U-542

PL 125
EXPLORATION WELL RÉSUMÉ
6508/5-1

NSEP 87-40
SEPTEMBER 1987

A/S Norske Shell

NSEP 87-40

3/

EXPLORATION WELL RESUME

Well 6508/5-1

A/S Norske Shell, Risavika
September 1987

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WELL RESUME 6508/5-1

1. INTRODUCTION

On 28.02.87, Licence PL 125 (Block 6508/5) was awarded to a group consisting of A/S Norske Shell (35% and Operator), Statoil (50%) and Norsk Occidental A/S (15%). With effect from 01.01.87, Occidental surrendered their interest, which was reassigned to A/S Norske Shell and Statoil in proportion to their original holdings. Thus Licence PL 125 and well 6508/5-1 are now held jointly by Norske Shell (41.18%) and Statoil (58.82%).

Well 6568/5-1 was spudded on 24.04.87 on a location designed to test Lower (and possibly Middle) Jurassic sandstones in the crest of a large NE-SW oriented horst.

Lower Jurassic Middle Drake Formation sandstones of good reservoir quality were encountered at 1775m bdf and one core was cut from 1786 to 1804 m bdf. These sandstones and all deeper ones were found water-bearing, and normally hydrostatically pressured on a common gradient. The well reached a TD of 2586 m bdf in Triassic Red Beds, and was plugged and abandoned as a dry hole on 25.05.87.

2.0 SITE SURVEY REPORT

2.1 INTRODUCTION

A/S Norske Shell commissioned Racal Survey Norge A/S to conduct a rig site survey at location 6508/5-A. Field work was carried out with M/V Dawn Flight between 10.09.86 and 09.11.86.

The purpose of the survey was to obtain bathymetric information and to detect any seabed obstructions or potential sub-seabed hazards to drilling operations by a semi-submersibel drill rig.

Echo-sounder and side-scan sonar equipment were used to map bathymetry and seabed features. A deep towed sparker and an analogue sparker were used to investigate the shallow strata. Digitally recorded multi-channel airgun data were used to investigate the deeper strata and to map the presence of any shallow gas pockets.

2.2 SURVEY PROGRAMME

The site survey area of ca 9 x 6.5 sq. km was covered by 38 NE-SW and 20 NW-SE profiles, utilising echo-sounder, side-scan sonar, deep towed sparker and analogue sparker. The NE-SE profiles were spaced 175 metres apart, while the NW-SE profiles were spaced 500 metres apart.

Forty high-resolution seismic profiles were shot with digital equipment. Fifteen lines were aligned in the NE-SW direction and twenty-five in the SE-NW direction. The line lengths varied from 2 to 8 km. The central lines in the NE-SW direction were spaced 175 m apart while the outer were spaced from 350 to 500 m apart. The profiles shot in the NW-SE direction were spaced 250 m apart over the central area and 500 m at the fringes.

2.3 SUMMARY

Survey target position:	Latitude 65 deg 42 min 51.4 sec N Longitude 08 deg 28 min 34.8 sec E
Water depth:	408 metres, varying between 390 and 430 m over the area surveyed.
Seabed slope:	Down to northeast at less than 1:500
Seabed sediments:	Less than 5 metres of soft silts and clays with pockmarks.
Seabed hazards:	None.
Sub-seabed conditions:	188 metres of Pleistocence sediments dipping to southwest overlying 735 metres of pliocene dipping to northwest. Cobbles and boulders are rare.
Drilling hazards:	Pockmarks seen at seabed. No severe dips seen in sections. No channel features observed on digital data. Amplitude anomalies at several levels, particularly at 190 m sub-seabed and 630 m sub-seabed.

In the event, no shallow gas bearing strata were encountered at the indicated levels, nor was any shallow gas found at any other depth.

R I G   P O S I T I O N I N G

"West Vanguard"

with

Navstar GPS and LORAN-C

Block 6508/5

April. 87

May 20'th 1987
SEATEX A/S

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1. SUMMARY OF RESULTS

During the rig-move operation of West-Vanguard to the block 6508/5 in april 1987 at Haltenbanken, GPS and Loran-C was used for positioning. GPS and LORAN-C in range/range mode was used for navigation during transit. GPS was only used for final positioning.

The equipment was operated by Seatex A/S with the reference station in Trondheim.

The GPS data logged on board "West-Vanguard" has been processed with the data from the reference station at Trondheim, and gave the;

<u>Final GPS position, ED 1950 datum</u>

UTM zone 32 :	Northing	7288341.9	Easting	475974.1
Geographic :	N	65° 42' 51.23"	E	08° 28' 35.44"

Norske Shell a.s. has given the

<u>Intended rig position, ED 1950 datum</u>

UTM zone 32 :	Northing	7288349.0	Easting	475965.0
Geographic :	N	65° 42' 51.45"	E	08° 28' 34.72"

This results in the following

<u>Difference between GPS, intended</u>

From intended position : Range 11.5 m Bearing 128°

2. POSITION FIXING WITH NAVSTAR GPS

2.1. The GPS concept

GPS (Global Positioning System) is a satellite based positioning system providing position, speed and timing information. The system is planned to be fully operational in 1988, containing 18 satellites in six orbital planes. Presently there are six healthy satellites in orbit.

The satellites transmit information about their position, and highly accurate time information. The receiver uses this information to automatically choose the satellites that give the best geometry for position computation. Four simultaneous range measurement to four satellites are required to solve for three position coordinates and receiver clock offset. If one coordinate is known, for instance the heigth above the geoid, as will be the case in a marine application, three satellites are sufficient. If the receiver is equipped with an atomic clock, positioning can be done with only two satellites visible.

The satellites use spread spectrum transmission, i.e. the transmission is modulated with a noise-like code in a broad band around the center frequency. Each satellite has its own code permitting all satellites to transmit on the same frequency. The receiver uses a replica of the individual satellite codes to lock onto the incoming signals.

Appendix C contains some GPS system data.

2.2. Accuracy considerations

Two levels of accuracy are available. The Precise Positioning System (PPS) and the Standard Positioning System (SPS). The satellites transmit two different codes. The P-code (Precision) for PPS, has a typical accuracy of 7 m CEP (Circular Error Probability). This means that 50 % of the measurements fall within this radius. This code is particularly invulnerable to jamming and is primarily intended for military use. Up to now the P-code has been available to civilian users as well, but this is unlikely to be the case after 1988.

A second code, the S-code (Short), earliar called the C/A-code (Coarse aquisition) with a lower accuracy, typically 40 m CEP, is intended for civilian users. It requires a much simpler receiver than the P-code.

2.3. Differential mode of operation

There exist two main types of GPS-receivers. The single frequency C/A code receivers and the dual frequency P-code receivers. When using dual frequency receivers, a correction for propagation delay through the ionosphere can be estimated.

When a single frequency receiver is used propagation delay will produce a position bias. By employing the method of differential correction this bias may be substantially reduced if ionosphere influences are correlated at the two receivers. Systematic errors due to inaccuracies in satellite ephemeries will be eliminated by this technique if the baslines are less than 500 km and if the receivers and dataprocessing are identical, and they use the same satellite constellation. In this operation the baseline between the rig and the reference station was approx. 275 km.

Two main differential correction methods are in use. (1) Differential position correction and (2) differential range correction. While (1) utilize coordinates corrections, (2) corrects the individual pseudo ranges. This means that (2) can be used in a situation where the two receivers do not use the same satellite constellation. Method (1) requires identical satellite constellations.

In this operation method (1), position corrections were used. And a close check was enforced that the two receivers tracked the same satellites. The only significant error left will be the errors caused by the individual receivers themselves.

3. FIELD EQUIPMENT AND PROCEDURES

3.1. GPS receivers

The final positioning of "West-Vanguard" was done with two Trimble 4000SX receivers. The mobile receiver was placed in the rig wheelhouse, the second receiver was located as the reference station at Trondheim. This is 5 channel receiver with 16 bit processors capable of producing a fix every second based on 2, 3 or 4 satellites in the solution. The 2 satellites fixes requires fixed height and a stable clock. In this operation HP cesium clocks where used. The 5'th channel enables the receiver to acquire and track a satellite that is not used in the fix solution. Thus a continous position fixing can procede without interuptions due to new satellite acquisition.

3.2 Satellite coverage

During the operation the following satellites where used :

3 6 9 11 12 13

satellite 8 was declared unhealthy due to failures in the cesium clock, with the result that the onboard crystal clock is used as master. This gives the pseudorange random variables a sigma of 28 m, instead of the normal value of 3 m. Satellite 8 may be used in differential mode, but is not recommended. In this operation it operation it was not used.

The PDOP plots for the two coverage periods are shown in figure 3.1 and 3.2. The numerical values is given in table 3.1 and 3.2. This is for 3 and 4 satellite coverage with elevation mask of 10 degrees, conditions suitable for calibration and final positioning. Time is referred to GMT.

The morning period has generally high PDOP values and was not used for either calibration or final positioning. Only a short period of 30 min is useful for precise positioning.

The afternoon period from 14:30 to 19:30 has three periods with PDOP lower than 10 and stable conditions. The period used for final positioning was from 16:00 to 17:30. See figure 3.2.

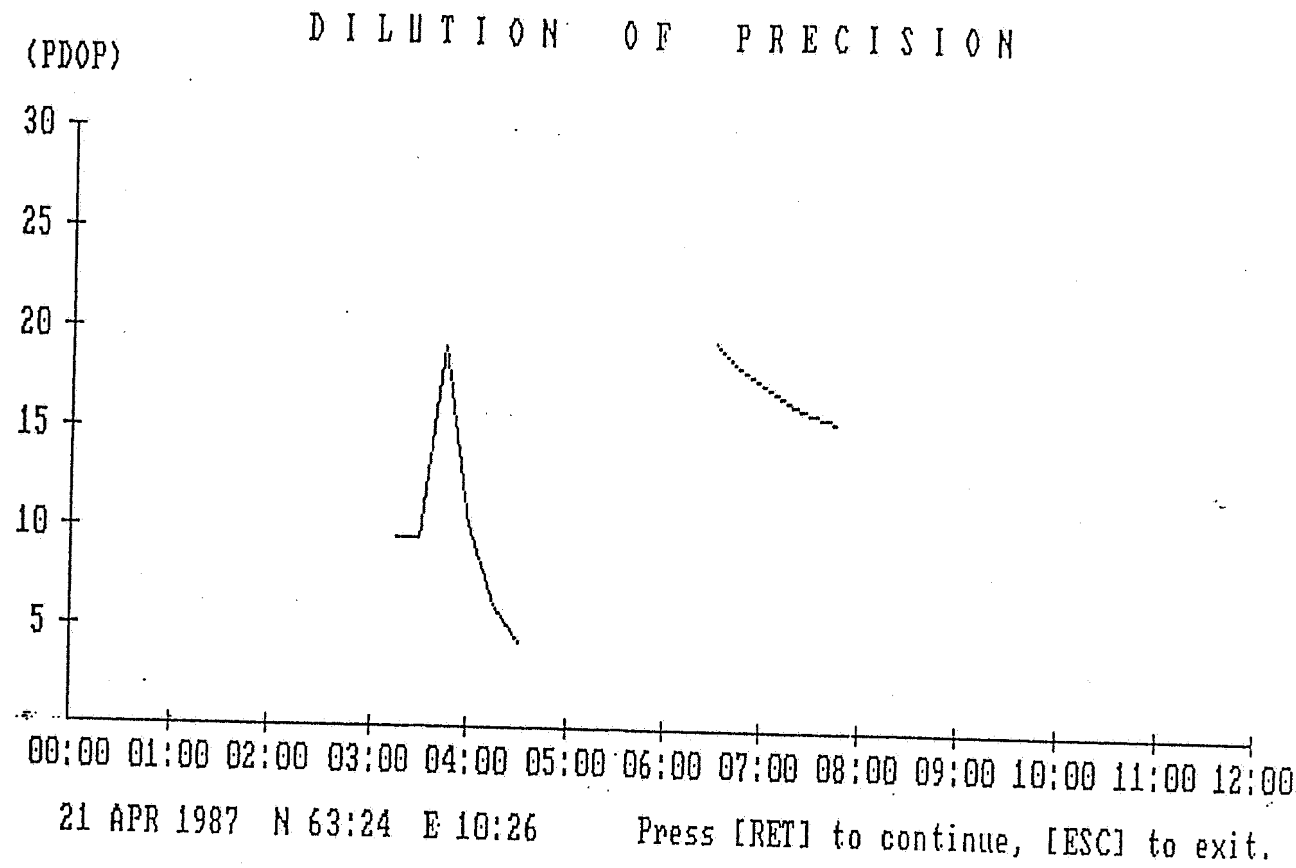


Figure 3.1 The morning period for 3 and 4 satellite coverage with elevation mask = 10 degrees.

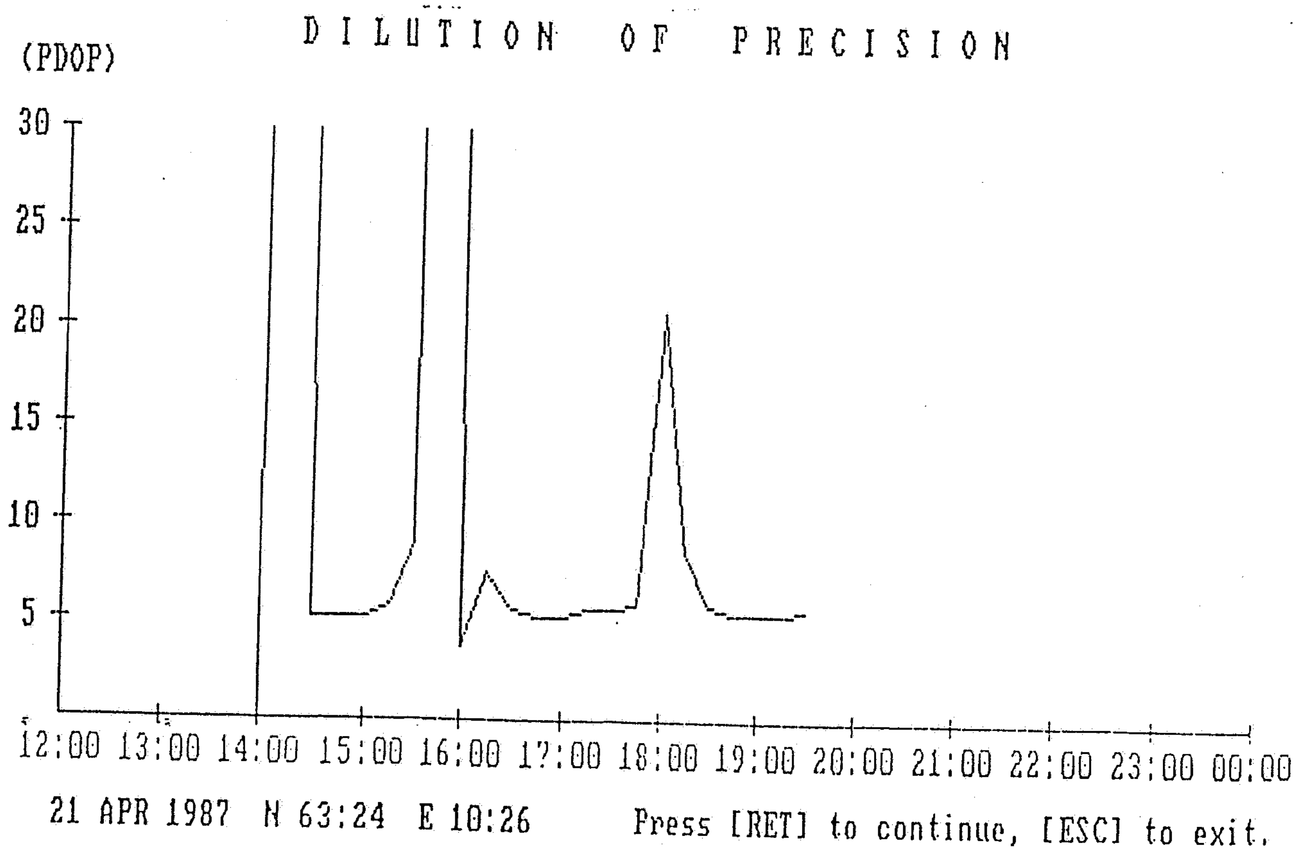


Figure 3.2 The afternoon period for 3 and 4 satellite coverage with elevation mask = 10 degrees.

AZIMUTH AND ELEVATION

Date for observation .... : 21 apr 1987
Observation position .... : N 63:24:42.5 E 10:26:45.6
Calculations based on data from file ... : c:1204-87.alm
Elevation mask (deg) .... : 10
No of sat's in PDOP calculations .... : 3 - 4

GMT/SAT	3	6	9	11	12	13	PDOP
12:00	0 0	211 43	0 0	0 0	0 0	0 0	
12:15	0 0	213 51	0 0	0 0	0 0	0 0	
12:30	0 0	215 59	226 11	0 0	0 0	0 0	
12:45	0 0	216 67	229 18	0 0	0 0	0 0	
13:00	0 0	214 75	232 25	0 0	0 0	0 0	
13:15	0 0	201 83	236 32	0 0	0 0	0 0	
13:30	0 0	114 85	239 39	0 0	0 0	0 0	
13:45	0 0	77 79	243 46	0 0	0 0	0 0	
14:00	0 0	73 71	247 54	0 0	0 0	0 0	
					Sat's in PDOP: 06-09-12		
14:15	0 0	73 63	251 62	0 0	252 14	0 0	8816.7
					Sat's in PDOP: 06-09-11-12		
14:30	0 0	76 56	255 70	117 14	255 21	0 0	5.5
14:45	0 0	78 49	260 78	114 20	259 27	0 0	5.3
15:00	0 0	81 41	270 85	110 26	262 34	0 0	5.3
15:15	0 0	85 34	75 85	105 32	266 41	0 0	5.9
15:30	0 0	88 28	85 78	99 38	269 48	0 0	9.1
15:45	0 0	92 21	90 70	92 42	273 55	0 0	418.1
					Sat's in PDOP: 06-09-12-13		
16:00	0 0	95 15	95 62	83 45	276 62	150 14	4.0
					Sat's in PDOP: 09-11-12-13		
16:15	0 0	0 0	99 55	72 46	278 70	148 21	7.6
					Sat's in PDOP: 03-09-11-12		
16:30	161 12	0 0	103 47	62 46	279 77	146 28	5.8
16:45	161 19	0 0	107 40	53 43	270 85	143 35	5.5
17:00	160 26	0 0	110 33	45 40	144 86	139 43	5.5
17:15	159 33	0 0	114 26	39 35	127 79	133 49	5.9
					Sat's in PDOP: 03-09-11-13		
17:30	157 41	0 0	117 20	35 29	127 71	125 55	5.9
17:45	153 48	0 0	121 13	32 23	129 63	113 59	6.0
					Sat's in PDOP: 03-11-12-13		
18:00	148 55	0 0	0 0	30 16	131 56	98 61	20.9
18:15	139 61	0 0	0 0	30 10	134 48	82 60	8.7
					Sat's in PDOP: 03-12-13		
18:30	124 66	0 0	0 0	0 0	137 41	69 57	6.0
18:45	105 68	0 0	0 0	0 0	140 34	60 52	5.7
19:00	85 66	0 0	0 0	0 0	142 27	54 46	5.6
19:15	70 62	0 0	0 0	0 0	145 20	51 39	5.6
19:30	62 56	0 0	0 0	0 0	147 13	49 33	5.7
19:45	57 49	0 0	0 0	0 0	0 0	49 26	
20:00	55 42	0 0	0 0	0 0	0 0	49 19	
20:15	54 35	0 0	0 0	0 0	0 0	50 13	

Tabel 3.1 Azimuth,elevation and PDOP for the morning period

A Z I M U T H   A N D   E L E V A T I O N

Date for observation .... : 21 apr 1987
Observation position .... : N 63:24:42.5 E 10:26:45.6
Calculations based on data from file ... : c:1204-87.alm
Elevation mask (deg) .... : 10
No of sat's in PDOP calculations .... : 3 - 4

GMT/SAT	3	6	9	11	12	13	PDOP
00:00	0 0	0 0	0 0	0 0	0 0	0 0	
00:15	0 0	0 0	0 0	0 0	0 0	0 0	
00:30	0 0	0 0	0 0	0 0	0 0	0 0	
00:45	0 0	0 0	0 0	0 0	0 0	0 0	
01:00	0 0	7 13	0 0	0 0	0 0	0 0	
01:15	0 0	3 18	0 0	0 0	0 0	0 0	
01:30	0 0	357 22	0 0	0 0	0 0	0 0	
01:45	0 0	350 25	0 0	0 0	0 0	0 0	
02:00	0 0	343 27	0 0	0 0	0 0	0 0	
02:15	0 0	335 27	23 13	0 0	0 0	0 0	
02:30	0 0	328 26	18 17	0 0	0 0	0 0	
02:45	0 0	320 23	11 21	0 0	0 0	0 0	
03:00	0 0	314 20	4 23	0 0	0 0	0 0	
					Sat's in PDOP: 06-09-12		
03:15	0 0	309 15	357 24	0 0	44 11	0 0	9.7
03:30	0 0	304 10	349 24	0 0	39 16	0 0	9.6
					Sat's in PDOP: 09-11-12		
03:45	0 0	0 0	342 22	316 13	33 20	0 0	19.2
04:00	0 0	0 0	335 19	317 19	27 23	0 0	10.3
04:15	0 0	0 0	330 15	317 25	20 24	0 0	6.4
04:30	0 0	0 0	325 10	315 32	12 25	0 0	4.5
04:45	0 0	0 0	0 0	313 38	5 24	0 0	
05:00	0 0	0 0	0 0	308 44	358 22	0 0	
05:15	0 0	0 0	0 0	301 49	353 18	0 0	
05:30	0 0	0 0	0 0	292 53	348 14	0 0	
05:45	0 0	0 0	0 0	279 56	0 0	336 10	
06:00	0 0	0 0	0 0	266 55	0 0	334 16	
06:15	0 0	0 0	0 0	253 53	0 0	332 22	
					Sat's in PDOP: 03-11-13		
06:30	343 11	0 0	0 0	243 48	0 0	328 28	19.6
06:45	341 17	0 0	0 0	236 43	0 0	323 33	18.5
07:00	337 23	0 0	0 0	230 36	0 0	316 37	17.6
07:15	333 28	0 0	0 0	226 29	0 0	308 40	16.8
07:30	327 32	0 0	0 0	223 22	0 0	299 41	16.2
07:45	319 35	0 0	0 0	221 15	0 0	289 41	15.7
08:00	311 37	0 0	0 0	0 0	0 0	280 38	
08:15	301 37	0 0	0 0	0 0	0 0	272 35	
08:30	292 36	0 0	0 0	0 0	0 0	266 30	
08:45	284 33	0 0	0 0	0 0	0 0	260 25	
09:00	277 28	0 0	0 0	0 0	0 0	256 19	
09:15	271 23	0 0	0 0	0 0	0 0	253 12	
09:30	267 17	0 0	0 0	0 0	0 0	0 0	
09:45	263 11	0 0	0 0	0 0	0 0	0 0	

Tabel 3.2 Azimuth,elevation and PDOP for the afternoon period

3.2 LORAN-C

3.2.1 Receiver

A Loran-C receiver of the type Racal-Mega Pulse 520 was used. This receiver can be utilized both in hyperbolic or in range mode. The range mode requires a stable clock. In this operation HP-cesium clocks was used.

