANDY/SILTY MATERIAL
REFLECTION TYPE 2: ARTIFICIAL MATERIAL
Strong Reflector ca. 1m below riverbed
STATION 173 to STATION 113
STATION 173
STATION 153
HYPERBOLIC ECHOES
Artificial Material
ca. 2 - 2.5m below riverbed
13m + PWD
DEPTH (METER)


CROSS SECTION 6
8 th MARCH '98
SHORTNUMBER 160 = STATION 204
OG---000.30T
SHOTNUMBER
SHOTNUMBER 500 = STATION 70
STATION 0 = TOP OF EMBANKMENT
REFLECTION TYPE 2: ARTIFICIAL MATERIAL
REFLECTION TYPE 1: SANDY/SILTY MATERIAL
STATION 160: Object close to riverfloor
STATION 147 to STATION 118
Reflector ca. 1m below riverbed
Artificial Material
STATION
DEPTH (METER)
13m + PWD

62


CROSS SECTION H1
8 th MARCH '98
SHORT NUMBER 220 = STATION 205
OH1..._000.30T
SHOTNUMBER
STATION
SHOTNUMBER 500 = STATION 65
STATION 0 = TOP OF EMBANKMENT
REFLECTION TYPE 1: SANDY/SILTY MATERIAL
REFLECTION TYPE 2: ARTIFICIAL MATERIAL
Reflector 1 to 1.5m below riverbed
Artificial Material
STATION 104
DEPTH (METER)
13 m + PWD


CROSS SECTION H2
8th MARCH '98
SHORT NUMBER 270 = STATION 211
OH2 --- 000.30T
13m+PWD
SHOTNUMBER
280 300 320 340 360 380 400 420 440 460 480 500
STATION
160 140 120 100 80
SHOTNUMBER 500 = STATION 51
STATION 0 = TOP OF EMBANKMENT
REFLECTION TYPE 1: SANDY/SILTY MATERIAL
REFLECTION TYPE 2: ARTIFICIAL MATERIAL
Reflector max. 1m below riverbed
Artificial Material
STATION 178 to STATION 104
STATION 161
STATION 121
Reflectors 2-2.5m below riverbed
DEPTH (METER)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30

4.2.2 Interpretation

On almost all of the profiles recorded by the ChirpII subbottom profiler two different basic reflection types are visible. Reflection type 1 is characterized by deeper subbottom penetration, continuous subbottom reflectors, and a generally weaker reflection intensity. Reflection type 2 shows only limited subbottom penetration, no continuous subbottom reflectors , and a generally stronger reflection intensity.

In the vicinity of Test Site II, Bahadurabad, we have the following material that may be found on or in the floor of the river:

1. sediment transported and deposited by the Jamuna river: mainly sandy-silty sediments or even finer grain-sizes (silty-clayey material), and
2. material used during the construction of Test Site II: mainly different types of concrete blocks, boulders, and bricks.

These two major groups of materials possible within the working area are generally characterized by different acoustical properties. The natural sediments delivered by the Jamuna are soft sediments, whereas the artificial materials used for the construction of the structure are hard material. The main difference between the two types of material is the density. Soft sediments are characterized by a generally lower density than hard materials. However, density is in conjunction with the speed of the main component of the so called acoustic impedance ($I = \rho \times Vp$, where ρ = density and Vp velocity of sound). It has been found in numerous studies, that for surface near sediments the density governs the acoustic impedance. The higher the acoustic impedance of the material on the floor of the river, the more energy is reflected to a receiver, and the less energy may penetrate the layer.

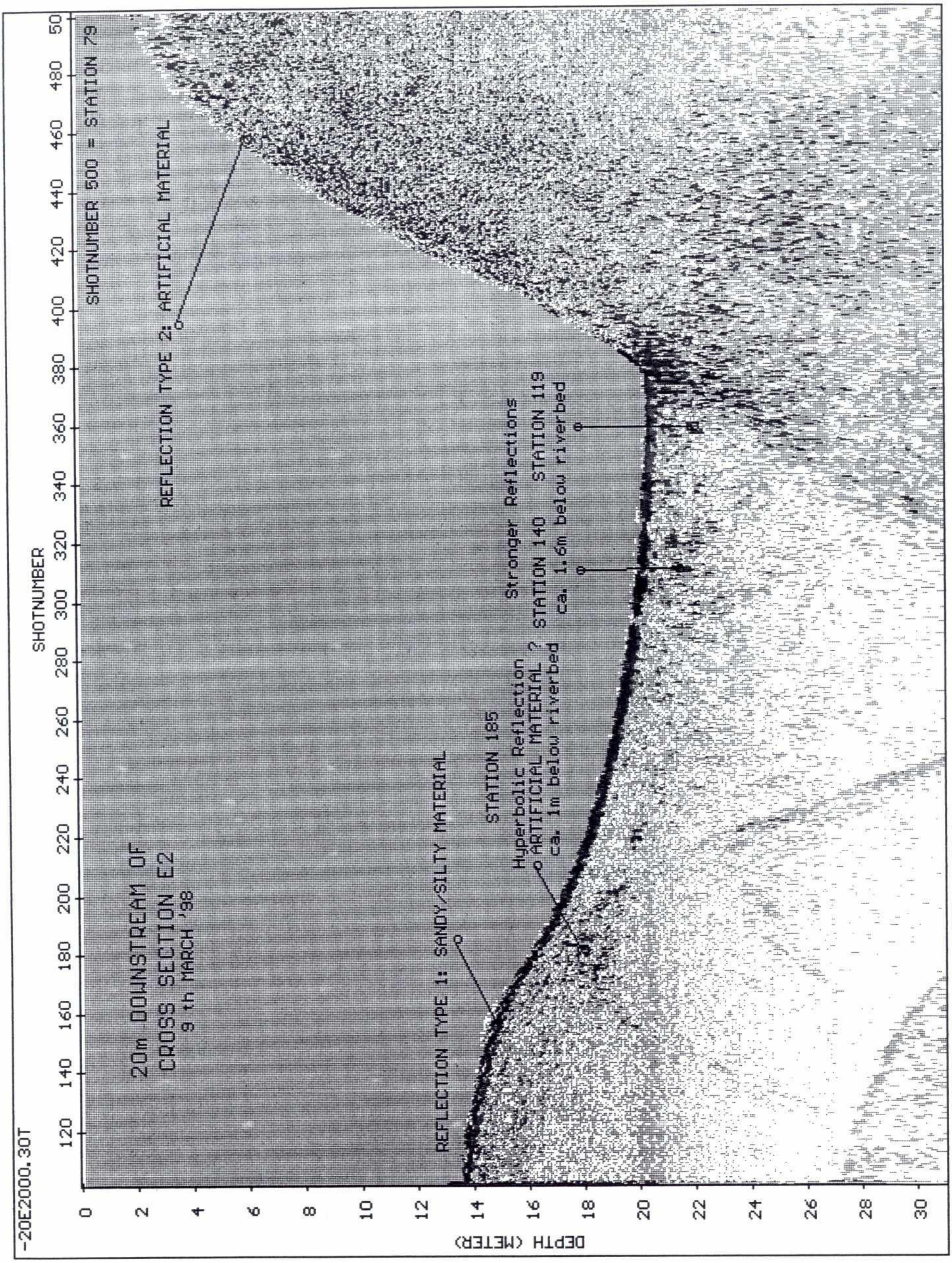
Applying this to our two reflection types leads to the conclusion that the higher reflection intensity, less penetration, etc. of reflection type 2 is due to the appearance of the more dense artificial construction material. Our reflection type 2 shows a deep penetration, lower reflection energy, and higher subbottom penetration. These features are the result of the lower density materials deposited on the floor by the Jamuna river.