3.2.2 Chain configuration

The North-Atlantic Loran-C chain with the master at Færøyene was used. This consist of:

Master - Færøene
SLX - Bø
SLY - Sylt
SLW - Sandur
SLZ - Jan Mayen

For the operations from westcoast of Norway to Haltenbanken the useable station where:

Master - Færøyene
SLX - Bø
SLZ - Jan Mayen

Occationly SLW - Sandur could be acquired, but not with any stability.

In range mode, the angel of cut between the three LOP's would be 66, 79 and 145. This gives an acceptable geometry and stable fixes.

3.3.3 Operation together with GPS

In range mode the receiver will calculate the difference from a clock determined reference time to the detection time for each loran-c signal. Thus there is no absolute determination of propagation time. Also this derived "pseudorange" drift with time as determined by the referenceclock. The Loran-C receiver behaves like the GPS with an unknown clockbias.

In this operation GPS was used to calibrate the Loran-C by determining this clockbias during periods with good GPS conditions. In periods without GPS Loran-C provided a continous position reference. Thus the two systems where complementary and gave an ecellent integrated system.

3.3 Computer

An HP 9000 Model 300 computer was used for reading the data from the Trimble and the Loran.C for processing and presentation on board the rig. The computer installation is specified in Appendix B. The same set-up was used at the reference station, except no Loran-C receiver was installed.

3.4. Software

The software was written espescially for this operation and consisted of a GPS differential part and a Loran-C positioning part.Then an integration part compared the two when GPS was operating.

Either GPS or Loran-C could be used as reference. When GPS was reference the C-O values for each Loran-C range was computed for each fix. By this way a direct comparison could be made during sailing. After calibration of Loran-C to GPS the C-O values should be 0.0 in average. Also the sigma value of the 3-way Loran-C fix should be small. These two conditions was then used by the operator to control the quality of the Loran-C in range mode.

GPS quality control was mainly established by monitoring the system performance at the reference station. Identical programs run at the reference station and at the mobile station. The user just defines himself as either reference or mobile at start-up.
To summarize the software package contains the following processing steps;

INTEGRATION part

* Get reference system position GPS or Loran-C
* Compute range and bearing to target position and anchors
* Compute ranges to the Loran-C stations and compare with obseved values. Compute the C-O.
* Display graphic picture on system console
* Hard-copy graphic and alphanumeric information on printer
* Log data on diskette for post-processing

GPS part

- Read output from Trimble 4000SX
- Datum shift WGS84 to ED50
- Conversion to UTM coordinates
- Filter data by Kalman or exponential filter
- Compensate for antenna offset
- Apply differential corrections

LORAN-C part

- Read range data from the receiver RMP-520
- Compute 3-way fix and fix statistics
- Datum shift to ED-50
- Calculate theoretical ranges based on GPS positions

3.4. Datum shift on location

The Trimble 4000SX outputs its position in geocentric lat,lon and height coordinates using the WGS84 datum.

Transformation from WGS-84 to ED-50 is carried out in several steps, this is because there exsist no official transformation parameters directly between the two. The steps are:

1. From WGS-84 Lat,Lon,Hei to WGS-84 geocentric X,Y,Z

2. From WGS-84 X,Y,Z to WGS-72 X,Y,Z by the transformation:

$$\Delta X = 0$$
$$\Delta Y = 0$$
$$\Delta Z = 4.5 \text{ m}$$
$$rX = 0$$
$$rY = 0$$
$$rZ = 0.554''$$
$$k = 0.2263E-6$$

The constants need reversed signs for WGS-84 to WGS-72.

3. From WGS-72 to NSWC9Z-2 (Transit Precise Ephemeris) by the Seppelin transformation:

$$Lat_{PE} = Lat_{WGS} + 0.0232'' \cdot \sin(2 \cdot Lat_{WGS})$$

$$Lon_{PE} = Lon_{WGS} - 0.26''$$

$$Hei_{PE} = Hei_{WGS} - 4.73 + 0.717 \cdot \sin^2(Lat_{WGS})$$

4. From NSWC9Z-2 to ED-50 by the 6 nation agreement parameters:

ΔX = 89.5
ΔY = 93.8
ΔZ = 127.6
rX = 0.0
rY = 0.0
rZ = 0.97"
k = -1.8E-6

3.5. Reference station

The reference station was located at Trondheim had the following coordinates:

In ED50 coordinates

Lat.	63° 24′ 42.506″
Lon.	10° 26′ 45.693″
Height	139.7m

In UTM coordinates zone 33

Northing	7032460.06
Easting	572210.29

The shift to ED-50 was performed similar to the procedure described in paragraph 3.5

3.6. Use of differential corrections during operation

The GPS data on the reference was read and presented as diffrences correction in northing and easting. No filtering was applied.

The differential corrections were printed, and logged on magnetic medium, and used for the postprocessing.

The operator at the reference station supplied differential correction to the rig via radiotelephone about every 1/2 hour during periods of calibration or during the final positioning with four satellites. The software in the mobile station accepts differential corrections from the operator's keyboard. These corrections were applied to the on-line presentation, but were not applied to the data logged on magnetic medium on the rig.

For calibration of Loran-C the corrections were applied to the on-board GPS data, and these datasets were converted to Loran-C computed ranges. Comparison with Loran-C observed data gave the C-O values. These values were entered into the software and Loran-C ranges was corrected for the C-O.

4. POST-PROCESSING

Post-processing included in this report refers only to the GPS data. It is outside the scope to investigate the Loran-C data.

The GPS data was post-processed by the Seatex software; Sea-plot.The data processing is very similar to what is done in the field, but a more comprehensive check is done on data quality during this phase.

The main processing steps are;

* Compare satellite track at mobile and reference
* Editing raw data in WGS84, if necessary
* Datum shift to ED-50
* Filter reference data if necessary
* Apply differential corrections for each sample
* Generate corrected GPS data for the rig
* Compute stastistics and plots
* Correction for antenna offset
* Derive final rig position for drillcenter
* Graphical and alphanumerical presentation

4.1 Satellite conditions on-board

The rig had completed the anchorhandling and final tensioning on the 21.4.87 and the final positioning was then performed during the afternoon period for GPS which gave the best coverage.

The general quality of the GPS data at the rig was determined by the tracking stability. The receiver was operated in 4 satellite mode. At numerous occations track of one satellite was lost and the receiver continued on three satellite fixing until it reaquired the fourth satellite. The result of this behaviour is jumps of 3 to 10 meters in position, mainly in east-west direction as satellite number 9 was in azimut 110 degrees.

Careful investigation of the on-board conditions was necessary before selecting the periods used for final positioning.Based on tabel 4.1 three periods where selected to compute corrected GPS data for the final position. One period with a constant 4 satellites tracking situation and two periods with change between 3 and 4 satellite tracking. This only applies for the rig, on the reference 4 satellites where tracked continously.The raw data from the rig can be examined on the figures 4.1.1, 4.2.1 and 4.3.1. Where 4.1.1 refers to period 1, 4.2.1 refers to period 2 etc.

Tabel 4.1 Observations avaiable for final positioning

"West Vanguard"			Reference station		
From	To	Satellites	From	To	Satellites
16:38	16:42	3 9 11 12	16:38	17:00	3 9 11 12
16:47	17:00	3 9 11 12			
17:16	17:22	3 9 11 12	17:00	17:22	3 9 11 12
17:22	17:24	3 9 11 13	17:22	17:57	3 9 11 13
17:24	17:33	3 11 13			
17:33	17:47	3 9 11 13			
18:04	18:40	3 11 12 13	17:58	18:12	3 11 12 13
18:41	18:53	3 12 13	18:12	19:35	3 12 13

The selected period were:

<u>Period 1: 21 April</u>

"West Vanguard"			Reference station		
From	To	Satellites	From	To	Satellites
16:38	16:42	3 9 11 12	16:38	16:42	3 9 11 12

During this period no dropouts occurred.

Period 2: 21 April

"West Vanguard"			Reference station		
From	To	Satellites	From	To	Satellites
16:47	16:59	3 9 11 12	16:47	16:59	3 9 11 12

During this period the receiver at the rig had satellite changes in that satellite 9 would dropout occationly.

Period 3: 21 April

"West Vanguard"			Reference station		
From	To	Satellites	From	To	Satellites
17:16	17:21	3 9 11 12	17:16	17:21	3 9 11 13

A shift between 3 and 4 satellites occur 17:16:30 as seen on figure 4.3.1

4.2 Satellite condition at reference station

The objective of using a reference station is twofolded. One provide correction data to the mobile user, and by monitoring the GPS position the field operator evaluate the instantaneous performance of GPS.

The reference station data for the 21.4.87 is seen on figure 4.2.1, 4.2.2 and 4.3.2 as the offset from the true position as a function of time for the 3 selected periods.

To summarize the mean and std.dev for each period tabel 4.2 is given.

Tabel 4.2; The overall offset from true position is:

Period		Position offset		Std dev.	
	Duration	North	East	North	East
1	4 min	-1.0	+3.4	0.6	0.3
2	12 min	-0.2	+1.4	0.1	0.6
3	4 min	-0.9	-0.2	0.1	0.3

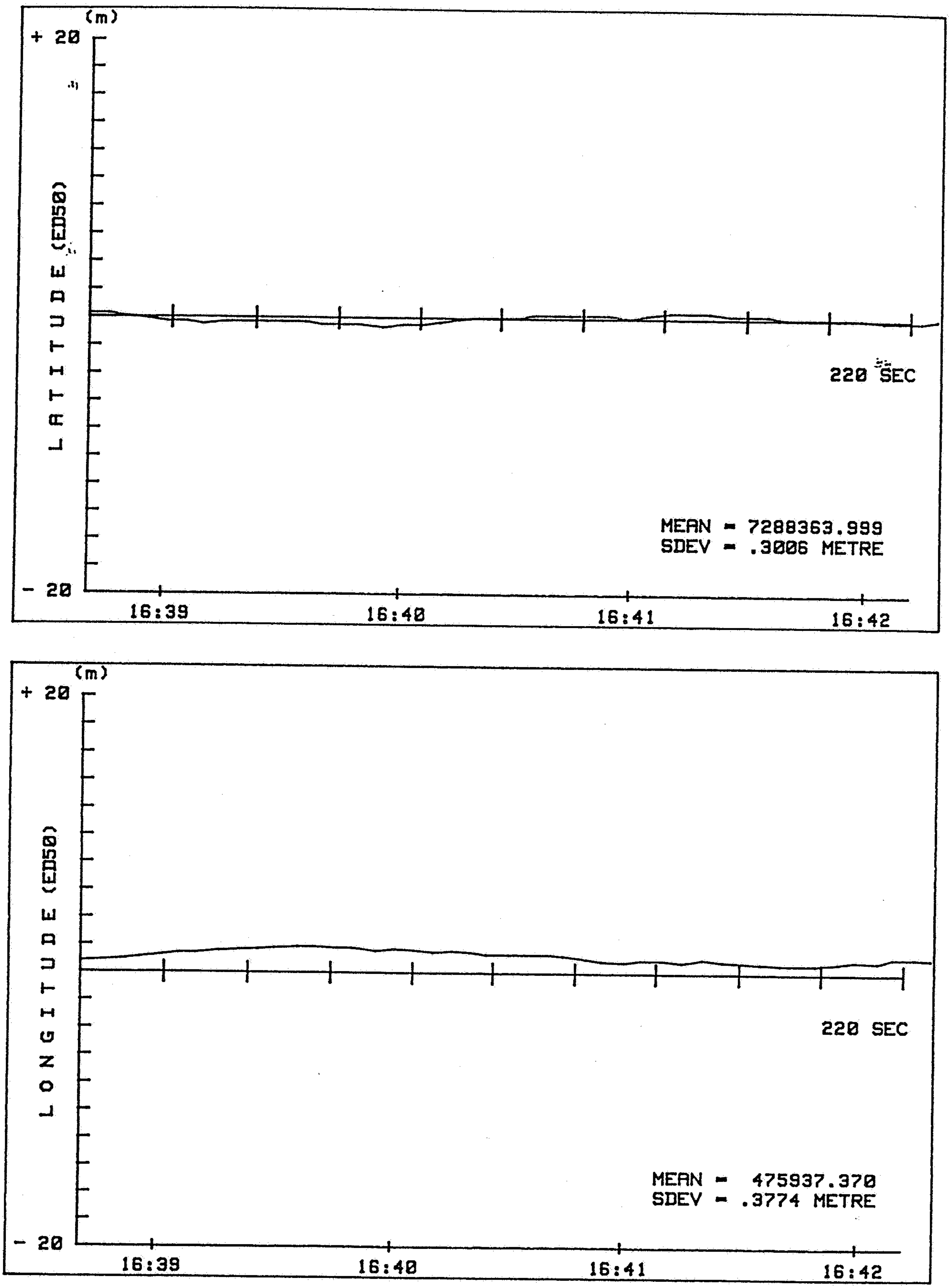
The results can be summarized to:

i) Only small shifts are seen in mean offsets.

ii) The std.dev variations are small indicating low noise and excellent GPS conditions.

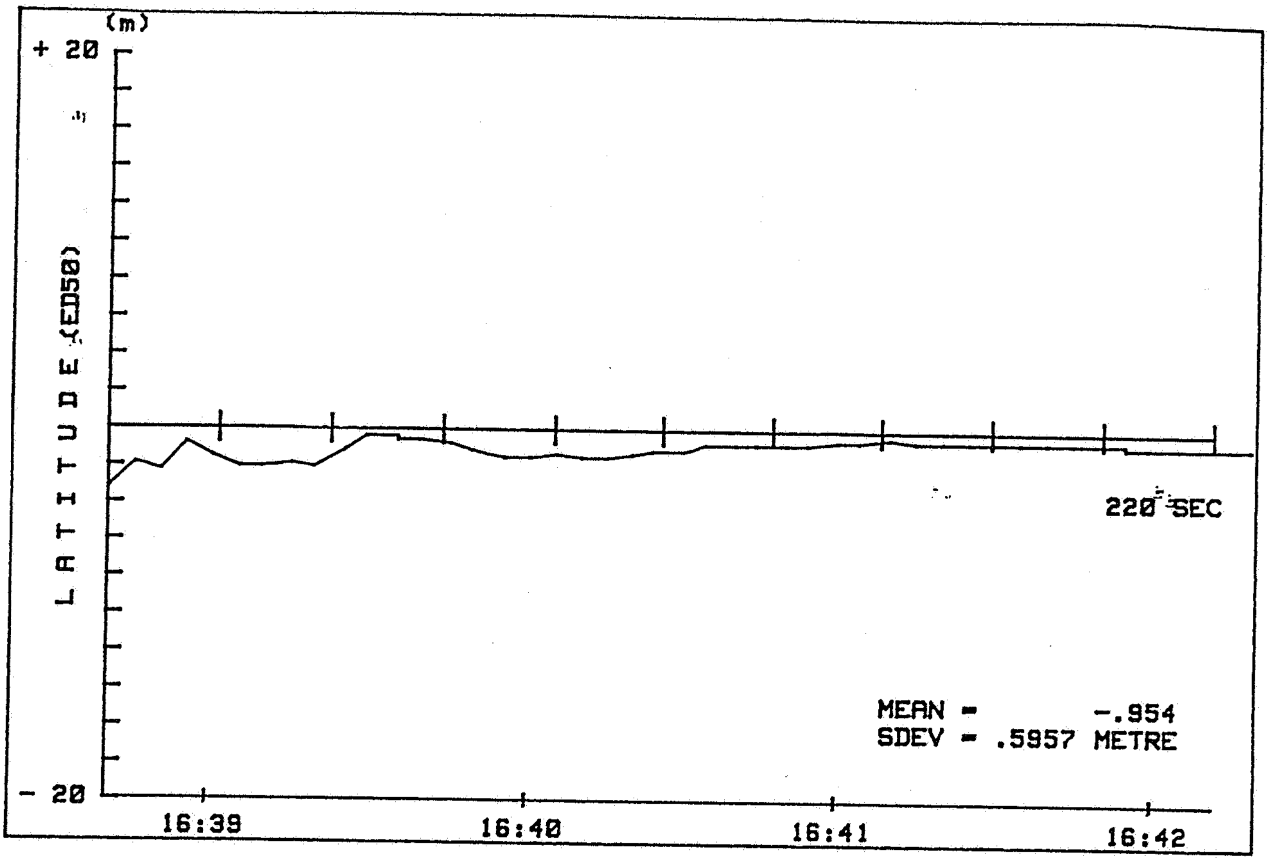
iii) No change in conditions are seen as a function of observation intervall length

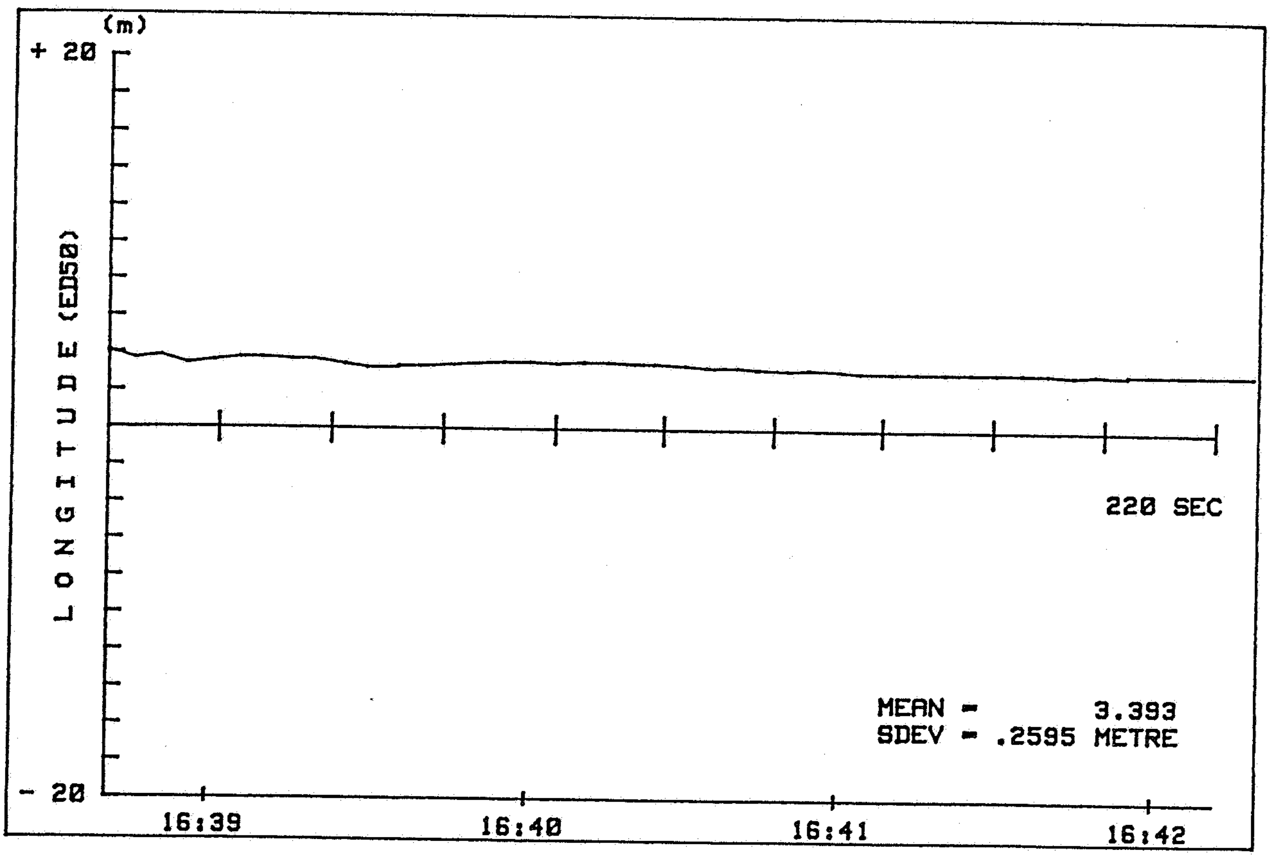
Period 1
16:38 to 16:43



WEST VANGUARD
WITHOUT CORRECTIONS
SAT 3-9-11-12
16:38:41 - 16:42:20 21 Apr 1987

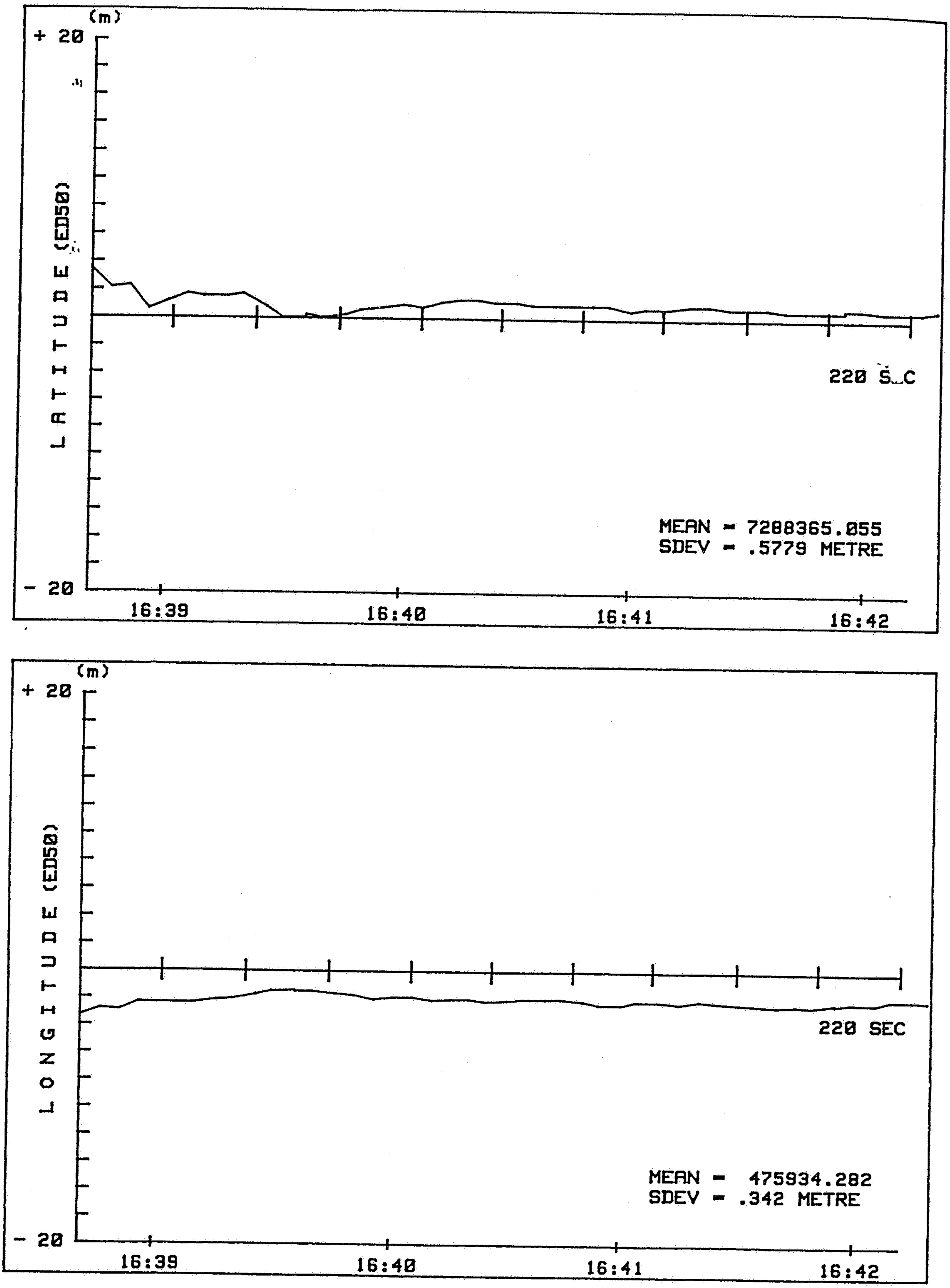
Figure 4.1.1 West Vanguard uncorrected for period 1





CORRECTIONS FROM
SEATEX A/S
SAT 3-9-11-12
16:38:41 - 16:42:20   21 Apr 1987

Figure 4.1.2 Reference station for period 1



WEST VANGUARD
CORRECTED WITH
DATA FROM SEATEX A/
SAT 3-9-11-12
16:38:41 - 16:42:20 21 Apr 1987

Figure 4.1.3 West Vanguard corrected with reference station period 1

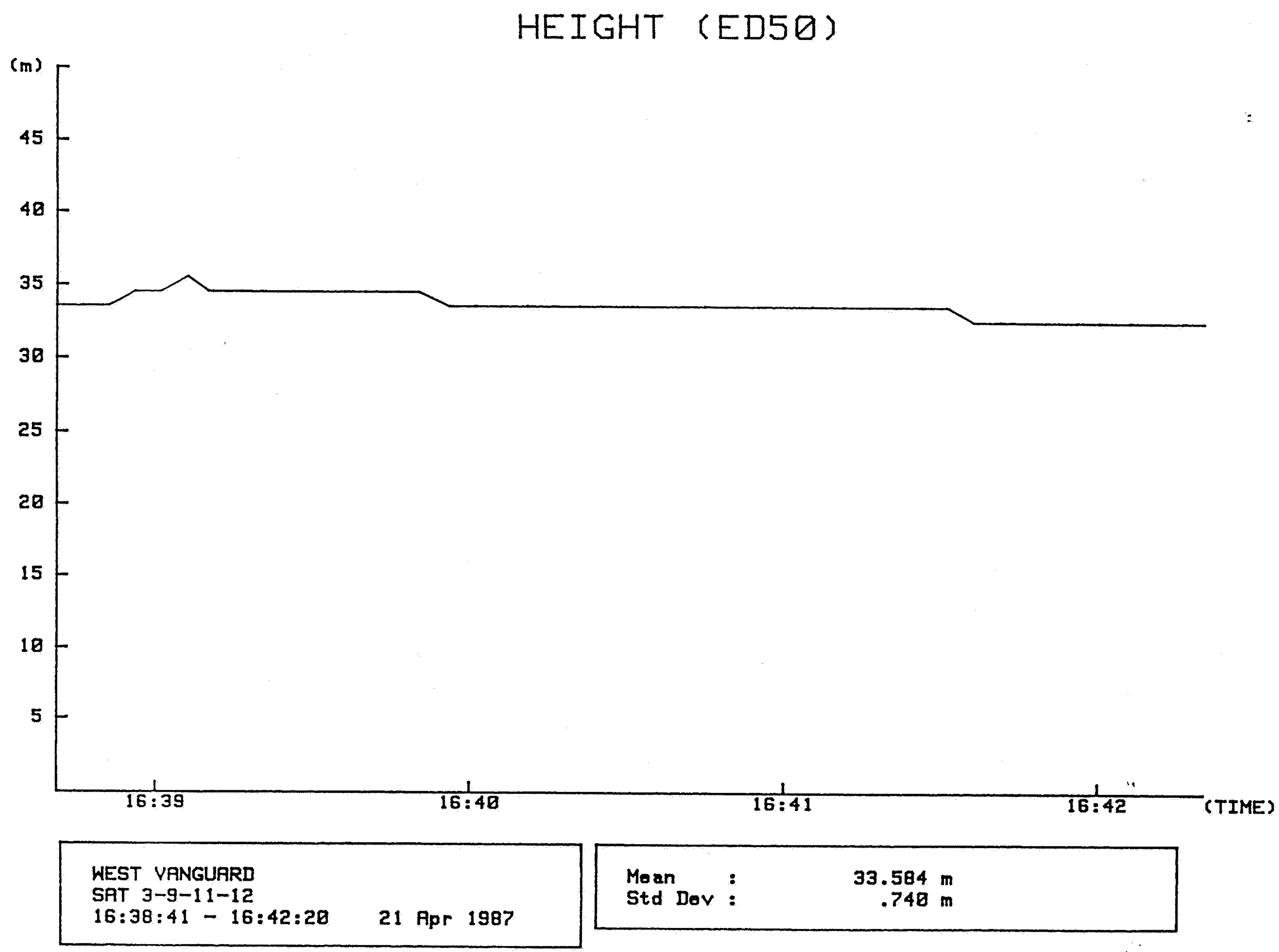


Figure 4.1.4 Height variation at West Vanguard for period 1

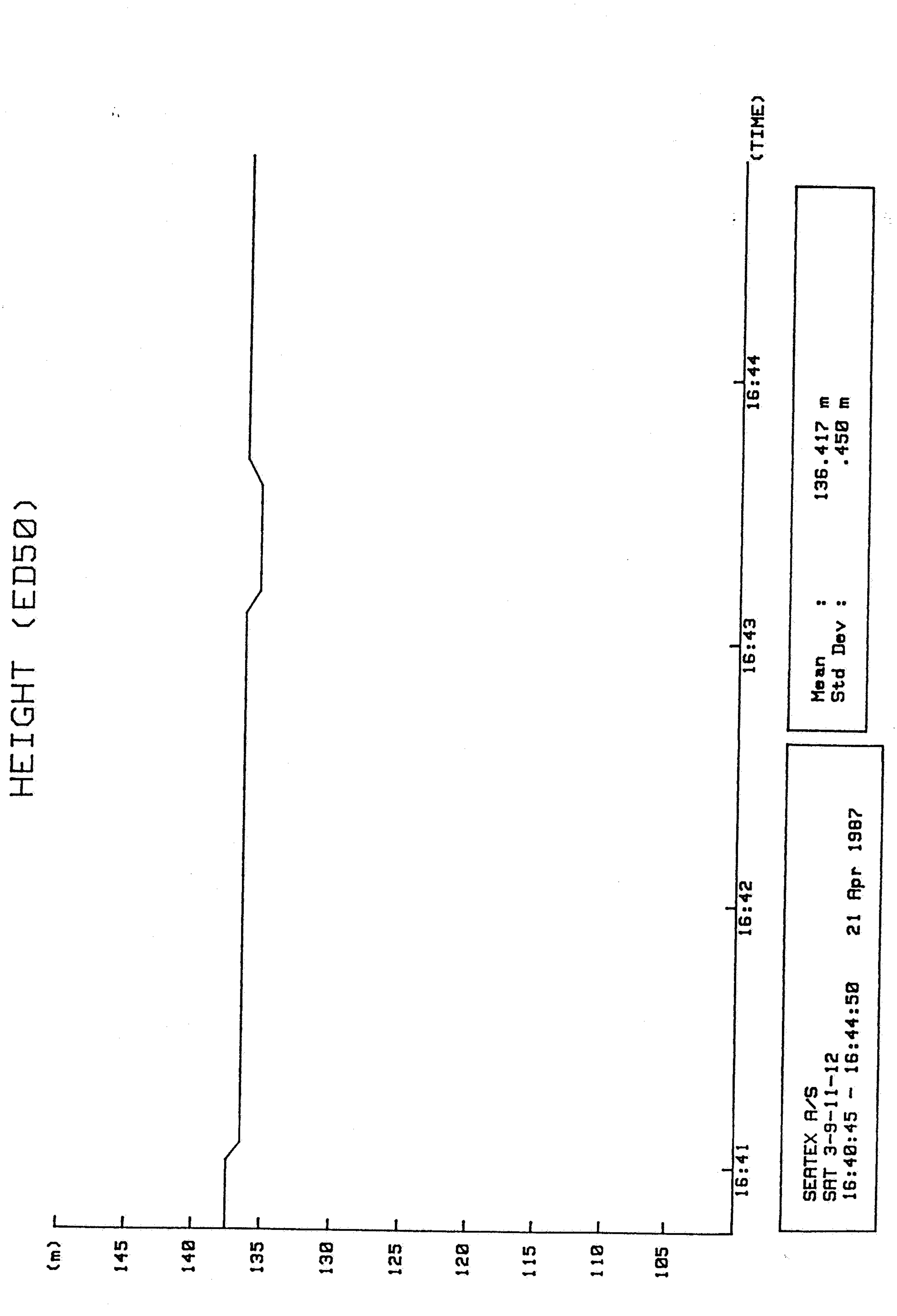


Figure 4.1.5 Height variations at reference for period 1

WEST VANGUARD 21 Apr 1987

Records in interval [50]
Sampling every [1] record
Mobile receiver

Statistics every [10] sample
Time [16:38:41 - 16:42:20]

L A T I T U D E (ED50)

TIME	GEOGRAPHIC MEAN	UTM MEAN	SDEV(m)	MAX(m)	MIN(m)
16:39	65:42:51.928	7288363.9	.3	.2	-.5
16:40	65:42:51.919	7288363.6	.1	-.3	-.7
16:40	65:42:51.937	7288364.1	.2	.2	-.3
16:41	65:42:51.943	7288364.3	.1	.4	0.0
16:42	65:42:51.934	7288364.0	.1	0.0	-.1
RESULT	65:42:51.932	7288364.0	.3	.4	-.7

L O N G I T U D E (ED50)

TIME	GEOGRAPHIC MEAN	UTM MEAN	SDEV(m)	MAX(m)	MIN(m)
16:39	8:28:32.551	475937.4	.3	1.7	.8
16:40	8:28:32.588	475937.9	.1	1.9	1.5
16:40	8:28:32.557	475937.5	.2	1.6	1.0
16:41	8:28:32.521	475937.0	.1	1.0	.7
16:42	8:28:32.521	475937.0	.2	1.2	.6
RESULT	8:28:32.548	~475937.4	.4	1.9	.6

Tabel 4.1.1 West Vanguard without corrctions for period 1

SEATEX A/S 21 Apr 1987

Records in interval [50]
Sampling every [1] record
Reference receiver

Statistics every [10] sample
Time [16:38:41 - 16:42:20]

L A T I T U D E (ED50)
Reference : 63:24:42.508

TIME	GEOGRAPHIC MEAN	UTM MEAN	SDEV(m)	MAX(m)	MIN(m)
16:39	0:00:00.061	-1.8	.7	-.7	-3.1
16:40	0:00:00.031	-.9	.5	-.3	-1.4
16:40	0:00:00.034	-1.0	.3	-.7	-1.4
16:41	0:00:00.019	-.5	.1	-.3	-.7
16:42	0:00:00.022	-.6	1	-.5	-.7
RESULT	0:00:00.033	-1.0	.6	-.3	-3.1

L O N G I T U D E (ED50)
Reference : 10:26:45.693

TIME	GEOGRAPHIC MEAN	UTM MEAN	SDEV(m)	MAX(m)	MIN(m)
16:39	0:00:00.268	3.8	.2	4.1	3.5
16:40	0:00:00.250	3.5	.1	3.6	3.3
16:40	0:00:00.247	3.4	.1	3.6	3.2
16:41	0:00:00.227	3.2	.1	3.3	3.1
16:42	0:00:00.224	3.1	0.0	3.1	3.1
RESULT	0:00:00.243	3.4	.3	4.1	3.1

Tabel 4.1.2 Reference station for period 1

WEST VANGUARD   21 Apr 1987

Records in interval [50]   Statistics every [10] samples
Sampling every [1] record   Time [16:38:41 - 16:42:20]
Mobile receiver corrected with reference receiver

L A T I T U D E (ED50)

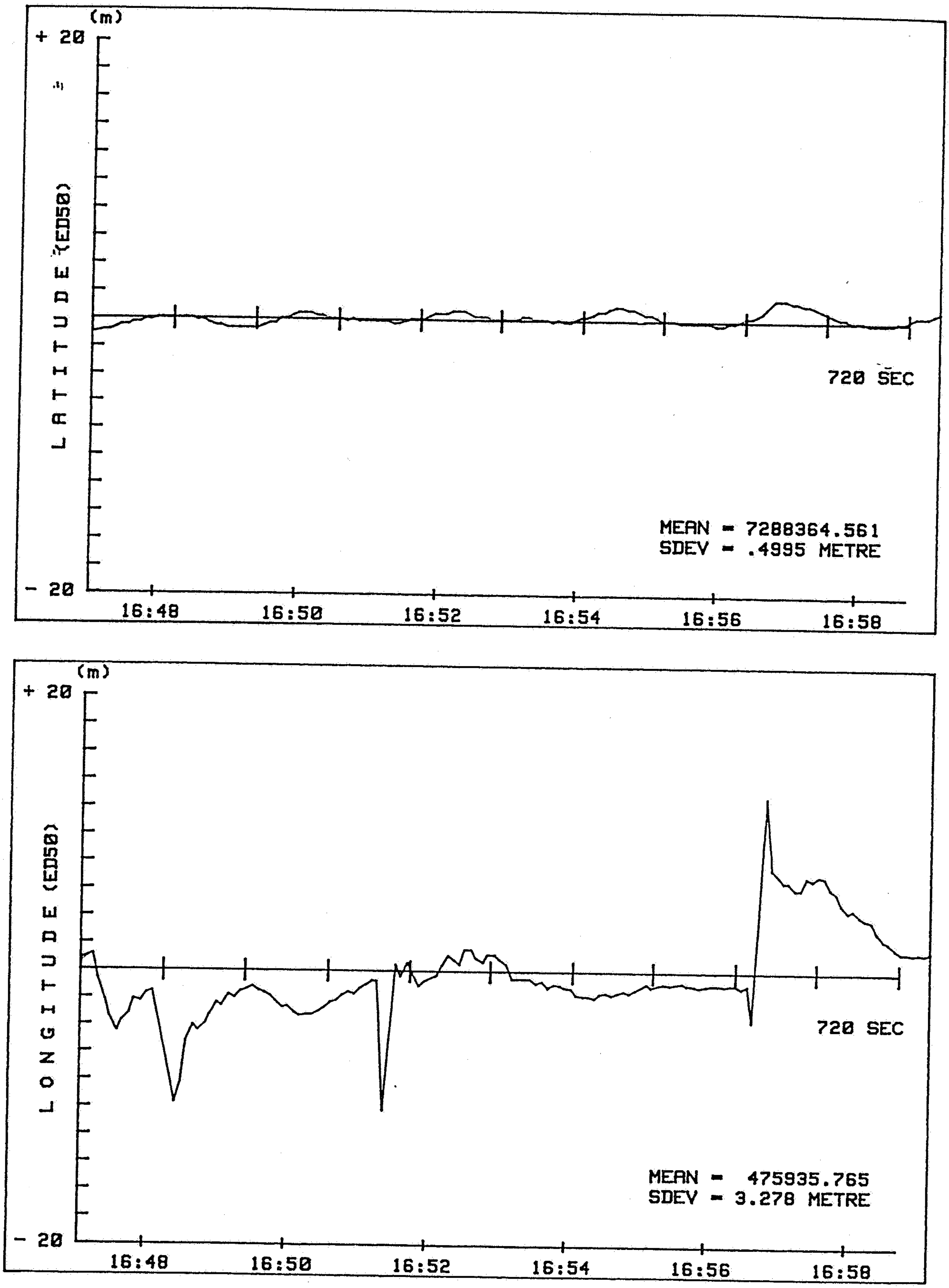
TIME	GEOGRAPHIC MEAN	UTM MEAN	SDEV(m)	MAX(m)	MIN(m)
16:39	65:42:51.989	7288365.8	.8	3.4	.7
16:40	65:42:51.951	7288364.6	.4	1.2	.1
16:40	65:42:51.970	7288365.2	.2	1.4	1.0
16:41	65:42:51.962	7288364.9	.1	1.0	.6
16:42	65:42:51.956	7288364.8	.1	.8	.6
RESULT	65:42:51.966	7288365.1	.6	3.4	.1

L O N G I T U D E (ED50)

TIME	GEOGRAPHIC MEAN	UTM MEAN	SDEV(m)	MAX(m)	MIN(m)
16:39	8:28:32.283	475934.0	.4	-1.4	-3.0
16:40	8:28:32.338	475934.7	.2	-1.1	-1.8
16:40	8:28:32.310	475934.4	.1	-1.7	-1.9
16:41	8:28:32.294	475934.1	.1	-1.8	-2.1
16:42	8:28:32.297	475934.2	.2	-1.7	-2.2
RESULT	8:28:32.305	475934.3	.3	-1.1	-3.0