Some of the hyperbolic echoes in the deep parts in front of the steep slope in front of the Test Site on the seismograms may be caused by blocks of construction material.

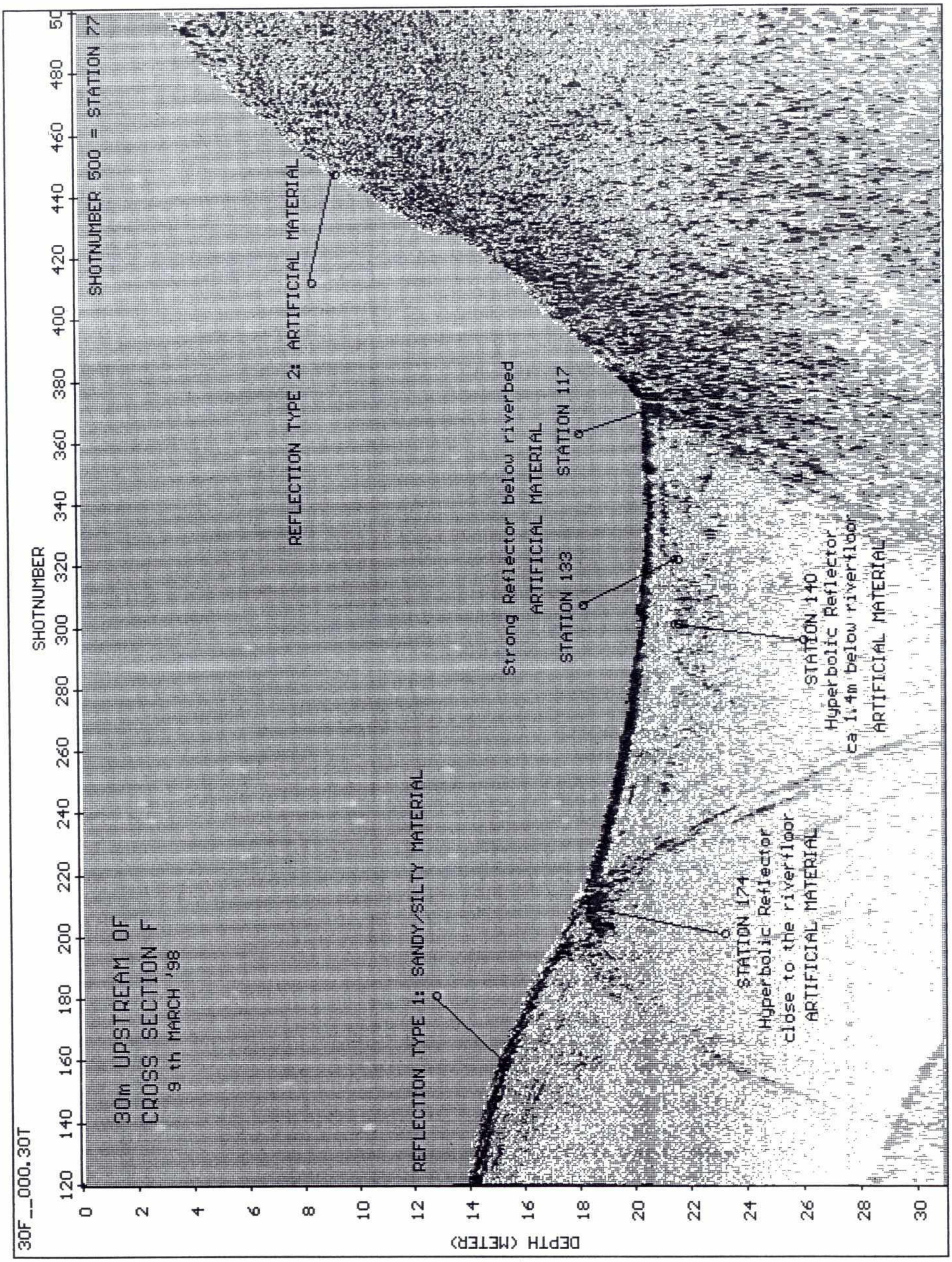
Strong subbottom reflectors at the base of the steep slope of the construction may very well be caused by construction material transported downslope.

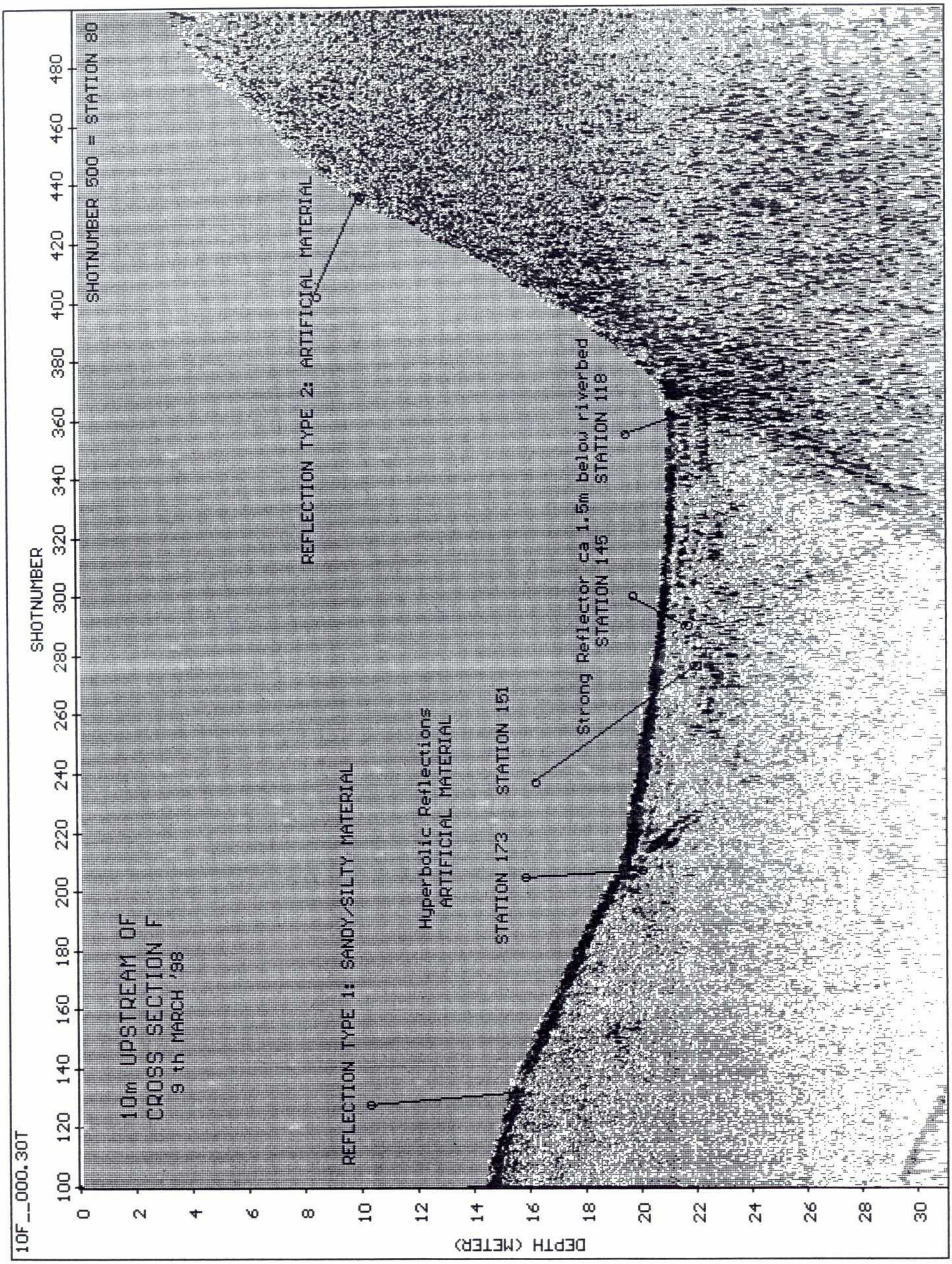
Additional Profiles

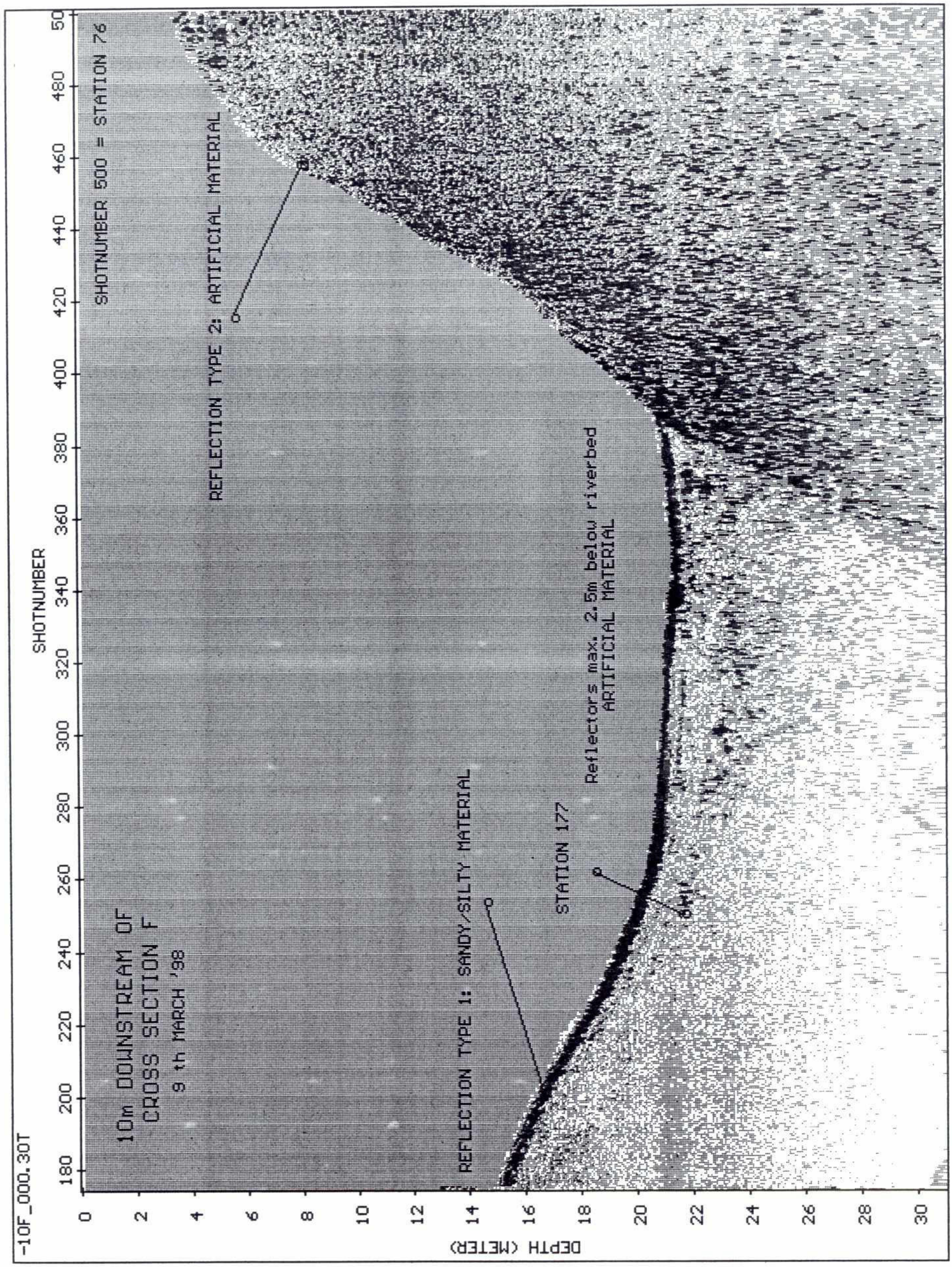
In addition to the profiles discussed above, which are the same as for the standard monitoring program, some additional seismograms are included to the report, in order to show the variation within each of the sections.