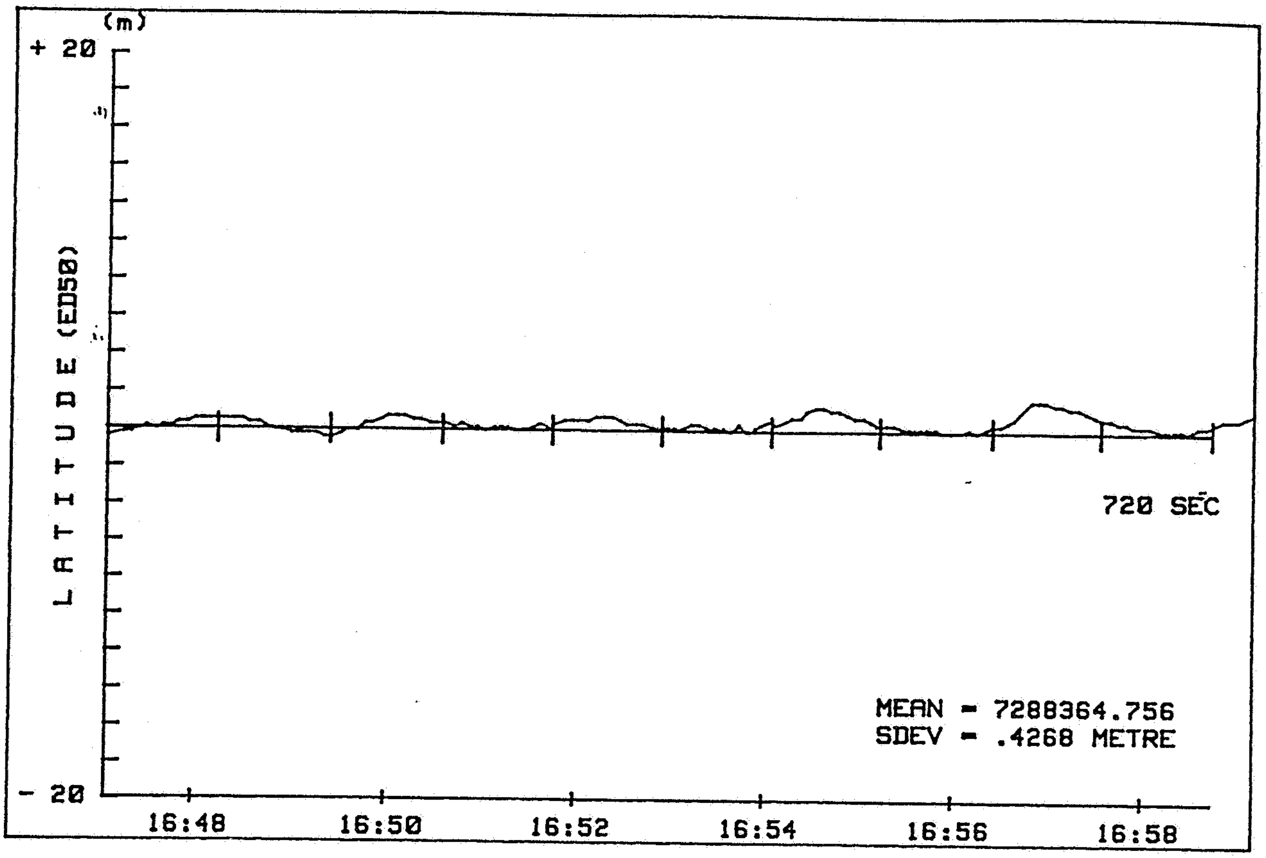
Tabel 4.1.3 West Vanguard corrected with reference station for period 1

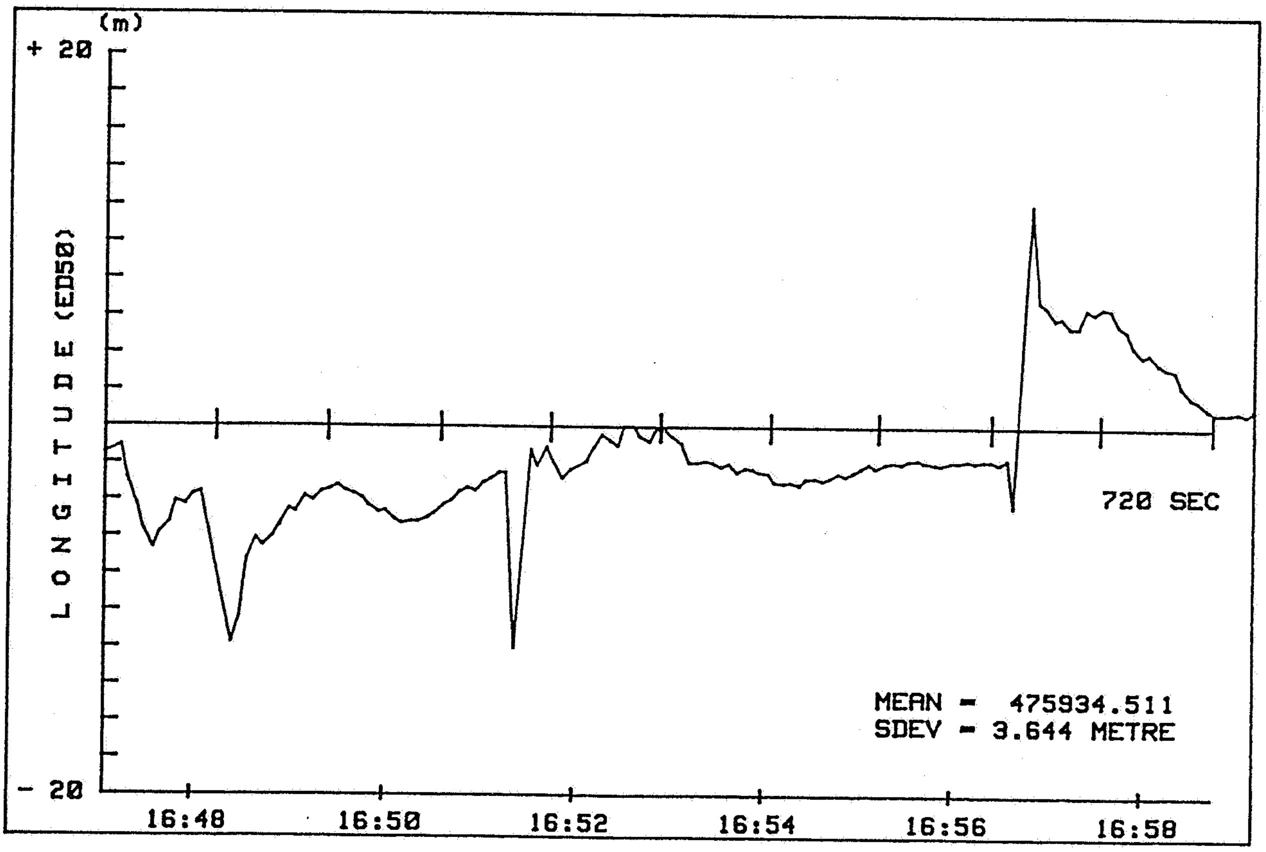
Period 2
16:47 to 17:00



WEST VANGUARD
WITHOUT CORRECTIONS
SAT 3-9-11-12
16:47:06 - 16:59:11   21 Apr 1987

Figure 4.2.1 West Vanguard uncorrected for period 2





WEST VANGUARD
CORRECTED WITH
DATA FROM SEATEX
SAT 3-9-11-12
16:47:06 - 16:59:11 21 Apr 1987

Figure 4.2.3 West Vanguard corrected with reference station period 2

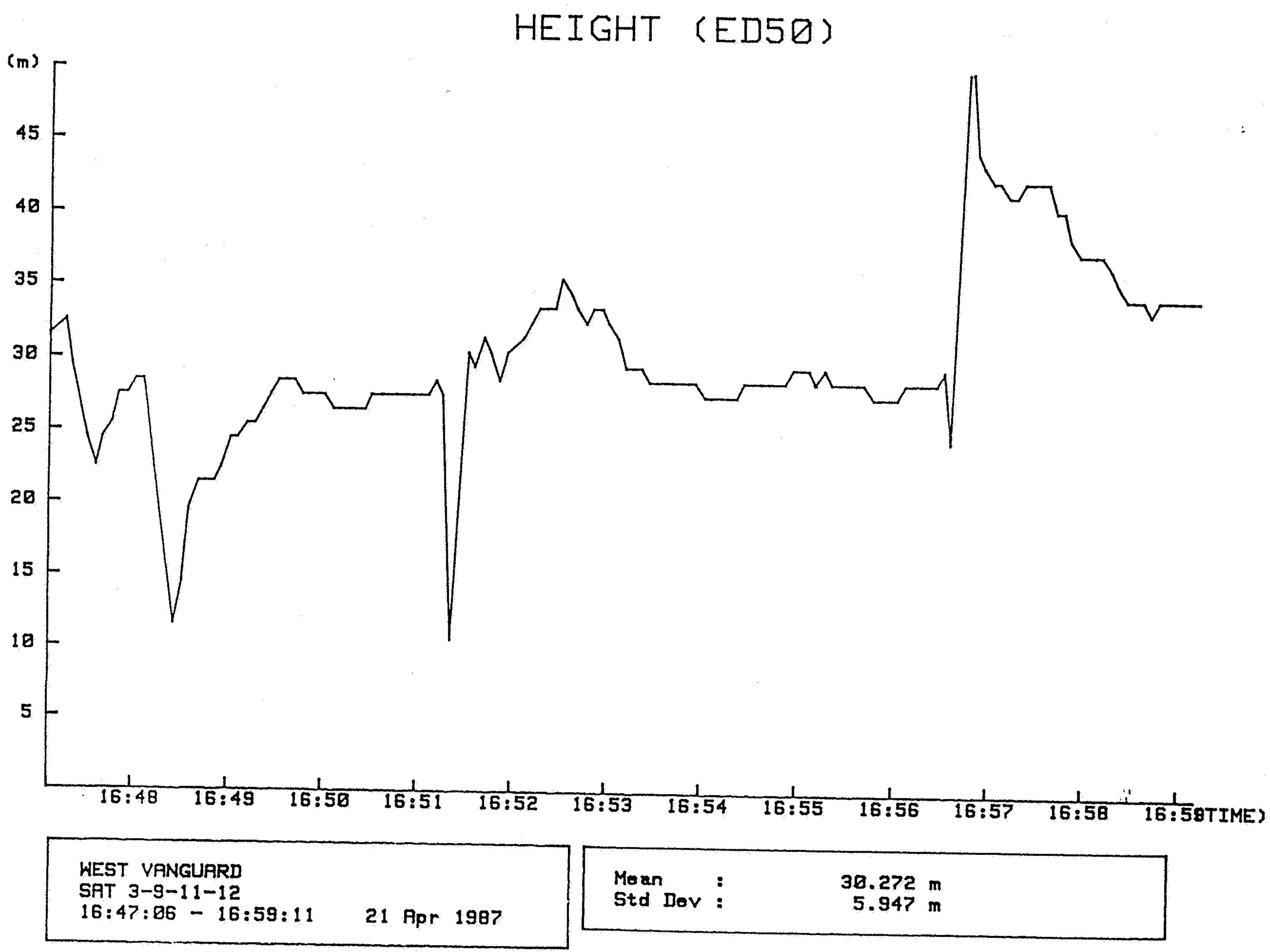
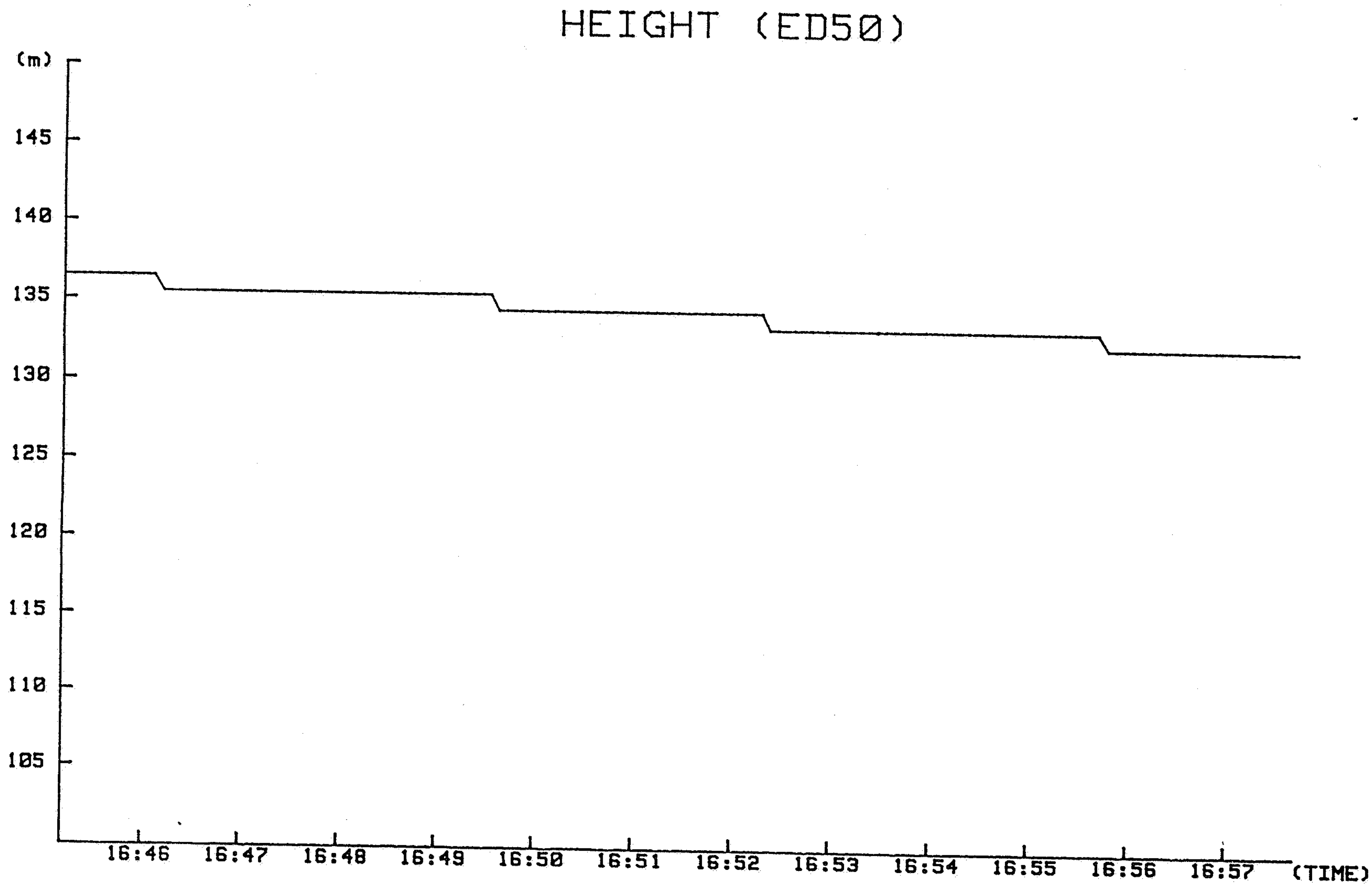


Figure 4.2.4 Height variation at West Vanguard for period 2



SEATEX A/S
SAT 3-9-11-12
16:45:10 - 16:57:41   21 Apr 1987

Mean : 134.298 m
Std Dev : 1.217 m

Figure 4.2.5 Height variations for reference for period 2

WEST VANGUARD   21 Apr 1987

Records in interval [151]
Sampling every [1] record
Mobile receiver

Statistics every [10] sample
Time [16:47:06 - 16:59:11]

L A T I T U D E (ED50)

TIME	GEOGRAPHIC MEAN	UTM MEAN	SDEV(m)	MAX(m)	MIN(m)
16:47	65:42:51.926	7288363.8	.3	-.1	-1.0
16:48	65:42:51.941	7288364.3	.2	.1	-.4
16:49	65:42:51.927	7288363.9	.2	-.3	-.6
16:50	65:42:51.954	7288364.7	.2	.5	.1
16:51	65:42:51.944	7288364.4	.1	.1	-.1
16:52	65:42:51.949	7288364.5	.3	.5	-.2
16:52	65:42:51.956	7288364.7	.2	.6	.1
1[illegible]53	65:42:51.949	7288364.5	.1	.3	-.1
16:54	65:42:51.954	7288364.7	.3	.8	-.1
16:55	65:42:51.964	7288365.0	.3	1.0	.1
16:55	65:42:51.942	7288364.3	.1	.1	-.3
16:56	65:42:51.959	7288364.8	.7	1.5	-.2
16:57	65:42:51.981	7288365.5	.4	1.5	.4
16:58	65:42:51.946	7288364.4	.2	.2	-.1
16:59	65:42:51.958	7288364.8	.3	.8	-.1
RESULT	65:42:51.950	7288364.6	.5	1.5	-1.0

L O N G I T U D E (ED50)

TIME	GEOGRAPHIC MEAN	UTM MEAN	SDEV(m)	MAX(m)	MIN(m)
16:47	8:28:32.292	475934.1	2.0	1.1	-4.5
16:48	8:28:32.088	475931.5	2.7	-1.5	-9.7
16:49	8:28:32.286	475934.0	.7	-1.2	-3.3
16:50	8:28:32.215	475933.1	.5	-1.8	-3.3
1[illegible]1	8:28:32.304	475934.3	.6	-.7	-2.8
.6:52	8:28:32.336	475934.7	3.2	.6	-10.3
.6:52	8:28:32.517	475937.0	.4	1.6	.5
6:53	8:28:32.406	475935.6	.6	.9	-1.2
6:54	8:28:32.326	475934.6	.4	-.9	-1.9
6:55	8:28:32.332	475934.6	.3	-.8	-1.7
6:55	8:28:32:365	475935.1	.1	-.8	-1.1
6:56	8:28:32.515	475937.0	5.1	12.9	-3.6
6:57	8:28:32.970	475942.8	.4	7.3	6.1
6:58	8:28:32.794	475940.5	.9	6.2	3.1
6:59	8:28:32.572	475937.7	.4	2.4	1.4
ESULT	8:28:32.421	475935.8	3.3	12.9	-10.3

Tabel 4.2.1 West Vanguard without corrctions for period 2

SEATEX A/S 21 Apr 1987

Records in interval [151]
Sampling every [1] record
Reference receiver

Statistics every [10] sample
Time [16:47:06 - 16:59:11]

L A T I T U D E (ED50)
Reference : 63:24:42.508

TIME	GEOGRAPHIC MEAN	UTM MEAN	SDEV(m)	MAX(m)	MIN(m)
16:47	0:00:00.016	-.5	.1	-.3	-.5
16:48	0:00:00.013	-.3	0.0	-.3	-.3
16:49	0:00:00.010	-.3	.1	-.2	-.3
16:50	0:00:00.007	-.2	0.0	-.2	-.3
16:51	0:00:00.006	-.1	.1	0.0	-.2
16:52	0:00:00.004	-.1	.1	0.0	-.2
16:52	0:00:00.001	0.0	0.0	0.0	-.2
16:53	0:00:00.001	-0.0	.1	0.0	0.0
16:54	0:00:00.003	-.1	.1	0.0	-.2
16:55	0:00:00.007	-.2	0.0	0.0	-.2
16:55	0:00:00.006	-.2	.1	-.2	-.2
16:56	0:00:00.002	-0.0	.1	0.0	-.2
16:57	0:00:00.001	-0.0	.1	0.0	-.2
16:58	0:00:00.007	-.2	0.0	-0.0	-.2
16:59	0:00:00.007	-.2	0.0	-.2	-.2
RESULT	0:00:00.006	-.2	.1	0.0	-.5

L O N G I T U D E (ED50)
Reference : 10:26:45.693

TIME	GEOGRAPHIC MEAN	UTM MEAN	SDEV(m)	MAX(m)	MIN(m)
16:47	0:00:00.153	2.1	.1	2.3	2.0
16:48	0:00:00.147	2.0	0.0	2.1	2.0
16:49	0:00:00.148	2.1	0.0	2.1	2.0
16:50	0:00:00.142	2.0	0.0	2.0	2.0
16:51	0:00:00.132	1.8	.1	2.0	1.8
16:52	0:00:00.121	1.7	.1	1.8	1.5
16:52	0:00:00.107	1.5	.1	1.5	1.4
16:53	0:00:00.096	1.3	0.0	1.4	1.3
16:54	0:00:00.091	1.3	0.0	1.3	1.2
16:55	0:00:00.083	1.1	0.0	1.2	1.1
16:55	0:00:00.070	1.0	.1	1.0	.9
16:56	0:00:00.059	.8	.1	1.0	.7
16:57	0:00:00.043	.6	.1	.7	.5
16:58	0:00:00.042	.6	.1	.7	.5
16:59	0:00:00.044	.6	.1	.7	.5
RESULT	0:00:00.098	1.4	.6	2.3	.5

Tabel 4.2.2 Reference station for period 2

WEST VANGUARD 21 Apr 1987

Records in interval [151]
Statistics every [10] sample
Sampling every [1] record
Time [16:47:06 - 16:59:11]
Mobile receiver corrected with reference receiver

L A T I T U D E (ED50)

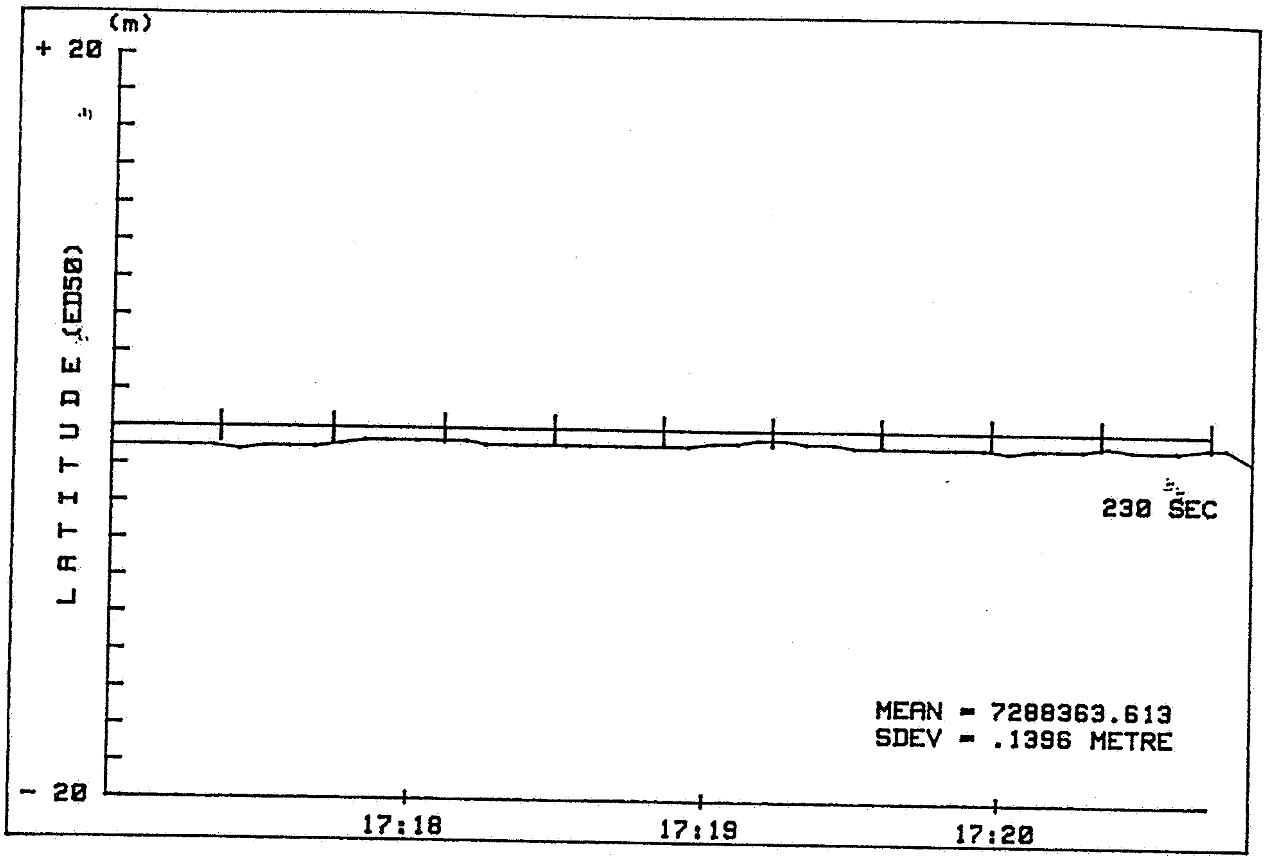
TIME	GEOGRAPHIC MEAN	UTM MEAN	SDEV(m)	MAX(m)	MIN(m)
16:47	65:42:51.942	7288364.3	.2	.3	-.4
16:48	65:42:51.954	7288364.7	.2	.5	0.0
16:49	65:42:51.937	7288364.2	.1	-0.0	-.4
16:50	65:42:51.961	7288364.9	.2	.7	.3
16:51	65:42:51.950	7288364.6	.1	.3	-0.0
16:52	65:42:51.954	7288364.7	.2	.5	0.0
16:52	65:42:51.957	7288364.8	.2	.7	.1
16:53	65:42:51.950	7288364.6	.1	.3	-0.0
16:54	65:42:51.957	7288364.8	.4	1.1	-0.0
16:55	65:42:51.971	7288365.2	.3	1.2	.3
16:55	65:42:51.948	7288364.5	.1	.3	-.1
16:56	65:42:51.961	7288364.9	.6	1.5	-0.0
16:57	65:42:51.982	7288365.5	.4	1.5	.6
16:58	65:42:51.952	7288364.6	.2	.4	.1
16:59	65:42:51.964	7288365.0	.3	1.0	.1
RESULT	65:42:51.956	7288364.8	.4	1.5	-.4

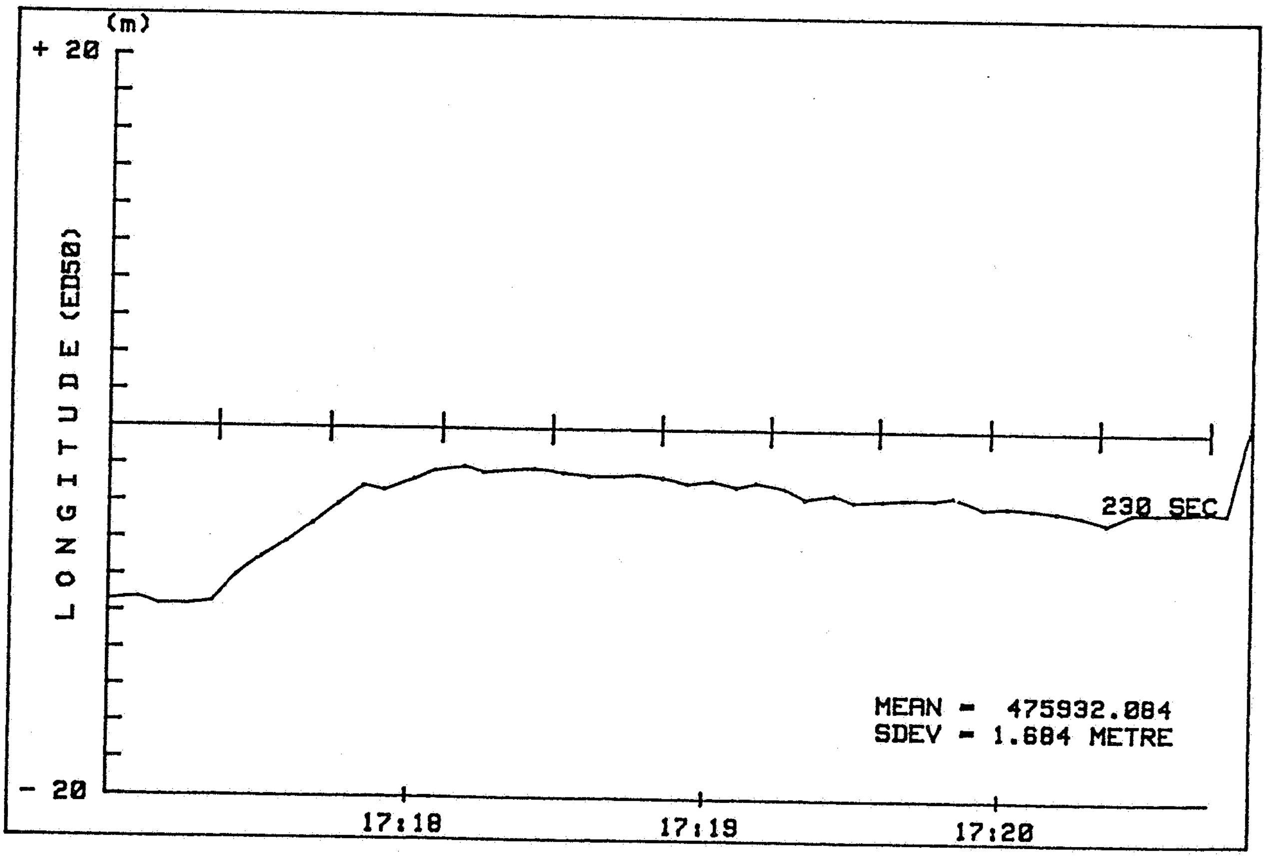
L O N G I T U D E (ED50)

TIME	GEOGRAPHIC MEAN	UTM MEAN	SDEV(m)	MAX(m)	MIN(m)
16:47	8:28:32.138	475932.2	1.9	-.9	-6.5
16:48	8:28:31.941	475929.6	2.7	-3.4	-11.6
16:49	8:28:32.138	475932.2	.7	-3.0	-5.2
16:50	8:28:32.073	475931.3	.5	-3.7	-5.1
16:51	8:28:32.172	475932.6	.7	-2.3	-4.6
16:52	8:28:32.215	475933.1	3.2	-1.0	-11.9
:6:52	8:28:32.410	475935.6	.4	.2	-1.0
.6:53	8:28:32.309	475934.3	.6	-.3	-2.3
.6:54	8:28:32.235	475933.4	.4	-2.1	-3.0
6:55	8:28:32.250	475933.6	.3	-1.9	-2.8
6:55	8:28:32.295	475934.2	.1	-1.6	-2.0
6:56	8:28:32.457	475936.2	5.1	12.2	-4.3
6:57	8:28:32.927	475942.2	.4	6.7	5.5
6:58	8:28:32.751	475940.0	1.0	5.7	2.4
6:59	8:28:32.528	475937.1	.3	1.8	.9
ESULT	8:28:32.323	475934.5	3.6	12.2	-11.9