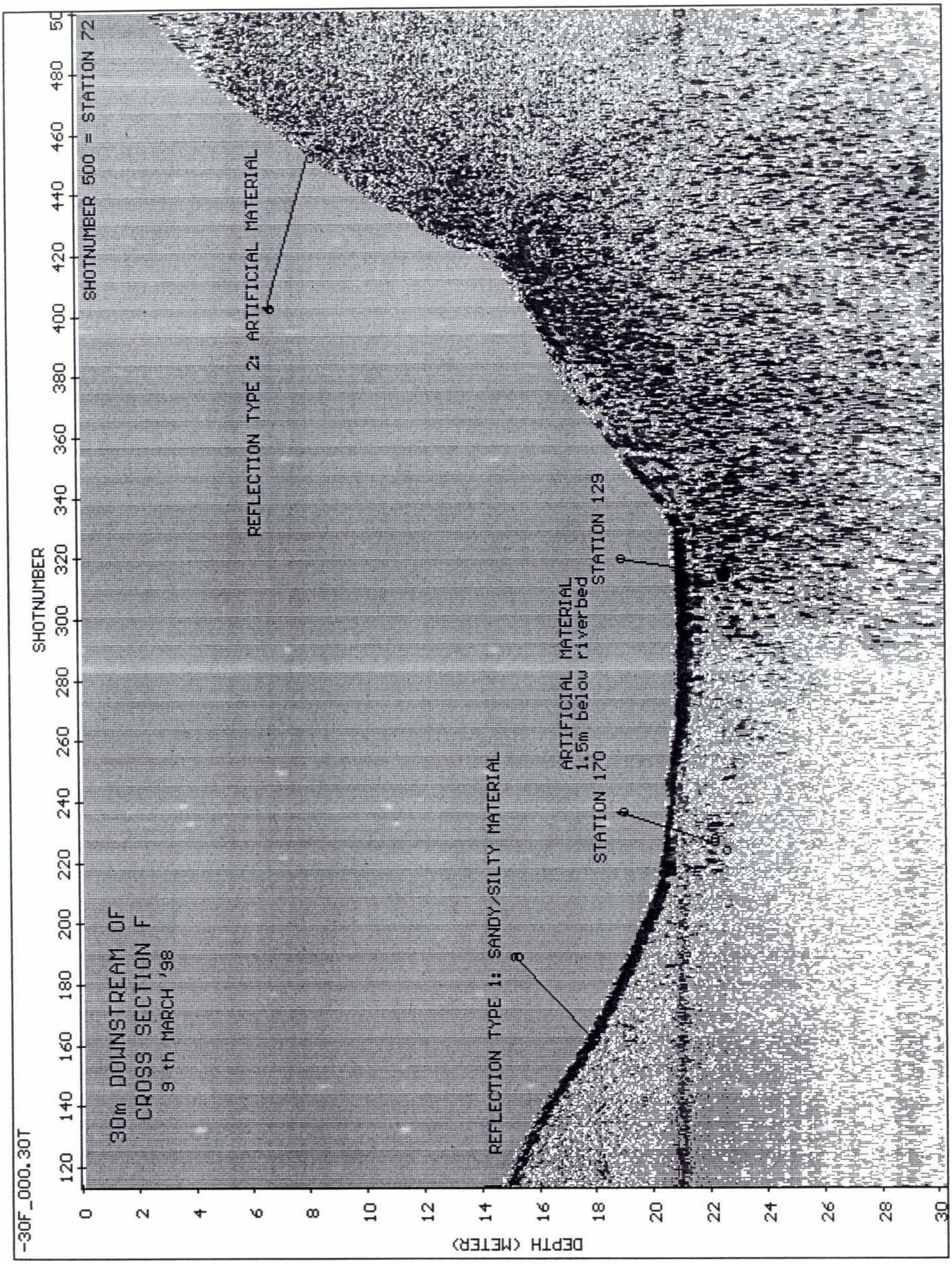


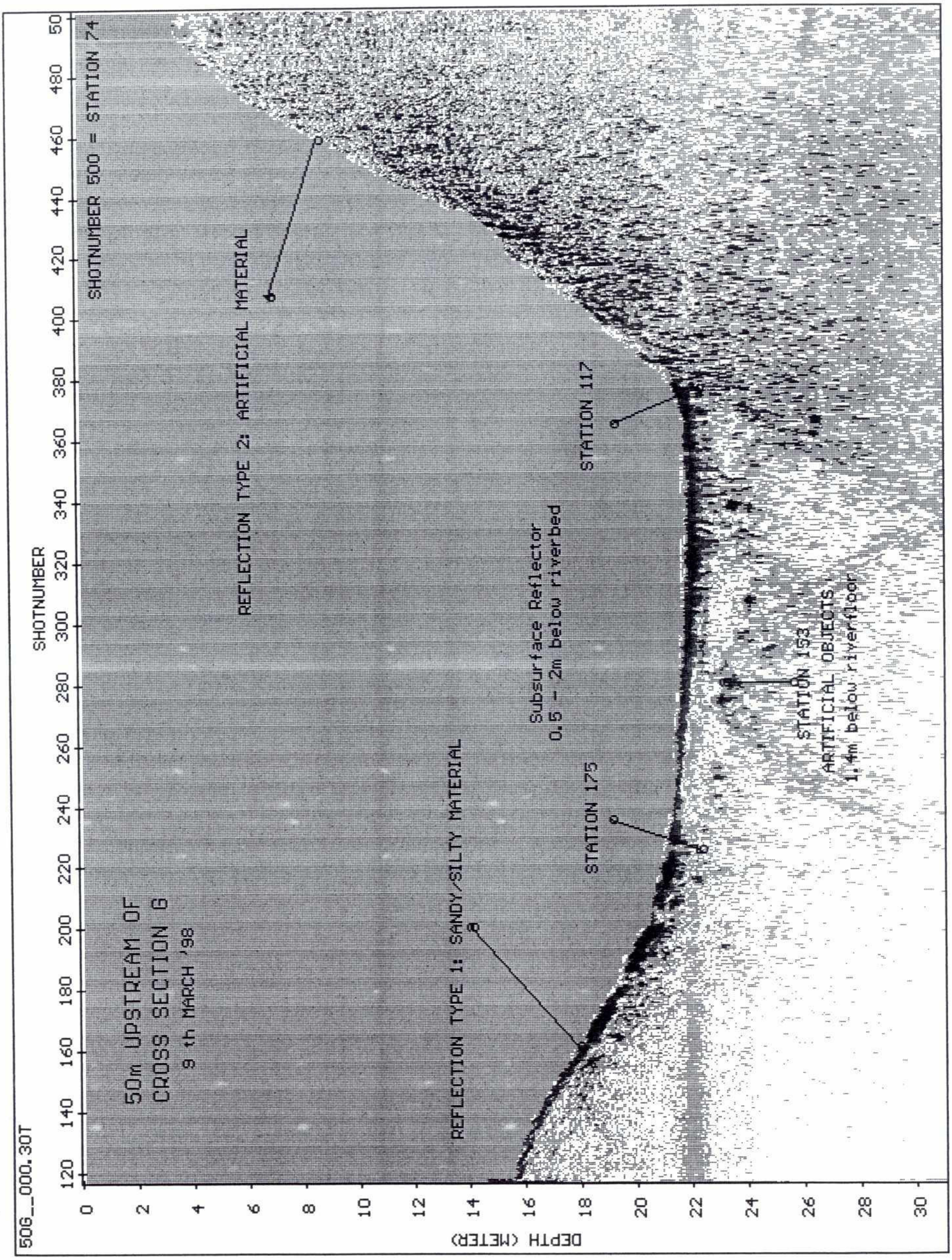
-20E2000.30T
SHOTNUMBER
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
SHOTNUMBER 500 = STATION 79
REFLECTION TYPE 2: ARTIFICIAL MATERIAL
Stronger Reflections
STATION 140
STATION 119
ca. 1.6m below riverbed
20m DOWNSTREAM OF
CROSS SECTION E2
9 th MARCH '98
REFLECTION TYPE 1: SANDY/SILTY MATERIAL
STATION 185
Hyperbolic Reflection
ARTIFICIAL MATERIAL ?
ca. 1m below riverbed
DEPTH (METER)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30