Tabel 4.2.3 West Vanguard corrected with reference station for period 2

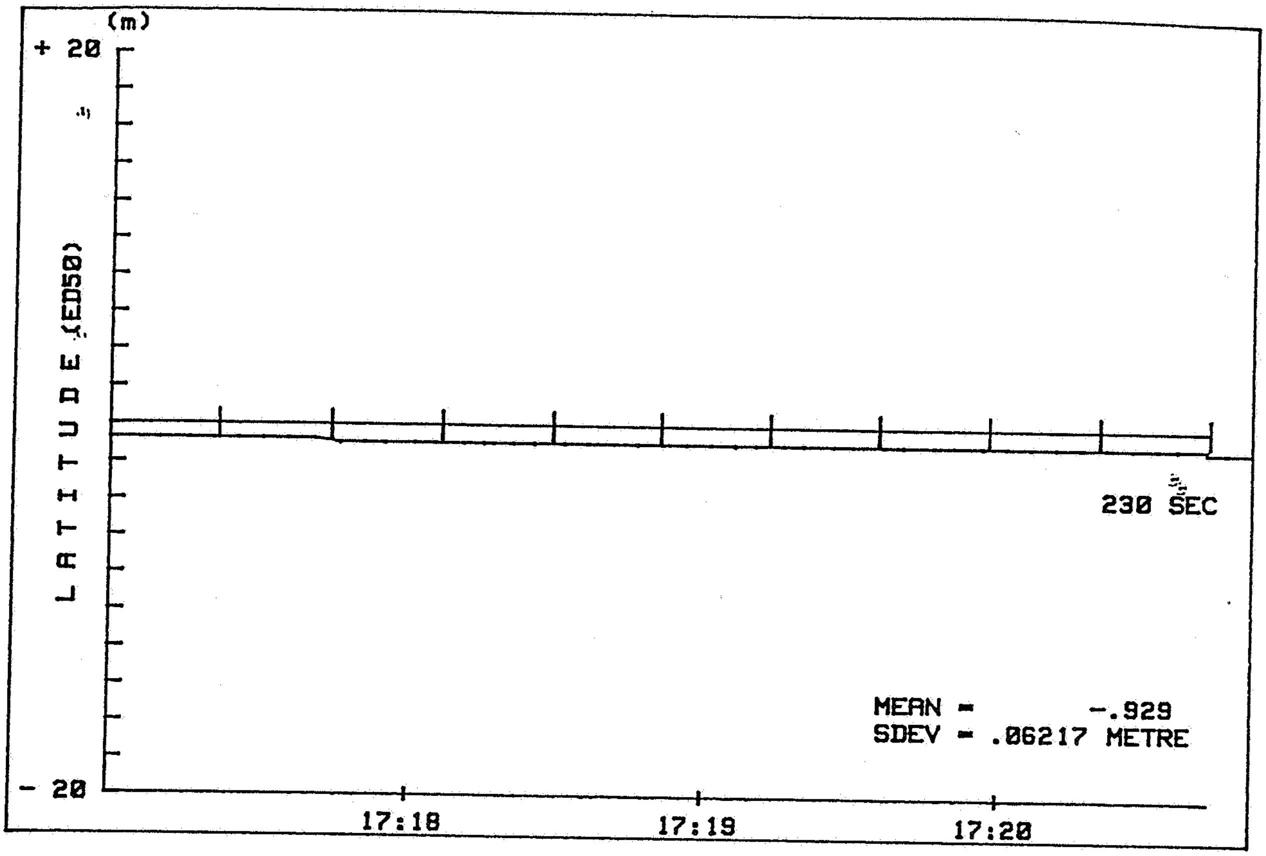
Period 3
17:17 to 17:21

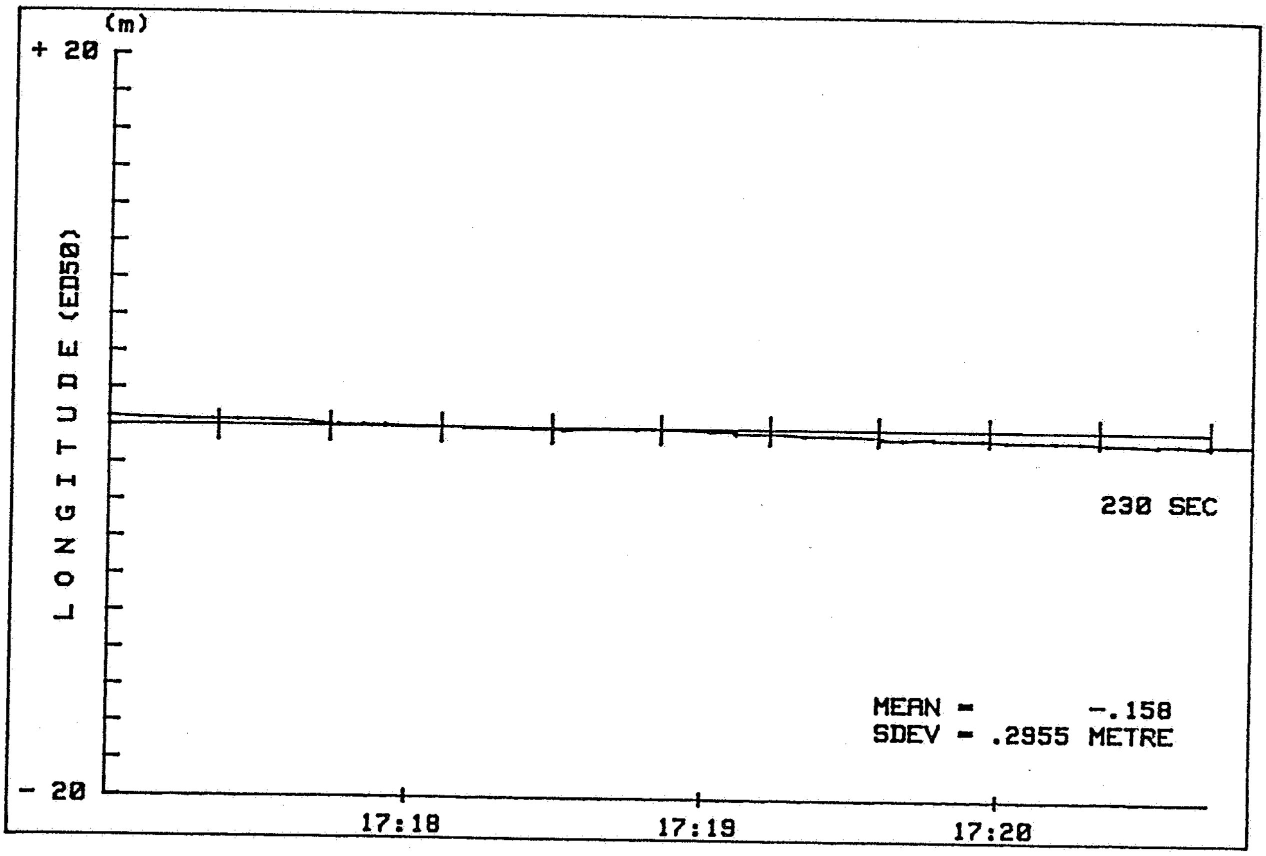




WEST VANGUARD
WITHOUT CORRECTIONS
SAT 3-9-11-12
17:17:00 - 17:20:51 21 Apr 1987

Figure 4.3.1 West Vanguard uncorrected for period 3





CORRECTIONS FROM
SEATEX A/S
SAT 3-9-11-12
17:17:00 - 17:20:51 21 Apr 1987

Figure 4.3.2 Reference station for period 3

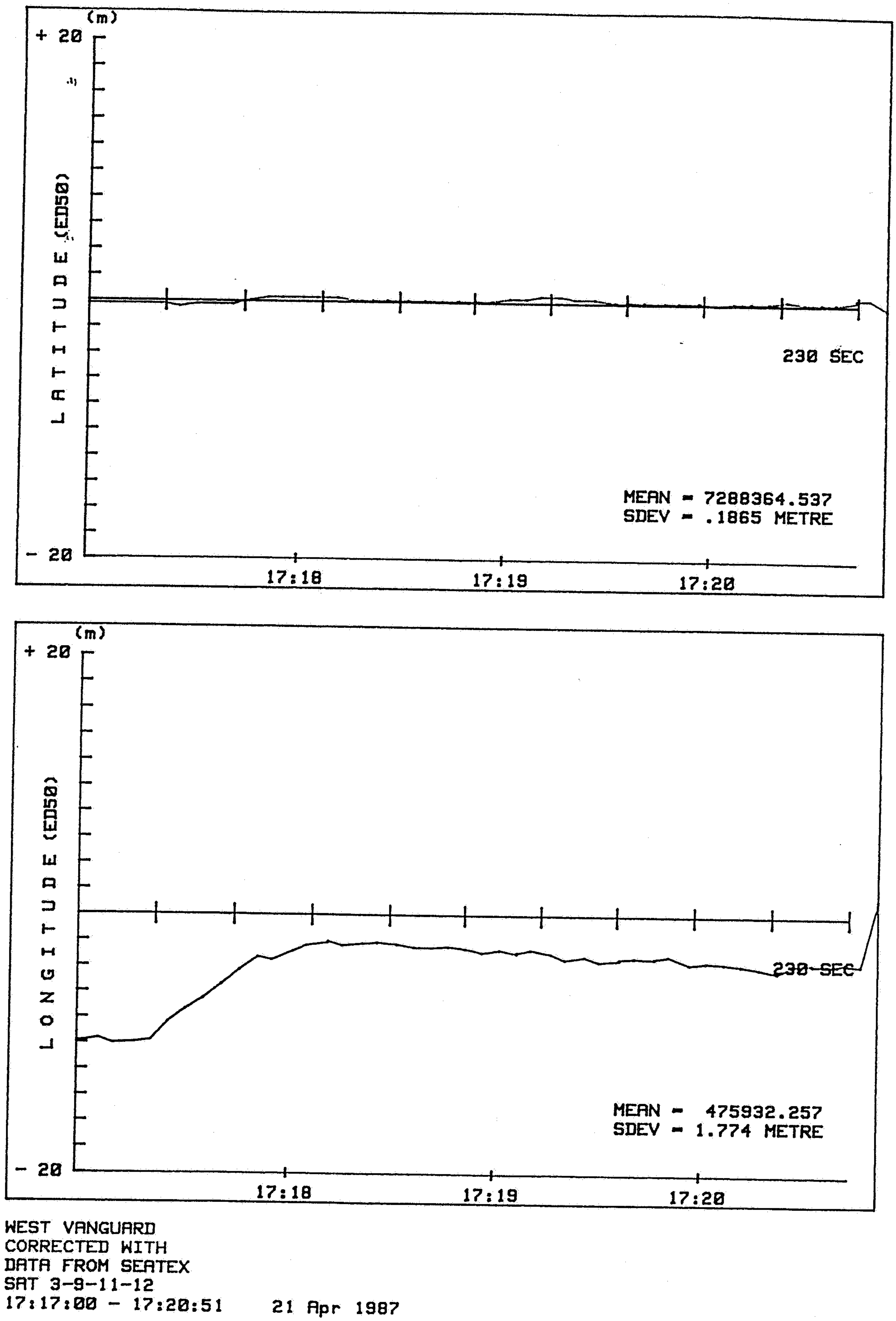


Figure 4.3.3 West Vanguard corrected with reference station period 3

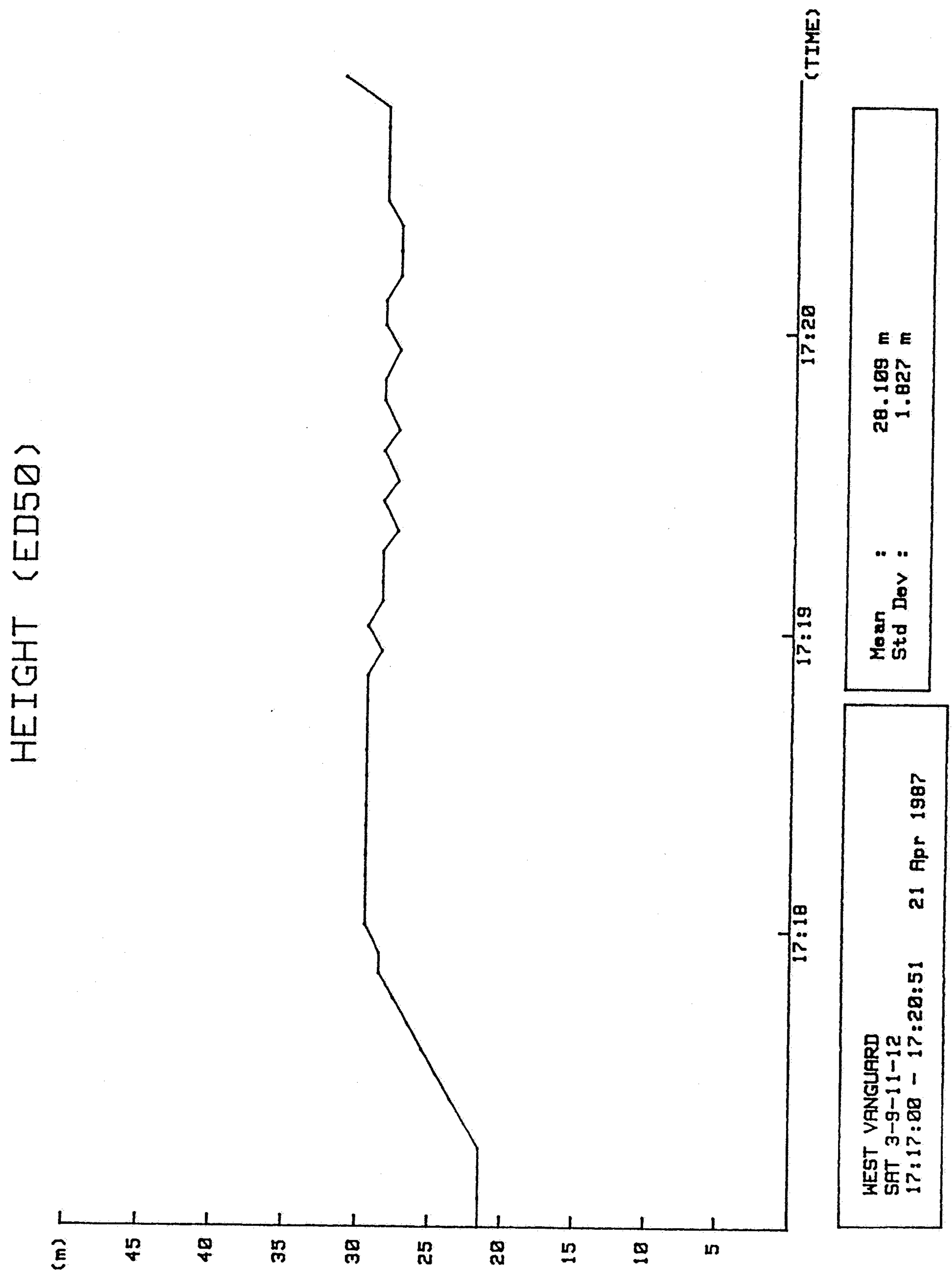


Figure 4.3.4 Height variation at West Vanguard for period 3

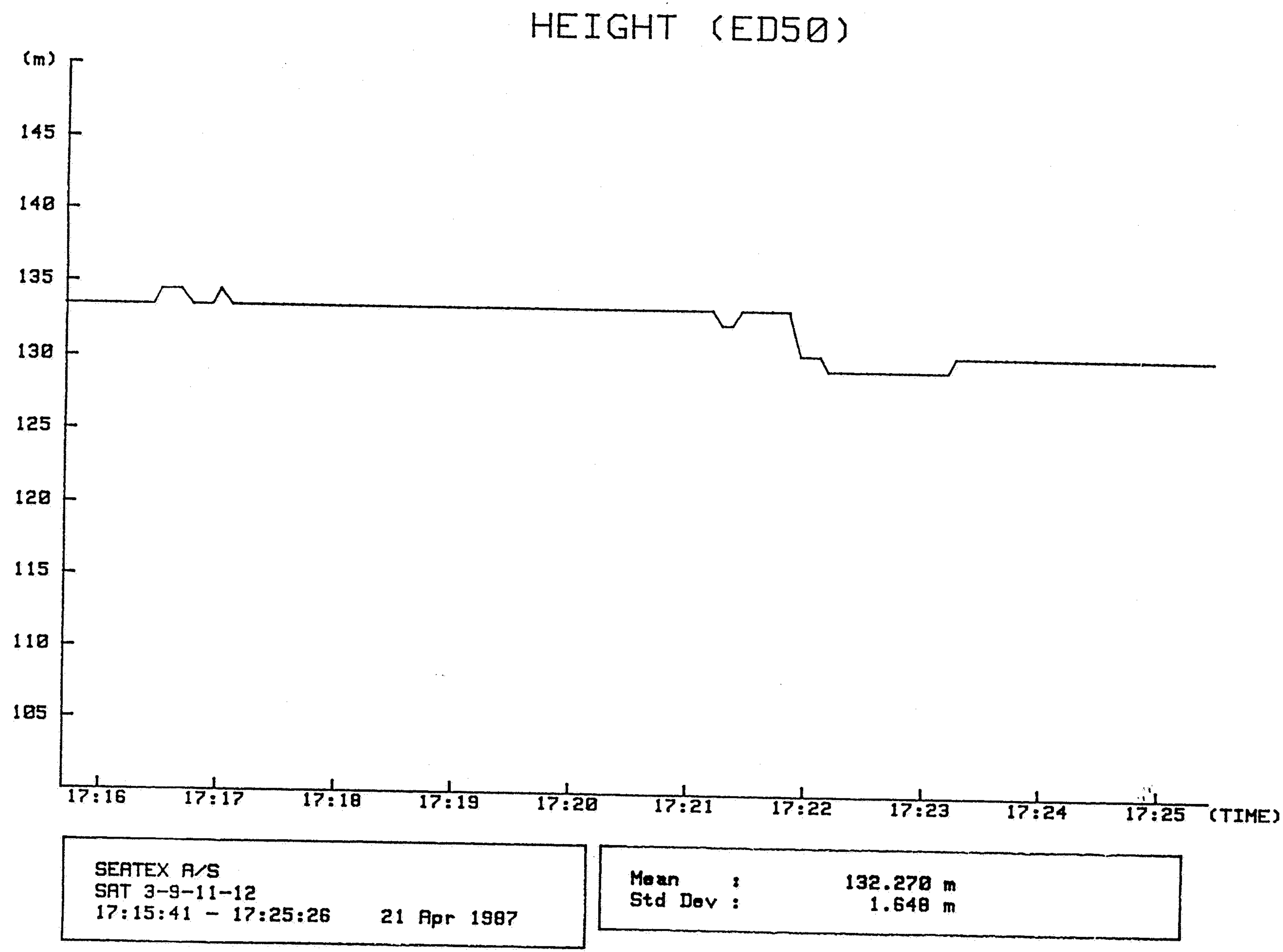


Figure 4.3.5 Height variations for reference for period 3

WEST VANGUARD 21 Apr 1987

Records in interval [118]
Sampling every [1] record
Mobile receiver

Statistics every [10] sample
Time [17:17:00 - 17:20:51]

L A T I T U D E (ED50)

TIME	GEOGRAPHIC MEAN	UTM MEAN	SDEV(m)	MAX(m)	MIN(m)
17:17	65:42:51.910	7288363.4	.1	-1.0	-1.1
17:17	65:42:51.917	7288363.6	.2	-.6	-1.0
[illegible]:18	65:42:51.924	7288363.8	0.0	-.6	-.6
1[illegible]:18	65:42:51.918	7288363.6	0.0	-.8	-.8
17:18	65:42:51.918	7288363.6	0.0	-.8	-.8
17:19	65:42:51.921	7288363.7	.1	-.6	-.8
17:19	65:42:51.925	7288363.8	.1	-.4	-.6
17:19	65:42:51.919	7288363.6	.1	-.6	-.8
17:20	65:42:51.916	7288363.5	.1	-.8	-1.0
17:20	65:42:51.917	7288363.6	.1	-.8	-1.0
17:20	65:42:51.919	7288363.6	.1	-.6	-.8
RESULT	65:42:51.918	7288363.6	.1	-.4	-1.1

L O N G I T U D E (ED50)

TIME	GEOGRAPHIC MEAN	UTM MEAN	SDEV(m)	MAX(m)	MIN(m)
17:17	8:28:31.786	475927.7	1.4	-6.2	-9.7
17:17	8:28:32.094	475931.6	1.1	-3.1	-6.2
17:18	8:28:32.226	475933.3	.5	-2.1	-3.4
1[illegible]18	8:28:32.259	475933.7	.1	-2.2	-2.4
17:18	8:28:32.242	475933.5	.1	-2.4	-2.6
17:19	8:28:32.214	475933.1	.2	-2.6	-3.1
17:19	8:28:32.177	475932.6	.4	-2.8	-3.7
17:19	8:28:32.147	475932.3	.1	-3.5	-3.8
17:20	8:28:32.129	475932.0	.2	-3.5	-4.1
17:20	8:28:32.100	475931.7	.2	-4.1	-4.5
17:20	8:28:32.091	475931.5	.3	-4.3	-4.9
RESULT	8:28:32.133	475932.1	1.7	-2.1	-9.7

Tabel 4.3.1 West Vanguard without corrctions for period 3

SEATEX A/S 21 Apr 1987

Records in interval [118]
Sampling every [1] record
Reference receiver

Statistics every [10] sample
Time [17:17:00 - 17:20:51]

L A T I T U D E (ED50)
Reference : 63:24:42.508

TIME	GEOGRAPHIC MEAN	UTM MEAN	SDEV(m)	MAX(m)	MIN(m)
17:17	0:00:00.025	-.8	0.0	-.8	-.8
17:17	0:00:00.028	-.9	.1	-.8	-.9
17:18	0:00:00.031	-.9	0.0	-.9	-.9
17:18	0:00:00.031	-.9	0.0	-.9	-1.0
17:18	0:00:00.031	-.9	0.0	-.9	-1.0
17:19	0:00:00.031	-1.0	0.0	-.9	-1.0
17:19	0:00:00.031	-1.0	0.0	-1.0	-1.0
17:19	0:00:00.031	-1.0	0.0	-1.0	-1.0
17:20	0:00:00.031	-1.0	0.0	-1.0	-1.0
17:20	0:00:00.031	-1.0	0.0	-1.0	-1.0
17:20	0:00:00.031	-1.0	0.0	-1.0	-1.0
RESULT	0:00:00.030	-.9	.1	-.8	-1.0

L O N G I T U D E (ED50)
Reference : 10:26:45.693

TIME	GEOGRAPHIC MEAN	UTM MEAN	SDEV(m)	MAX(m)	MIN(m)
17:17	0:00:00.023	.3	.1	.5	.3
17:17	0:00:00.012	.2	.1	.3	.1
17:18	0:00:00.003	.1	.1	.1	-0.0
17:18	0:00:00.004	-0.0	0.0	-0.0	-.1
17:18	0:00:00.004	-0.0	0.0	-0.0	-.1
17:19	0:00:00.007	-.1	.1	-0.0	-.2
17:19	0:00:00.018	-.2	0.0	-.2	-.3
17:19	0:00:00.028	-.4	.1	-.3	-.4
17:20	0:00:00.034	-.4	0.0	-.4	-.5
17:20	0:00:00.039	-.5	0.0	-.5	-.5
17:20	0:00:00.046	-.6	0.0	-.6	-.7
RESULT	0:00:00.013	-.2	.3	.5	-.7

Tabel 4.3.2 Reference station for period 3

WEST VANGUARD 21 Apr 1987

Records in interval [118] Statistics every [10] sample
Sampling every [1] record Time [17:17:00 - 17:20:51]
Mobile receiver corrected with reference receiver

L A T I T U D E (ED50)

TIME	GEOGRAPHIC MEAN	UTM MEAN	SDEV(m)	MAX(m)	MIN(m)
17:17	65:42:51.935	7288364.2	.1	-.2	-.4
17:17	65:42:51.945	7288364.4	.3	.3	-.2
17:18	65:42:51.954	7288364.7	0.0	.3	.3
17:18	65:42:51.948	7288364.5	0.0	.1	.1
17:18	65:42:51.948	7288364.5	0.0	.1	.1
17:19	65:42:51.951	7288364.6	.1	.3	.1
17:19	65:42:51.956	7288364.8	.1	.5	.3
17:19	65:42:51.949	7288364.6	.1	.3	.1
17:20	65:42:51.947	7288364.5	.1	.1	-0.0
17:20	65:42:51.948	7288364.5	.1	.1	-0.0
17:20	65:42:51.949	7288364.6	.1	.3	.2
RESULT	65:42:51.948	7288364.5	.2	.5	-.4

L O N G I T U D E (ED50)

TIME	GEOGRAPHIC MEAN	UTM MEAN	SDEV(m)	MAX(m)	MIN(m)
17:17	8:28:31.763	475927.4	1.4	-6.5	-10.0
17:17	8:28:32.082	475931.4	1.1	-3.3	-6.5
17:18	8:28:32.222	475933.2	.6	-2.0	-3.5
17:18	8:28:32.263	475933.7	.1	-2.1	-2.3
17:18	8:28:32.246	475933.5	.1	-2.3	-2.6
17:19	8:28:32.221	475933.2	.1	-2.6	-2.9
17:19	8:28:32.195	475932.9	.3	-2.6	-3.4
17:19	8:28:32.175	475932.6	.1	-3.2	-3.6
17:20	8:28:32.163	475932.5	.2	-3.1	-3.7
17:20	8:28:32.139	475932.2	.2	-3.6	-4.0
17:20	8:28:32.136	475932.1	.3	-3.6	-4.3
RESULT	8:28:32.146	475932.3	1.8	-2.0	-10.0

Tabel 4.3.3 West Vanguard corrected with reference station P3

5. RESULTS

5.1 Postprocessing

In the post-processing data from the rig and from the reference station have been split up into 10 sample intervals. The mean position, standard deviation and maximum and minimum values have been computed for each interval. Tables 4.1.1 and 4.1.2 show the computed values from the rig and the reference station, respectively for period 1. Tabels for period 2 and 3 are referred as 4.2.- and 4.3.-. After computing statistics for uncorrected rig- and reference station data, the corrected rig position statistics are processed.

The results of the corrctions are shown in figures 4.1.3, 4.2.3 and 4.3.3 and numerical values given in tabels 4.1.3, 4.2.3 and 4.3.3.

While period 1 and have stable tracking period 2 and 3 have dropouts of satellite 9. The reason for this tracking unstability is not easy to determine. It can origin from multipath interference or general noisy conditions. The reference station did not experience the same type of tracking problems and is therefore probably a local problem on-board the rig. This is clearly seen on the difference in height variations on figure 4.2.4 and 4.2.5.

5.2. <u>Final positioning</u>

GPS data was collected on board "West Vanguard" during three periods all during coverage of satellite 3 9 11 12 on the 21.4.87

The data on the rig is corrected for the differential corrections generated at the reference station for each sample. As stated before 3 periods of data was computed.

To calculate the most accurate position a mean of these three periods are used. Each period may be considered uncorraleted and unbiased estimates of the rig position. Difference are due to GPS unaccuracy and movements of the rig. The data give in UTM zone 32 coordinates:

Mean corrected antenna position, "West Vanguard"

	Northing	std.dev	Easting	std.dev
Period 1 :	7288365.1	0.6	475934.3	0.3
Period 2 :	7288364.8	0.4	475934.5	3.6
Period 3 :	7288364.5	0.2	475932.3	1.8

<u>Mean differential shifts applied</u>

Period 1 :	Northing +1.1 m	Easting -3.1 m
Period 2 :	Northing +0.2 m	Easting -1.3 m
Period 3 :	Northing +0.9 m	Easting +0.2 m

5.2.1 Antenna offset

Antenna offset from the center of the derrick was taken from the a scaled rig drawing. This offset was used for the on-line position that was presented on board.

For the purpose of accurate post-processing, offsets from the rig centre for the antenna position was also measured on deck with a tape measure. The height above sea level was also measured directly.

The basic data was:

Rig heading	= 313°
Operational draught	= 23.5 m
Antenna position	= port side of wheelhouse

Offsets measured:

Foreward	= 45.4 m
Port	= 10.9 m
Height above keel	= 49.3 m

This gives the following

<u>Corrections for antenna offset</u>

Heading = 313

Period 1,2,3 : North corr -22.9 East corr 40.1

resulting in the

Position reduced to rig centre

Period 1 :	Northing	7288342.2	Easting	475974.7
Period 2 :	Northing	7288341.9	Easting	475974.9
Period 3 :	Northing	7288341.6	Easting	475972.7
Average	Northing	7288341.9	Easting	475974.1

Final Navstar position, ED 1950 datum

UTM zone 32 :	Northing	7288341.9	Easting	475974.1
Geographic :	N	65° 42' 51.23"	E	08° 28' 35.44"

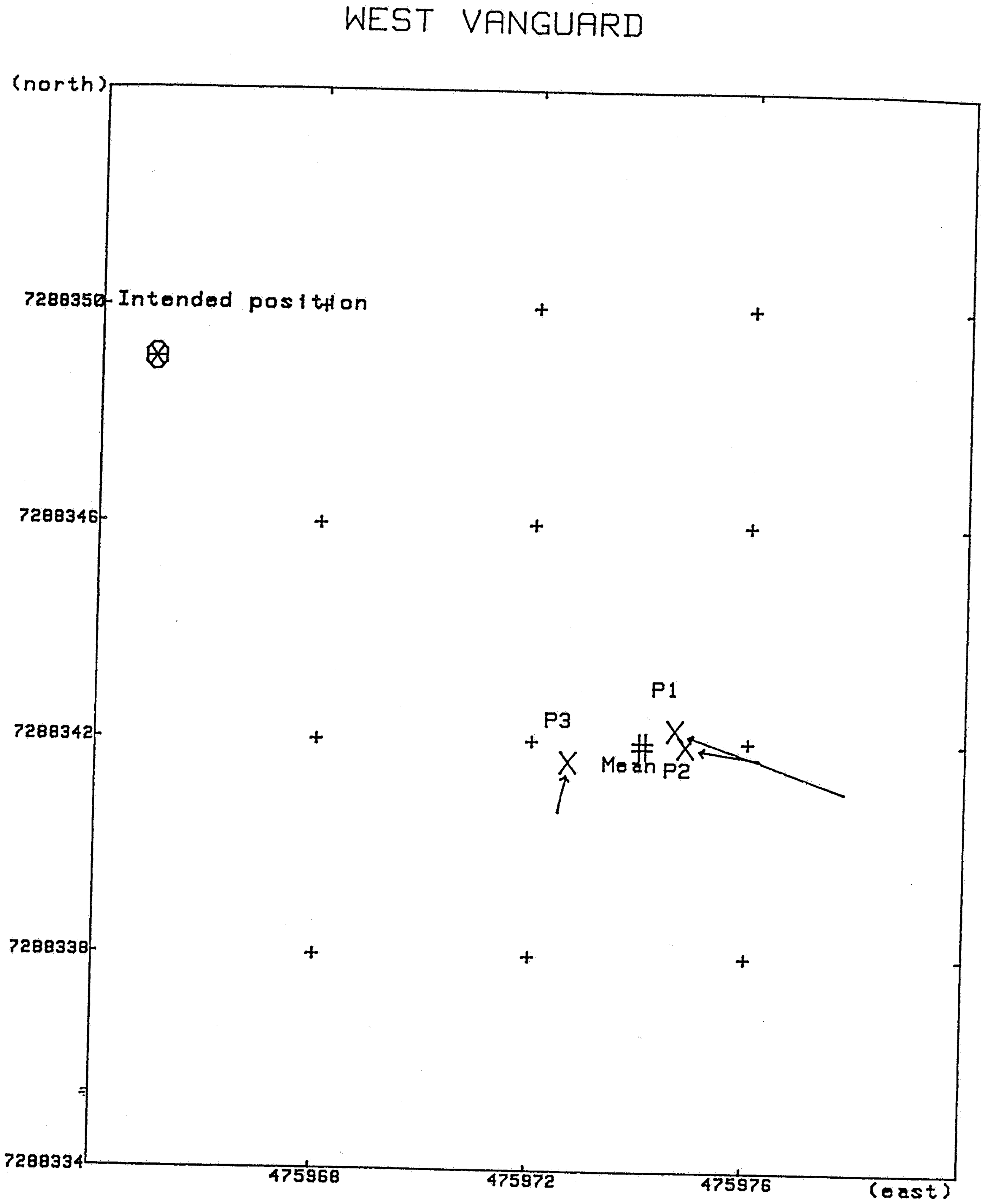
5.3 Conclusion final positioning.

The final positioning of West Vanguard was carried out on the 21 of April 1987 in the period from 16:38 to 17:21 divided into three periods.

A Trimble 4000SX receiver was used both on-board and on the reference station. A high stable cesium clock was used as frequency reference to the receivers. All equipment and software used functioned well and the quality of the data is good.

The satellites used were 3 9 11 12 and the PDOP for this periods was 5.4 to 5.7. A 4 satellite solution was used, allowing for determination of height.

The results from the three periods are plotted on figure 5.1 and shows the excellent closeness after differential corrected have been applied. All differential shift tends to draw the fixes together.



- Mean of P1-P2-P3
X - Corrected GPS positions P1-P2-P3
* - Intended position
Vectors represent GPS differential corrections

Figure 5.1 Plot of the final-position and intended position and differential corrections

4. DRILLING HISTORY WELL 6508/5-1

The rig West Vanguard commenced moving from the Halsnøy yard 20:00 hrs on 15.04.87. Before entering open sea the rig was waiting on weather 11 hours. The move continued at 10:00 hrs 16.04.87 and the rig arrived at the Nordland II, 6508/5-A, location at 06:00 hrs 19.04.86, at which time the drilling contract commenced.

During anchor handling an anchor and chain were dropped on the sea bottom after a brake failure on the anchor winch, both were fished and re-installed on the rig. The anchors were successfully pre-tensioned to 230 - 250 tons after several attempts at resetting them on the soft seabed.

The rig was monoeuvred onto location with the Loran-C integrated with the NAVSTAR GPS satellite system for calibration.

The final rig position was:

N: 65 deg 42 min 51.22 sec
E: 08 deg 28 min 35.37 sec

This was 11 meters on bearing 131 degrees from the intended position.

A seafloor penetration test resulted in 5 m penetration with 5 tons weight on a 26" bit, and the following distances were established

Seabed	433.5 m BDF
Water depth	411.5 m

The temporary guide base was run and landed on seabed at an angle of 3/4 degree on the slop indicator.

At 08:30 hrs on 22.04.87 well 6508/5-1 was spudded using a 26" bit with a 36" hole opener. 26"/36" hole was drilled to 530 m, inclination of the hole being recorded up to 3 degrees. 7 joints of 30" casing (Grade-B, 310 lbs/ft and 457 lbs/ft for the housing joint) were run and landed with the permanent guide base. The casing was cemented with the shoe at 519 m BDF and 30" housing at 432 m, good cement returns being observed throughout the displacement.

The cement was drilled out from 516 m to 535 m with a 17 1/2" bit and a 26" hole opener. A 12 1/4" pilot hole was drilled, without a marine riser to 975 m using sea water and viscous pills on connections. The returns were observed on seabed with the rig TV camera. No gas was observed and after reaching 975 m the following logs were run:

1. ISF/LSS/SP/GR
2. LDL/CNL/GR/CAL

There was no indication of gas on the logs.

The pilot hole was opened to 26" down to 970 m using sea water and viscous pills on each connection. On the subsequent wiper trip heavy reaming was necessary to clear ledges at 620 m. High viscosity mud was spotted in the open hole section before the drillstring was pulled.

42 joints of 20" casing (X-52, 129 lbs/ft, Vetco LS-LH) were run on HWDP and cemented with the shoe at 960 m, using a micro silica based cement slurry specially designed to prevent gas migration. (Note: 75 percent excess cement slurry was pumped over and above theoretical open hole annular volume. The caliper run in the 12-1/4" pilot hole showed gauge hole). The casing was pressure tested to 1000 psi on bumping the plug. Following one trip to clean the wellhead and 4 hours waiting on weather the 18-3/4" BOP stack was run on the marine riser. The BOP was landed on the wellhead but the H-4 connector could not be latched due to pressure trapped in the Emergency Disconnect System (Hot point) Preventing the shuttle valves shifting to the "closed" position. The hydraulic line of the Disconnect System was cut with the ROV, which was operational

for the first time on this well. The trapped pressure was bled off, the H-4 was function tested before the BOP was landed, and the H-4 connector was successfully closed.

The BOP stack was successfully tested and a Teleco directional MWD tool was run in with he 17 1/2" drilling assembly. The hole was displaced to 1.20 SG KCL/Polymer mud prior to drilling out the 20" casing shoe. After drilling 5 m of new formation to 980 m, the bit was pulled back into the 20" shoe (960 m) and a leak off test performed to 1.5 SG equivalent mud weight.

Drilling continued to 1021 m where heavy solids build-up caused mud losses over the shakers and the shaker box. A further 10 m was drilled but it was not possible to stem the surface losses. The shaker screens were replaced by coarser screens, new volume built and drilling recommenced with controlled penetration rates at 20 to 30 m/hr, the mudweight being gradually increased to 1.40 SG by 1370 m. High viscosity pills were circulated frequently to improve hole cleaning. A wiper trip was made at 1400 m and tight spots with overpulls greater than 30 tons were reamed and washed between 1271 m and 1242 m. Drilling of 17 12" hole continued to 1467 m before the bit was pulled. Overpulls of maximum 30 tons were seen from bottom to 1375 m.
Back on bottom with the new bit, the Teleco MWD tool would not transmit data. Fluctuations in the stand pipe pressure were indicating partial blockage of the MWD tool or the bit. Drilling of 17 1/2" hole continued, without the MWD tool working until a drilling break at 1580 m indicating the top of the Kimmeridge Clay formation. The hole was drilled on to 1603 m and the bit was pulled for logging. Minimal gas levels were recorded during the whole interval, an average background reading of 0.01 percent C1 being recorded.

The following logs were run:

1. ISF/LSS/SP/GR
2. LDL/CNL/GR/CAL

On the repeat section of the LDT/CNL-log the tool would not pass 970 m. A wiper trip was made and the tight spots on the caliper log reamed without observing resistance.

98 joints of 13-3/8" 72 lb/ft N80 buttress casing were run and landed on HWDP with the shoe at 1589 m. On the cement job, while attempting to shear the top plug, the dart held up in the bore of the BJ mandrel, however the dart was eventually released by applying 7600 psi pressure and the top plug was sheared normally with 1700 psi. Excessive corrosion (scale) was found to be restricting the internal diameter of the mandrel.
The cement was eventually displaced with mud but the plug was not bumped.

After testing the BOP, a 12-1/4" drilling assembly with a Teleco RGD MWD tool was run in hole. Top of cement was located 23 m above the float collar and the 13-3/8" casing was pressure tested to 2500 psi. The mud was diluted back to 1.28 SG and the cement and 5 meters of new formation were drilled out, whereafter a leak off test was carried out to an equivalent mud weight of 1.62 SG.

The first objective, the Haltenbanken formation, was shaled out. This was a secondary objective of the well. The primary objective, the Middle Drake reservoir, was found at 1777 m as indicated by a drilling break and decreasing GR and resistivity on the MWD tool. At 1786 m a 12-1/4" fiber-glass coring assembly was run. On bottom it proved impossible to break circulation and the coring assembly was pulled and the core barrel was found plugged up with cuttings. A second run with the 12-1/4" fiber-glass coring assembly was run the following interval was cored:

Core no. 1: 1786 - 1804m. Recovery 68%

Due to drag and solids build up in the mud, the KCL content was brought back to 80 kg/m^3. Drilling of 12-1/4" hole was continued with the RGD-MWD tool to 2180 m whereafter the MWD tool was laid down and drilling continued to 2392 m. After a BOP test drilling of 12-1/4" hole resumed to TD at 2586 m, which was 14 m into the Trias Red Beds. During the whole interval minimal gas readings, a background reading of 0.01 percent C1, were recorded, and no hydrocarbon shows were seen.

The following logs were run:

1.	ISF/LSS/GR/SP/MSFL	
2.	LDL/CNL/NGT/CAL	
3.	SHDT	
4.	RFT	
5.	SAT	
6.	CST	60 shots, 54 recovered 3 empty, 2 lost, 1 misfire.
7.	CST	30 shots, 27 recovered 2 empty, 1 lost.
8.	CBL/VDL on 13-3/8" casing (Run no. 1) t.o.c. +/- 800 m.	

There were no indication of hydrocarbons on the logs.

230 m of 2-7/8" cement stinger and cementing flow-sub was run in hole on 5" drillpipe and abandonment cement plug no. 1 was set from 2050 - 1850 m. A 12-1/4" bit was run in hole and top of cement was tagged at 1855 m with 10 tons weight on the bit.

The 2-7/8" cement stinger was run in hole to 1850 m, and abandonment cement plug no. 2 was set from 1850 - 1650 m. The cement stinger was pulled to 1650 m and abandonment cement plug no. 3 was set from 1650 - 1450 m. The plug was tagged at 1441 m (148 m into the 13-3/8" casing) with 10 tons weight on a 12-1/4" bit and was successfully pressure tested to 1000 psi for 15 minutes.

Schlumberger was rigged up and run in hole with a 13-3/8" casing punching tool and perforated (1 ft, 4 shots per foot) at 460 m, the well was observed stable for 15 minutes.

The 2-7/8" cement stinger was run in hole and abandonment cement plug no. 4 was set from 650 m to 450 m. The plug was tagged at 457 m with 10 tons weight on a 12-1/4" bit. The marine riser and BOP were pulled. The wellhead explosive severing tool was run in hole on the rig sandline, and the 13-3/8", 20" nd 30" casings were cut at 439,5 m (6 m below seabed). The 18-3/4" well head was inspected with the rig TV camera and the 13-3/8" wear bushing was observed to be protruding above the wellhead. The wear bushing, 13-3/8" casing hanger and casing stub was retrieved whereafter the 18-3/4" H-4 connector was run on a jarring assembly and 5" drillpipe and latched onto the 18-3/4" housing and the Permanent and Temporary Guide Bases, 30" and 20" casing stubs were retrieved.

After a ROV inspection of the seabed, anchor handling commenced. The last anchor was bolstered as the rig went off contract 23:30 hrs 24.05.87.

BIT RECORD SUMMARY WELL NO 6508/5-1

RUN NO.	BIT NO.	BIT SIZE INCH	MAKE/TYPE	JET SIZE 1 2 3 4	DEPTH OUT	MTRS	HRS	WOB (1000 LBS)	RPM	PUMP PRESS (BAR)	GPM	MUD WT	MUD VIS	CODE T	CODE B	CODE G	REMARKS
1	1	26 36	SEC S35J RB/H-0	3 x 22 4 x 20	530 530	96.5	14.5	5-8	75	115	1000	1.03	S/W	2	3	0	Serial 463501
2	2	17½ 26	REED S11 RB/H-0	3 x 24 3 x 24	535 535	5	0.5	5	95	115	1000	1.03	S/W	1	1	0	Drilled shoetrack.
3	3	12-1/4	HTC X3A	3 x 18	976	441	15	0-10	120	100	600	1.03	S/W	7	3	2	Serial 813 CK form 215 - 220 m.
4	4	26	SEC S3S	3 x 22	970	436	16	8-12	120	140	1000	1.03	S/W	6	8	3	Serial 409201
5	5	17½	REED S11C	1 x 16 3 x 18	1467	497	24.7	10-25	100	210	1000/ 800	1.25/ 1.40	55	4	5	2	Serial H13950 2 cones skidded
6	6	17½	REED S13G	2 x 20 1 x 40	1603	138	8.1	10-25	100	210	900/ 800	1.40	55	1	2	1	Drill plug + cmt, and clst
7	6	17½	R.R. no. 6	Casing check trip													
8	7	12-1/4	HTC XT6	3 x 14	1786	183	9.0	10/20	100	240	650	1.30	45	4	4	1	Drill shoe track and clst
9	8	12-1/4	WEASEL 3	COREHEAD	1804	18	7.1	3/7	110/130	70	430	1.27	57	10%		1/16	Clst/Sst
10	9	12-1/4	HTC 3D3	3 x 14	2007	203	10.4	5/15	100/110	275	670	1.27	42	5	3	2/16	Sst
11	10	12-1/4	HTC XDV	3 x 14	2180	173	17.1	12/15	90	270	670	1.29	48	4	2	1/8	Sst/Shale
12	11	12-1/4	HTC J22C	3 x 14	2392	212	41.1	10/23	100/60	220	650	1.27	40	2	2	1	Sandstone/clay, sh
13	12	12-1/4	HTC 322C	3 x 14	2586	194	34.3	20/26	80/60	223	650	1.27	43	3	3	0	Sandstone/shale

Table 4.1

FORMATION LEAK OFF TEST DATA WELL 6508/5-1

NO.	DATE	CASING		HOLE		MUD Wt. IN USE		MAX.EQUIVALENT MUD Wt.		STAB. EQUIVALENT MUD Wt.		REMARKS:
		SIZE (")	DEPTH (M)	SIZE (")	DEPTH (M)	SG	PSI/ 1000 FT	SG MAX/STAB	PSI/ 1000 FT MAX/STAB	SG	PSI/1000 FT	
1	2.5.87	20	960	17½	980	1.2	520	1.507	649	1.492	644	
2	8.5.87	13-3/8	1589	12-1/4	1608	1.3	561	1.622	701	1.618	696	

Table 4.2

DEVIATION DATA WELL NO. 6508/5-1

(MAGNETIC DECLINATION 3.5^{o} E. OF TRUE NORTH 1987)

(DISTANCE FROM DRILL FLOOR (DF) TO MEAN SEA LEVEL (MSL) = 22 M)

Rig coordinates: (ed 50)
N 65 Deg 42' 51.22"
E 08 Deg 28' 35.37"
UTM: N 7,288,342 m
Zone 32 E 475,973 m

DEPTH AH (M.BDF)	ANGLE (DEGREE FROM VERT.)	DIRECTION (DEGREE TRUE)	DEPTH T.V. M.BDF	NORTHING (M.FROM LOCN)	EASTING (M.FROM LOCN)	DOG LEG (^{o}/ 100 M)
433.5	0.00	0.00	433.5	0.0	0.0	0.00
541.0	1.20	287.90	541.0	0.4	- 1.1	.34
634.0	1.80	290.70	634.0	1.2	- 3.4	.20
729.0	1.80	297.80	728.9	2.4	- 6.1	.07
818.0	1.30	292.80	817.9	3.4	- 8.3	.18
903.0	1.10	293.90	902.9	4.1	- 9.9	.07
968.0	1.20	290.70	967.9	4.6	- 11.1	.06
975.0	1.00	279.10	975.9	4.7	- 11.2	1.14
1074.0	.50	259.40	1073.8	4.7	- 12.5	.17
1158.0	.60	275.30	1157.8	4.7	- 13.3	.07
1254.0	.30	194.40	1253.8	4.5	- 13.9	.20
1347.0	.40	184.20	1346.8	3.9	- 13.9	.04
1444.0	.10	125.10	1443.8	3.6	- 13.8	.11
1462.0	.40	145.50	1461.8	3.5	- 12.5	.52
1586.0	1.00	100.00	1585.8	3.0	- 12.4	.19
1598.0	.80	132.50	1597.8	2.4	- 11.4	1.37
1691.0	.70	119.50	1690.8	2.2	- 10.6	.06
1777.0	.70	131.80	1776.8	1.6		.05
1869.0	.80	134.30	1868.8	.7	- 9.7	.03
1962.0	1.10	148.00	1961.8	- .5	- 8.7	.12
1998.0	1.20	148.70	1997.8	- 1.1	- 8.4	.09
2090.0	1.80	155.40	2089.7	- 3.2	- 7.3	.21
2167.0	1.80	151.90	2166.7	- 5.4	- 5.2	.04

Table 4.3

DEVIATION DATA WELL NO. 6508/5-1 (cont'd)

DEPTH AH (M.BDF)	ANGLE (DEGREE FROM VERT.)	DIRECTION (DEGREE TRUE)	DEPTH T.V. M.BDF	NORTHING (M.FROM LOCN)	EASTING (M.FROM LOCN)	DOG LEG (^{o}/ 100 M)
* 2292.0	1.50	153.5	2291.7	- 8.6	- 4.5	0.23
* 2387.0	1.00	146.0	2386.6	- 10.4	- 3.5	0.57
* 2581.0	1.00	155.0	2580.6	- 13.3	- 1.9	0.07
2586.0	1.00	155.0	2585.6	- 13.4	- 1.8	0.00 TD (estrapolated)

Teleco MWD measurements.

* Eastman Magnetic Single Shots.

CEMENTATION DATA WELL 6508/5-1

JOB DATE	JOB DESCRIPTION	HOLE SIZE/ DEPTH (M. BDF)	CASING SHOE (M.BDF)	CEMENT TYPE	M/TONS USED	SLURRY WEIGHT (PPG)	MIXWATER	ADDITIVES	LOSSES (BBLS)	REMARKS
23.04.87	30" csg	36"/530	519	Class G	38.0 Lead 40.0 Tail	13.2 sg 15.8 sg	Seawater Seawater	3.2 LHK A-3L 5.33 LHK A-7L	-	1) The units on the liquid additive tanks were indicated in liters. During the cement job the units were taken for gallons. Consequently too little additives were used. The cement hardened ok. 2) Cement to seabed.
28.04.87	20" csg	26"/970	960	Class G	31.2 Lead I 17.4 Lead II 18.7 Tail	1.58 sg 1.63 sg 1.90 sg	Seawater Seawater Seawater	3.55 LHK A-3L 0.53 LHK R-15L 35% BWOC EMSAC 1.4% BWOC D-19 2.0 LHK D-31 LN 5.33 LHK A-7L	-	1) Micro Silica anti gas migration slurry 2) Cement to seabed.
07.05.87	13-3/8"	17½"/1603	1589	Class G	46.7 Lead 11.8 Tail	1.58 sg 1.90 sg	Seawater Drillwater	3.20 LHK A-3L 0.98 LHK R-15L 0.71 LHK R-12L	-	Did not bump the plug. Cement underdisplaced with 60 strokes. Top of cement 20" x 13-3/8" annulus: 800 m.
21.05.87	Abandonment plug no. 1	12-1/4"/ 2589	1589	Class G	20.0	1.90 sg	Drillwater	0.67 LHK R-12L	-	Plug set from:2050 - 1855 m BDF
21.05.87	Abandonment plug no. 2	12-1/4"	1589	Class G	22.2	1.90 sg	Drillwater	0.53 LHK R-12L	-	Plug set from: 1850 - 1650 m BDF
21.05.87	Abandonment plug no. 3	12-1/4" 13-3/8 csg	1589	Class G	25.2	1.90 sg	Drillwater	0.53 LHK R-12L	-	Plug set from: 1650 - 1441 m BDF
22.05.87	Abandonment plug no. 4	13-3/8" csg	1589	Class G	28.1	1.90 sg	Seawater	5.33 LHK A-7L	-	Plug set from: 750 - 457 m BDF

Table 4.4

CASING DATA WELL 6508/5-1

DATE RUN	SIZE	GRADE	WT/FT	COUPLING	SHOE DEPTH (M.BDF)	REMARKS
23.04.87	30"	B	457 lbs/ft 310 lbs/ft	ST-2	520 m	Top joint 1.5" wall thickness
28.04.87	20"	X-52	129 lbs/ft	Vetco LS-LH	960 m	LH shoetrack. 2 centralizers on shoe joint 3 centralizers on every second joint from btm. 1 centralizer inside 30" shoe.
06.05.87	13-3/8	N-80	72 lbs/ft	BTC	1589 m	LH shoe track. 2 centralizers on shoe joint. 6 centralizers, every second joint from btm. 2 centralizers inside 20" shoe

Table 4.5

Table 4.6

TIME ALLOCATION 6508/5-1

Started well at 19:00 hrs 15.04.87. (Start tow)
Spudded well at 08:30 hrs 22.04.87.
Finished well at 23:30 hrs 24.05.87. (Last anchor off btm.)