30F__000.30T
SHOTNUMBER
SHOTNUMBER 500 = STATION 77
DEPTH (METER)
30m UPSTREAM OF
CROSS SECTION F
9 th MARCH '98
REFLECTION TYPE 1: SANDY/SILTY MATERIAL
REFLECTION TYPE 2: ARTIFICIAL MATERIAL
Strong Reflector below riverbed
ARTIFICIAL MATERIAL
STATION 133
STATION 117
STATION 140
Hyperbolic Reflector
ca 1.4m below riverfloor
ARTIFICIAL MATERIAL
STATION 174
Hyperbolic Reflector
close to the riverfloor
ARTIFICIAL MATERIAL


10F__000.30T
SHOTNUMBER
SHOTNUMBER 500 = STATION 80
100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420 440 460 480
DEPTH (METER)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
10m UPSTREAM OF
CROSS SECTION F
9 th MARCH '98
REFLECTION TYPE 1: SANDY/SILTY MATERIAL
Hyperbolic Reflections
ARTIFICIAL MATERIAL
STATION 173
STATION 151
Strong Reflector ca 1.5m below riverbed
STATION 145
STATION 118
REFLECTION TYPE 2: ARTIFICIAL MATERIAL


-10F_000.30T
SHOTNUMBER
SHOTNUMBER 500 = STATION 76
REFLECTION TYPE 2: ARTIFICIAL MATERIAL
Reflectors max. 2.5m below riverbed
ARTIFICIAL MATERIAL
STATION 177
REFLECTION TYPE 1: SANDY/SILTY MATERIAL
10m DOWNSTREAM OF
CROSS SECTION F
9 th MARCH '98
DEPTH (METER)


-30F_000.30T
SHOTNUMBER
120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420 440 460 480 500
DEPTH (METER)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
30m DOWNSTREAM OF
CROSS SECTION F
9 th MARCH '98
REFLECTION TYPE 1: SANDY/SILTY MATERIAL
STATION 170
ARTIFICIAL MATERIAL
1.5m below riverbed
STATION 128
REFLECTION TYPE 2: ARTIFICIAL MATERIAL
SHOTNUMBER 500 = STATION 72


50G__000.30T
SHOTNUMBER
SHOTNUMBER 500 = STATION 74
120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420 440 460 480 500
50m UPSTREAM OF
CROSS SECTION 6
9 th MARCH '98
REFLECTION TYPE 1: SANDY/SILTY MATERIAL
REFLECTION TYPE 2: ARTIFICIAL MATERIAL
STATION 175
STATION 117
Subsurface Reflector
0.5 - 2m below riverbed
STATION 153
ARTIFICIAL OBJECTS
1.4m below riverfloor
DEPTH (METER)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30

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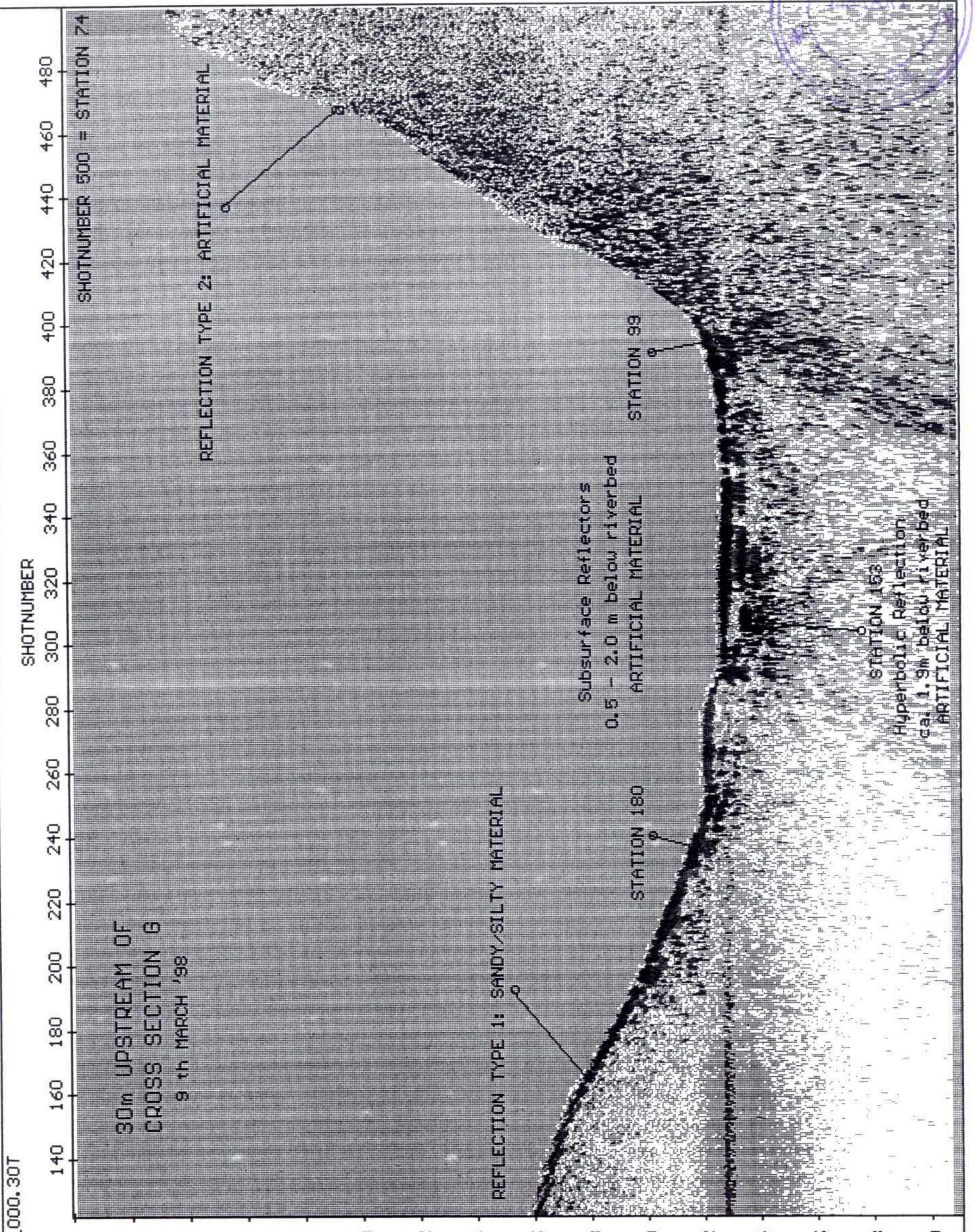
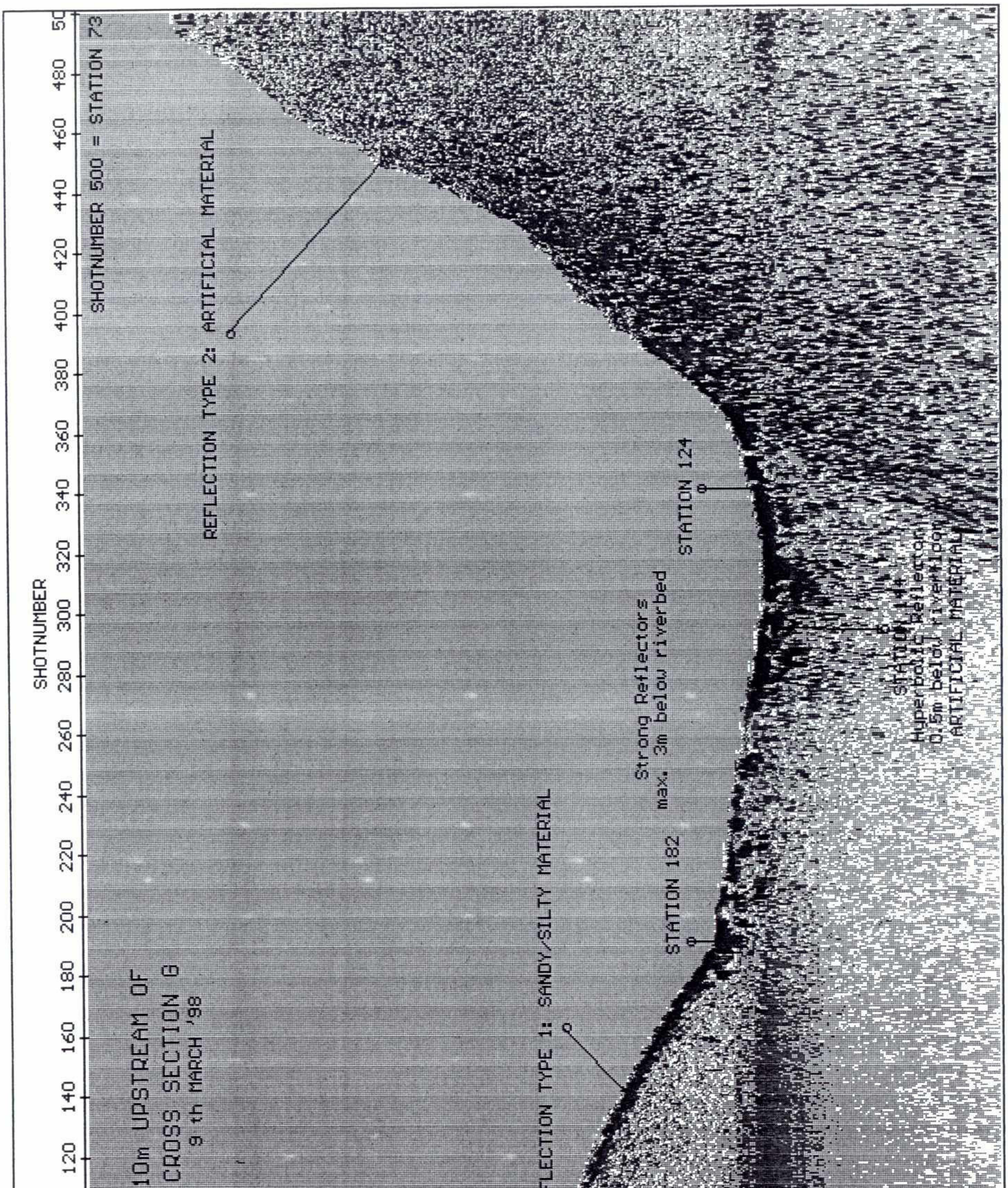
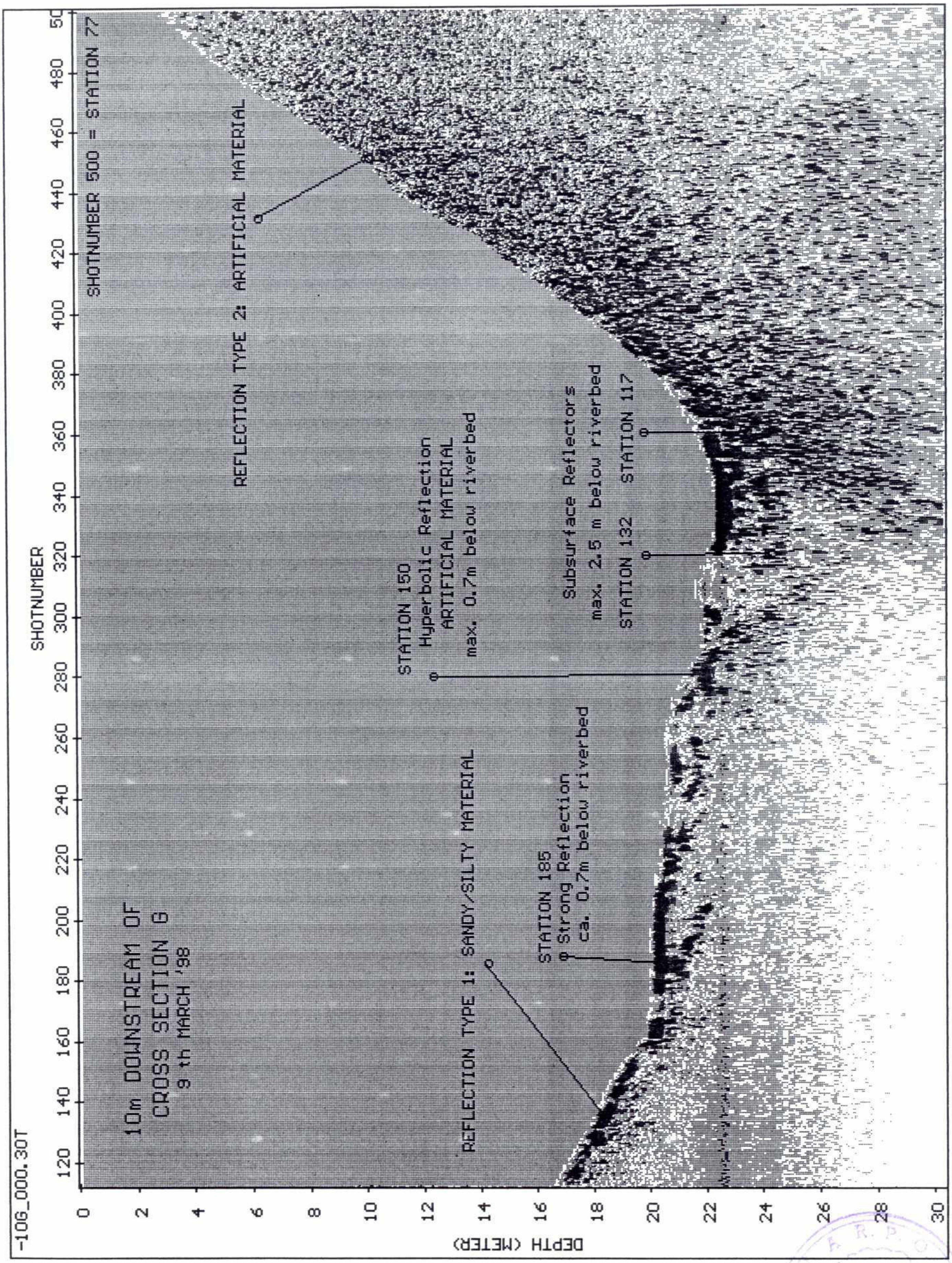


30G__000.30T
SHOTNUMBER
SHOTNUMBER 500 = STATION 74
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
DEPTH (METER)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
30m UPSTREAM OF
CROSS SECTION 6
9 th MARCH '98
REFLECTION TYPE 1: SANDY/SILTY MATERIAL
REFLECTION TYPE 2: ARTIFICIAL MATERIAL
Subsurface Reflectors
0.5 - 2.0 m below riverbed
ARTIFICIAL MATERIAL
STATION 180
STATION 99
STATION 163
Hyperbolic Reflection
ca. 1.9m below riverbed
ARTIFICIAL MATERIAL


10G__000.30T
10m UPSTREAM OF
CROSS SECTION G
9 th MARCH '98
SHOTNUMBER
SHOTNUMBER 500 = STATION 73
REFLECTION TYPE 2: ARTIFICIAL MATERIAL
REFLECTION TYPE 1: SANDY/SILTY MATERIAL
STATION 182
STATION 124
Strong Reflectors
max. 3m below riverbed
ARTIFICIAL MATERIAL
DEPTH (METER)


-106_000.30T
SHOTNUMBER
120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420 440 460 480 500
DEPTH (METER)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
SHOTNUMBER 500 = STATION 77
REFLECTION TYPE 2: ARTIFICIAL MATERIAL
STATION 117
Subsurface Reflectors
max. 2.5 m below riverbed
STATION 132
STATION 150
Hyperbolic Reflection
ARTIFICIAL MATERIAL
max. 0.7m below riverbed
STATION 185
Strong Reflection
ca. 0.7m below riverbed
REFLECTION TYPE 1: SANDY/SILTY MATERIAL
10m DOWNSTREAM OF
CROSS SECTION G
9 th MARCH '98

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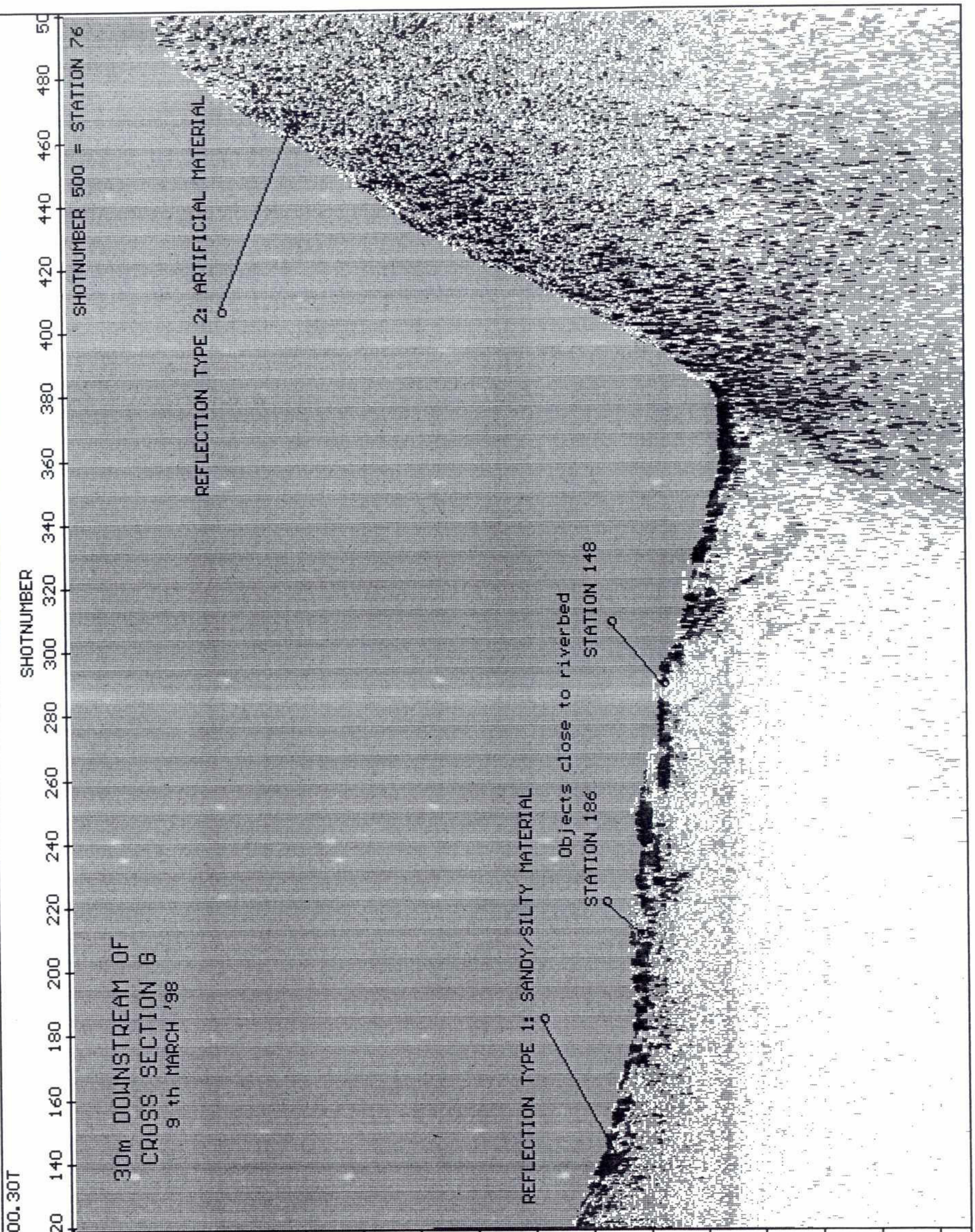
-30G_000.30T
SHOTNUMBER
SHOTNUMBER 500 = STATION 76
REFLECTION TYPE 2: ARTIFICIAL MATERIAL
Objects close to riverbed
STATION 148
STATION 186
REFLECTION TYPE 1: SANDY/SILTY MATERIAL
30m DOWNSTREAM OF
CROSS SECTION 6
9 th MARCH '98
DEPTH (METER)

5 SUMMARY

The combination of side scan sonar and subbottom profiler has been proven to be a valuable tool for mapping the distribution of materials on and below the floor of the river. The side scan sonar clearly shows materials on the riverbed. Areas covered by geo-bags could be clearly differentiated from areas covered by concrete blocks or boulders. It was also possible to classify the continuously covered areas and partly covered areas of the bed of the river.

Although the subbottom profiler is not a dedicated echosounder for bathymetric measurements, the morphology of the river floor is also recorded and can be used for interpretation. The subbottom profiler clearly shows two different reflection patterns. One reflection pattern is generated by the sediments deposited by the Jamuna river, whereas the artificial materials on the slope are responsible for the second reflection pattern. In addition to the sediment types, deeper reflectors and objects covered by a sediment layer can clearly be seen on the seismograms.

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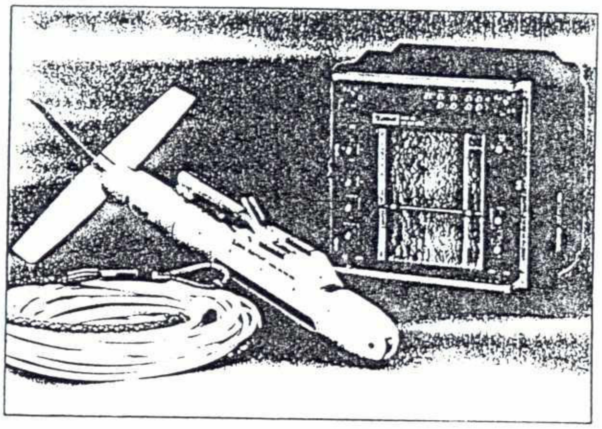
Appendix 1
Data Sheet
EG&G (EDGETECH) 260/272 SIDE SCAN SONAR



Model 260 System Specifications

General

Range (each side) (meters)	25	50	75	100	150	200	300	400	600
Scale	1:250	1:500	1:750	1:1000	1:1500	1:2000	1:3000	1:4000	1:6000

Resolution:	1/400 of range
Tow Fish Height:	1% to 47% of horizontal range
Towing Speed:	0 to 12.7 knots

Model 260 Unit

GRAPHIC RECORDING MECHANISM

Type:	Digital, gray-tone graphic printer
Number of Gray Tones:	16, each pixel
Display Width:	256 mm
Pixels/Line:	2048
Pixel Size:	0.125 mm
Number of Styli:	128
Stylus Travel:	2 mm
Line Width:	0.125 mm
Printing Speed:	0 to 50 lines/second
Stylus Life:	In excess of 1500 hours

DISPLAY FORMAT

Seafloor Map:	Plan view image
Width:	20 cm, 1600 pixels 10 cm each side of tow fish track
Scale Markers:	25-meter intervals along and across the tow fish track
Seafloor Profile:	Vertical display of water column and seafloor beneath tow fish to 47% of range
Width:	4.8 cm, 384 pixels
Scale Lines:	25-meter intervals
Bottom Tracking:	Dashed line indicates tracking height above seafloor used for corrections.

DISPLAY FORMAT (CONT.)

Annotations:	At each event mark Elapsed time standard TIME/LINE NO./SHOT NO. optional Optional navigation data
Event Mark:	Manual, external input, or internal timed
Control Settings:	Range and Gain values printed between map and profile image

RECORDING PAPER

Type:	Dry Electrosensitive
Size:	28 cm wide by 40 meters long roll
Dynamic Range:	23 dB from black to white (16 gray tones)

SPEED CORRECTION

General:	Input speed from any one of several sources is used to position each data point (pixel) at its true distance along the track of the tow fish.
Accuracy:	±1% of distance traveled
Speed Range:	0 to 12.7 knots (function of range)
Printer Line Density:	8 lines per mm -- independent of speed

EG&G

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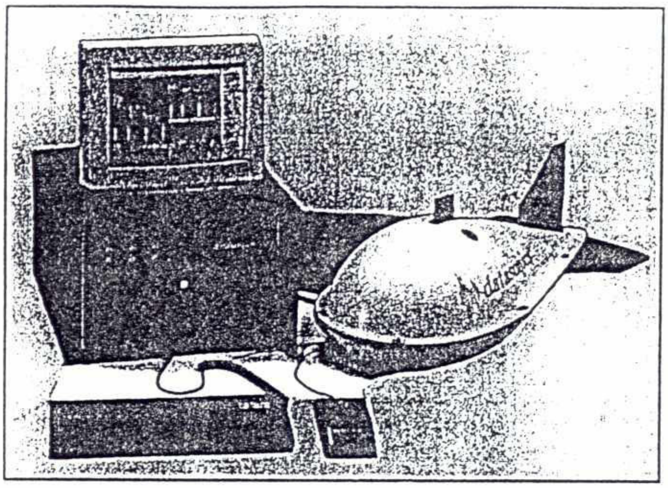
Appendix 2
Data Sheet
DATASONICS CAP 6600 CHIRPII SUBBOTTOM PROFILER

MODEL CAP-6600
CHIRP ACOUSTIC PROFILING SYSTEM



GENERAL SPECIFICATIONS

Main Processor	Sonar work station with TIGA graphics engine
DSP Sonar Signal Processing	Two DSP channels, 16 bit A/D, continuous FFT each transmission, each channel
Data Storage	Exabyte, 8mm tape, stores raw data in SEG-Y format (magneto disk optional)
Operator Software	Chirpscan in Windows environment
Display	1280x1024 color monitor
Ping Rate	12 pings/second
Pulse Length	User selectable from 1 msec. To 160 msec Pulse waveforms stored in memory
Output Power	4 KW each channel
Transducers	AT-471, Chirp bands 1 to 10 kHz AT-12D7, Chirp bands 8 to 23 kHz
Cable	Kevlar electical umbilical cable
Fish Depth	600M maximum
Navigation /Annotation	Nema 0183 interface, event/fix marks, external interrupt
Hard Copy Recorder	Optional HP color printer or grey scale graphic recorder, centronix interface

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