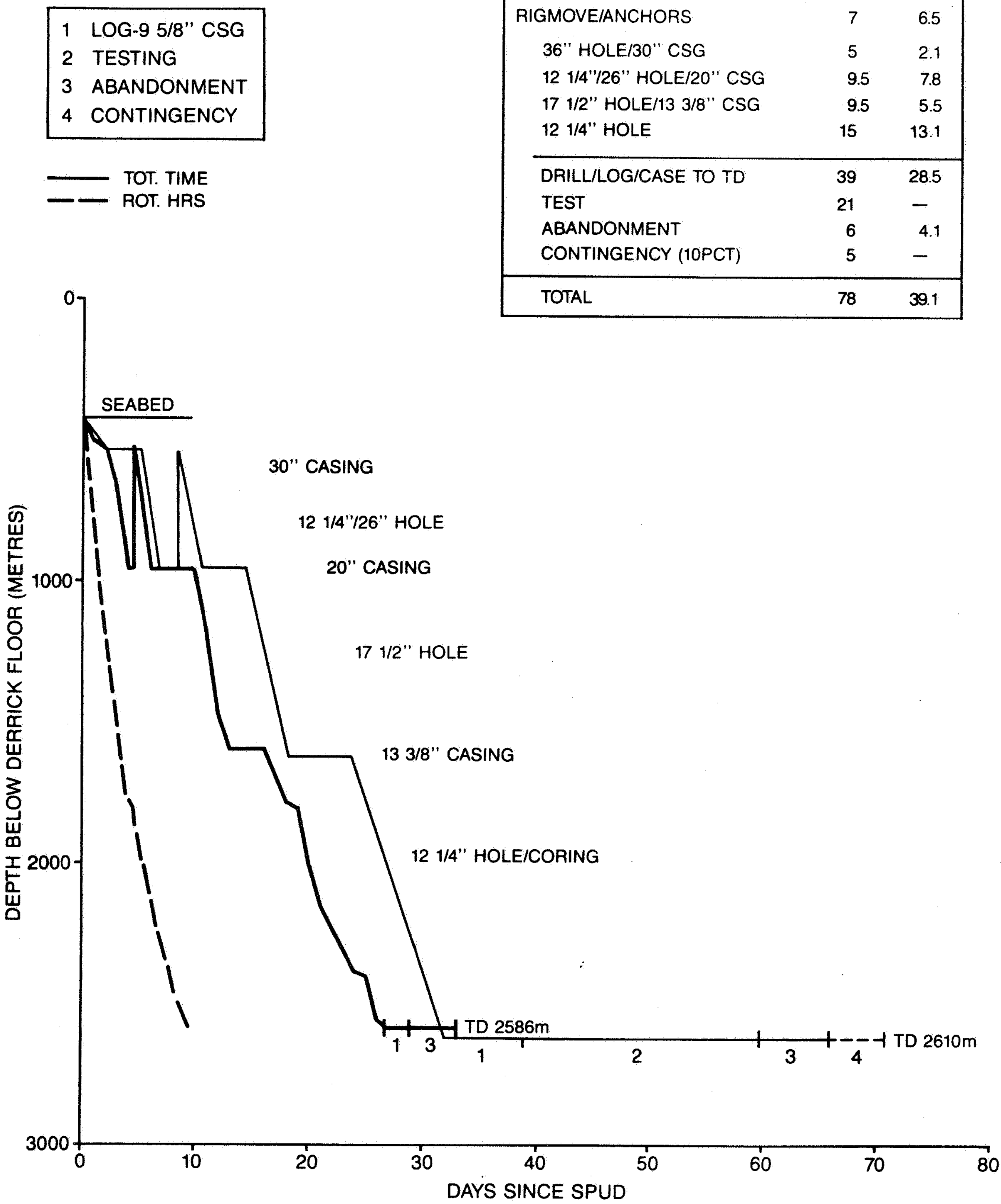
PHASE	ITEM	APRIL	MAY	TOTAL HRS	%
PREPARATION	- Towing	72.0		72	7.66
	- Laying/ pulling anchors	57.0		57	6.06
	- General preparation	12.0		12	1.28
	- Waiting on weather	11.0		11	1.17
	Sub total	152.0		152	16.16
DRILLING	- Bit on bottom	38.0	185.25	223.25	23.74
	- Round tripping	38.25	110.0	148.25	15.76
	- Reaming/ enlarging	32.0	4.25	36.25	3.85
	- Circulation/ condition mud	8.75	35.75	44.5	4.73
	- Running casing/drilling cement	28.75	32.25	61.0	6.49
	- Leak off test	-	2.5	2.5	0.27
	- Cementing & WOC	10.0	5.0	15.0	1.59
	- Running/ pulling riser BOP	25.5	-	25.5	2.71
	- Flanging up and testing	-	41.0	41.0	4.36
	- Repairs (pumps/ drawworks)	9.5	1.5	11.0	1.17
	- Surveys	2.5	3.25	5.75	0.61
	- Waiting on weather	4.0	-	4.0	0.43
	- Diving ops.	6.75	-	6.75	0.72
	- Kick drills	-	0.75	0.75	0.08
	Sub total	204.0	421.5	625.5	66.51
EVALUATION	- Coring (on bottom)		8.25	8.25	0.88
	- Round trip with core barrel		22.0	22.0	2.34
	- Circulating for samples		0.25	0.25	0.03
	- Recovery of core	-	2.0	2.0	0.21
	- Condition hole for logging	1.0	-	1.0	0.11
	- Logging	8.0	56.5	64.5	6.86
	- Waiting on weather				
	Sub total	9.0	89.0	98.0	10.42
SUSPENSION	- Plugging back and WOC		7.25	7.25	0.80
	- Cut/retrieving casing		14.5	14.5	1.54
	- Pull riser/BOP stack		11.5	11.5	1.22
	- Lay down string		14.0	14.0	1.49
	- Preparing for rigmove		0.5	0.5	0.05
	- Anchor handling/off loading		14.5	14.5	1.54
	- Tow		-	-	-
	- Waiting on weather		2.75	2.75	0.29
	Sub total		65.0	65	6.91
	TOTAL HOURS:			940.5	100.00

Total time: 39 days 4.5 hrs

FIG.4.1

6508/5-A (1) DRILLING PROGRESS CURVE

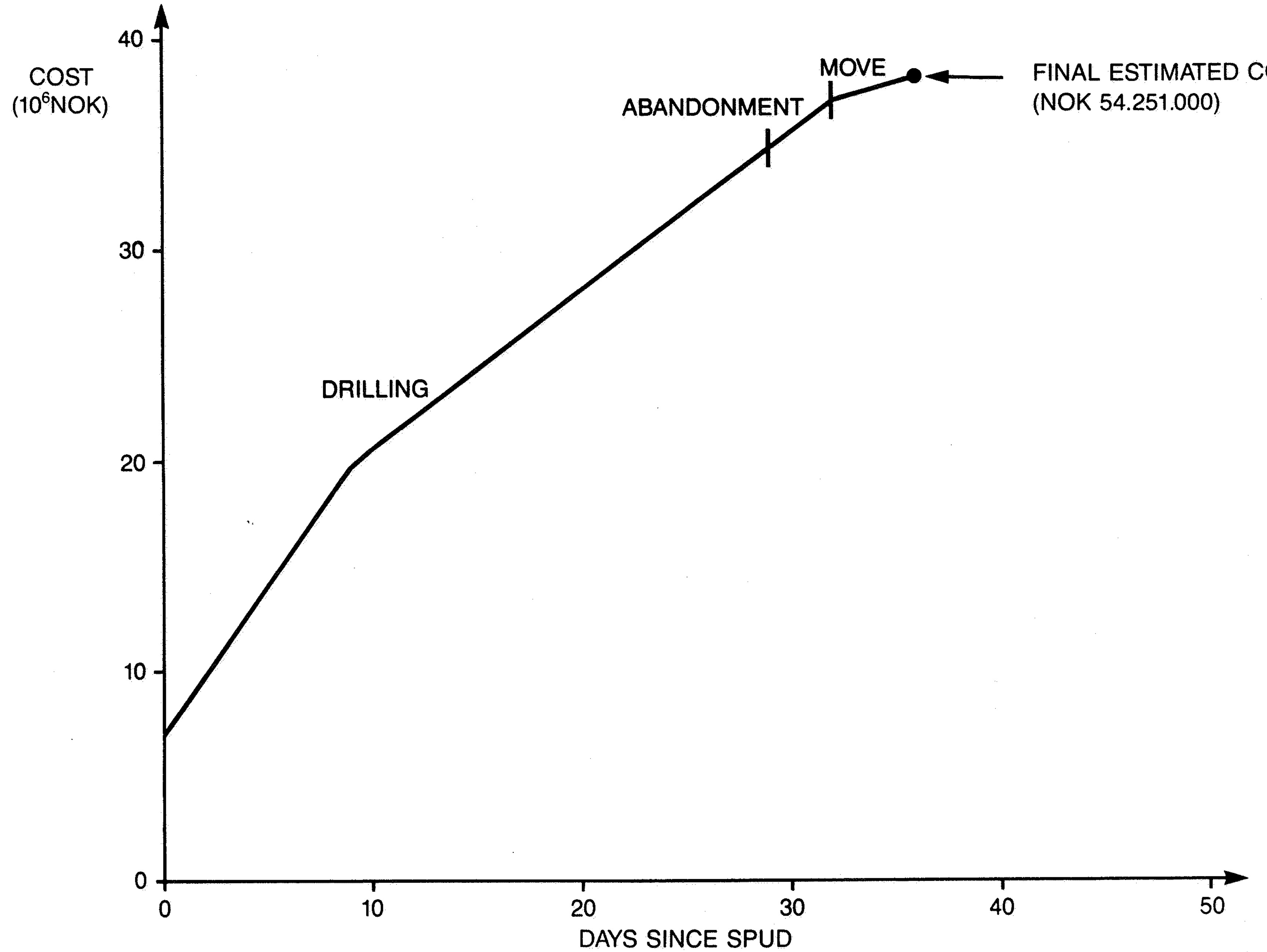
TIME BREAK DOWN (DAYS)	PLAN	ACT
RIGMOVE/ANCHORS	7	6.5
36" HOLE/30" CSG	5	2.1
12 1/4"/26" HOLE/20" CSG	9.5	7.8
17 1/2" HOLE/13 3/8" CSG	9.5	5.5
12 1/4" HOLE	15	13.1
DRILL/LOG/CASE TO TD	39	28.5
TEST	21	—
ABANDONMENT	6	4.1
CONTINGENCY (10PCT)	5	—
TOTAL	78	39.1



A/S Norske Shell

G 2652/1

TIME/COST CURVE 6508/5-1



A/S Norske Shell

FIG.4.2

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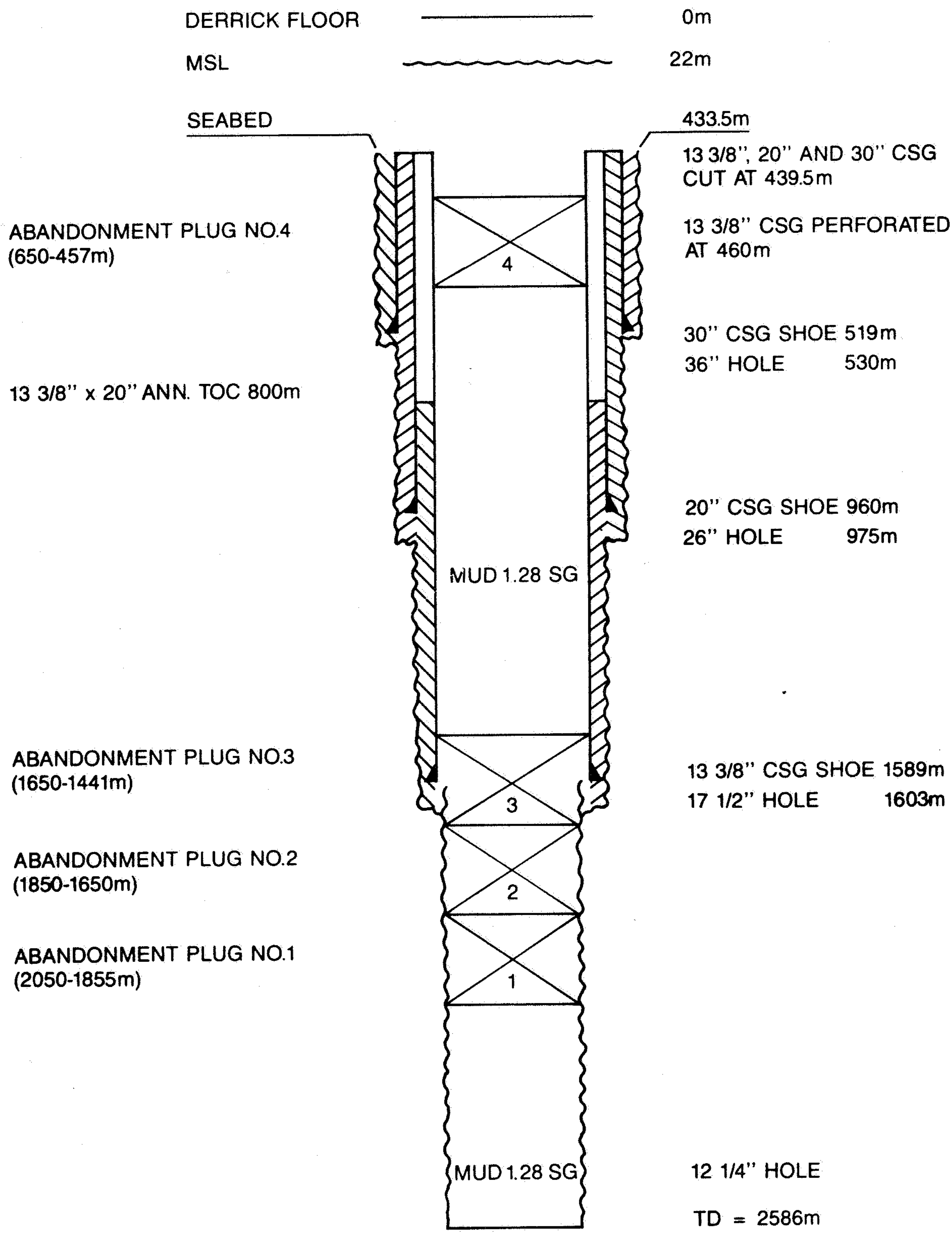
FIG.4 .3

ABANDONMENT WELL 6508/5-1



A/S Norske Shell

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6. GEOLOGICAL REPORT

Ditch Cuttings

Cuttings samples were collected every 10 m from 960 to 1589 m bdf, and every 3 m in the interval 1589 to 2586 m bdf (TD).

Sidewall Samples

Sidewall samples were shot in the hole section below 1589 m bdf. A total of 90 samples were attempted, 84 of which were recovered.

Cores

One fiberglass core was cut:
Core no.1: 1786 - 1804 m, recovery 68%, core size 5 1/4".

A detailed lithological core description is presented in Appendix 1.

6.2 Stratigraphy

6.2.1 Lithostratigraphy

Nordland/Hordaland Group. (Seafloor 411.5 mbdf - 1427 m)

From seafloor to 975 m no returns to surface.

The series consist of grey to light brown clay and claystone, varicoloured towards the base with fine sand and siltstone intercalations and locally glauconite streaks. Small fragments of metamorphic rocks and numerous isolated gravity grains were reported in the upper part.

Rogaland Group (1427 - 1527 m)

<u>Balder Formation</u> (1427 - 1476 m)

Dark grey to brown non-calcareous siltstone and claystone, soft to hard, occasionally with black specks.

<u>Sele/Lista Formation</u> (1476 - 1527 m)

Mainly varicolored claystone with a few white limestone streaks at base.

<u>Cromer Knoll Group</u> (1527 - 1580 m)

Non calcareous brick red and red brown claystone grading to light grey marl at base.

<u>Humber Group</u> (1580 - 1778 m)

<u>Kimmeridge Clay Formation</u> (1580 - 1650 m)

Consists essentially of black to dark brown claystone, moderately hard and slightly silty.

<u>Heather Formation</u> (1650 - 1710 m)

Grey and silty claystone, soft to firm, slightly pyritic and micaceous with pale grey limestone stringers.

<u>Dunlin Group</u> (1710 - 1981 m)

<u>Upper Drake Formation?</u> (1710 - 1778 m)

Grey and silty claystone with limestone stringers, similar to Heather Formation, called Upper Drake because of age.

Middle Drake Formation (1778 - 1824 m)

Consists essentially of fine to medium sand, occasionally coarse, well sorted and rounded, very poorly cemented with excellent reservoir properties (see Chap. 6.6)

Lower Drake Formation (1824 - 1842 m)

The formation consists of clear sand and sandstone, very fine to medium, moderately sorted and local silica cemented, locally grading to siltstone with shale and claystone intercalations.

Neill Klinter Formation (1842 - 1981 m)

Very fine to medium sand and sandstone intercalated with shale and claystone. This formation differs little from the Lower Drake Formation.

Kap Stewart Formation (1981 - 2383 m)

This thick formation consists of an alternation of fine to coarse sandstone, angular to subrounded, occasionally micaceous, poorly cemented with medium grey to dark brown silty and micaceous non-calcareous shale and claystone, locally associated with coal development.

New Red Sandstone Group

Kap Biot Formation (2383 - 2572 m)

Alternation of soft grey to green silty shale, micaceous and pyritic, non-calcareous to calcareous with clear fine to medium sandstone, occasionally micaceous and calcite cemented.

Red Beds Formation (2572 - 2586 m)

Red to brown claystone, soft to firm, slightly silty and calcareous.

6.2.2 Biostratigrphy Well 6508/5-1

Above 1000 m	No return
1000-1160 m	Early Pliocene
1180-1220 m	Miocene (Oligocene?)
1240-1340 m	Oligocene
1350-?1390 m	Late Eocene
1410-1460 m	Early Eocene
1470-1490 m	(Paleocene?)
1510-1520 m	Non diagnostic
At 1530 m	Albian
At 1540 m	Aptian
At 1560 m	Early Aptian
At 1570 m	Barremian?
At 1580 m	Hauterivian/Ryazanian
1590-1630 m	Early Portlandian - Late Kimmeridgian
1642-1648 m	Middle? Callovian
At 1659 m	Middle - Early Callovian
At 1699.8 m	Early Bathonian - Late Bajocian
At 1710 m	Bajocian - Aalenian
1730-1823 m	Aalenian - late Toarcian
At 1839 m	Toarcian
1850-1919.5 m	Pliensbachian -?Sinemurian
1948-2100 m	Sinemurian - Hettangian
2115-2229 m	Hettangian - Rhaetian
2273-2556.1 m	Rhaetian

6.3 Hydrocarbon Indications

No fluorescence or other hydrocarbon indications were observed on cuttings or any of the 84 SWS recovered. Background gas indications were only observed in the upper part of the section from 975 m (start of drilling with returns) to 1555 m with C1 gas readings not exceeding 2%.

6.4 Seismic Calibration

Velocity survey

A check shot survey was carried out between 450 m and 2575 m bdf by Schlumberger. After the first shot at 450 m shots were taken at 100 m intervals down to 1550 m. Between 1550 m and 2575 m the interval was set to 25 m. A total of 53 shots were recorded.

Synthetics

Synthetic seismograms have been processed using a minimum and a 'zerophase Ricker' wavelet, and displayed at normal and reverse polarity. A zerophase version with normal polarity is shown in Figure 6.1.

Stratigraphic Identification of reflectors

To get a good match between synthetic seismograms and the seismic, the seismograms have been processed using different frequencies on the input wavelet. A 40 Hz zerophase wavelet convolved with the reflection train and displayed with normal polarity gives an excellent fit to line 86 - 122. This allows a good correlation to the geological markers.

Table 6.4

Two way reflection times to formation tops (Figure 6.2)

Formation	Depth (mbdf)	TWT msl.(ms)
Base Quaternary	613	738
Base Pliocene	1163	1221
Balder Fm.	1427	1472
Cromer Knoll Gp Base Tertiary	1527	1572
Kim. Clay Fm.	1580	1620
Heather Fm.	1650	1693
Middle Drake Fm.	1778	1793
Lower Drake Fm.	1824	1828
Neill Klinter Fm.	1842	1841
Kap Stewart Fm.	1981	1947
Kap Biot Fm.	2383	2221
Red Beds Fm.	2572	2339

6.5 Geological Setting

The structure drilled by well 6508/5-1 is located in the western part of the Helgeland Basin which forms the northern part of the relatively undeformed Trøndelag Platform. The platform is bounded to the east by the Norwegian mainland and to the west by the Trøndelag Platform fault zone where the Jurassic and older series are progressively downfaulted on to the Halten Terrace. The structurally higher Nordland Ridge and Traenabanken area bound the Helgeland Basin to the north and northwest.

In the Helgeland Basin and over most of the Trøndelag Platform, tectonic activity died out shortly after the late Kimmerian Unconformity. The Nordland Ridge however, remained tectonically active until the Pliocene.

6.6 Reservoir Geology

The principal objective was the sandstone of the Lower Jurassic Middle Drake Formation. The Neill Klinter Formation was a secondary objective in the case of a shaled out Middle Drake Formation or well developed Lower Drake Formation acring as a seal. The Haltenbanken Formation, as expected from regional geological considerations, was not present.

The sandstone of the Middle Drake Formation (46 m) was cored from 1787 to 1804 m with a 68% recovery. The cored section exhibits excellent porosities with an average of 32% and permeabilities of generally several hundreds of mD to tens of Darcies. From petrophysical log evaluation the whole formation has a net to gross of 64% and the same porosity average as in the cored section using a porosity cut off of 15%.
The Neill Klinter Formation also possesses excellent reservoir characteristics with 50% net to gross and 34% average porosity. Reservoir characteristics remain good in the Kap Stewart Formation with an average prosity of 31% and, at the bottom of the well, the Triassic Kap Biot Formation still exhibited reasonable porosities with an average of 25% at around 2500 m.

grey beds

6.7 Dipmeter Survey

A dipmeter survey was run over the interval 1590 - 2580 m, giving the following general readings:

Humber Group (1590 - 1710 m)

Kimmeridge Clay Formation (1590 - 1650 m)

Mainly unreliable readings with highly varied orientation apart from the very base of the interval with 2-3^{o} dips.

Heather Formation (1650 - 1710)

Very unreliable readings in the upper part. The dip pattern becomes more consistent below with readings varying mostly around 1^{o} to 3^{o} and also varied in orientation.

Dunlin Group (1710 - 1981 m)

Upper Drake Formation (1710 - 1778)

Top part mainly consistent readings varying from 1^{o} to 3^{o}. Readings become more erratic at base.

Middle Drake Formation (1778 - 1824 m)

Scattered dips in the upper part, followed by more consistent dip readings increasing with depth from 1^{o} at top to around 4^{o} at base, with varying azimuth but a noted concentration to a more westerly direction.

Lower Drake Formation (1824 - 1842 m)

Very similar to the above formation.

Neill Klinter Formation (1842 - 1981 m)

Dip ranging from 1^{o} to 10^{o} with a consistant NW azimuth in the upper part. In the middle part dips of the same order are observed but with eratic azimuth, while in the lower part dips from 1^{o} to 6^{o} with a southerly azimuth are observed.

Kap Stewart Formation (1981 - 2383 m)

Very constant westerly dip (1^{o} - 2^{o}) in the top part. Down to 2180 m very erratic dips are observed from 2^{o} to 30^{o}, occasionally higher of which the majority have an azimuth ranging from NNE to E. Lower down, dips become more consistent, especially in the thicker shaly intervals and range from 2^{o} to 8^{o} with a general westerly azimuth, but become more scattered within the sandy intervals.

Kap Biot and Red Beds Formation (2383 - 2586 m)

Very consistent dips 1^{o} to 2^{o} on average changing in azimuth from SW in the upper part to ESE in the lower part

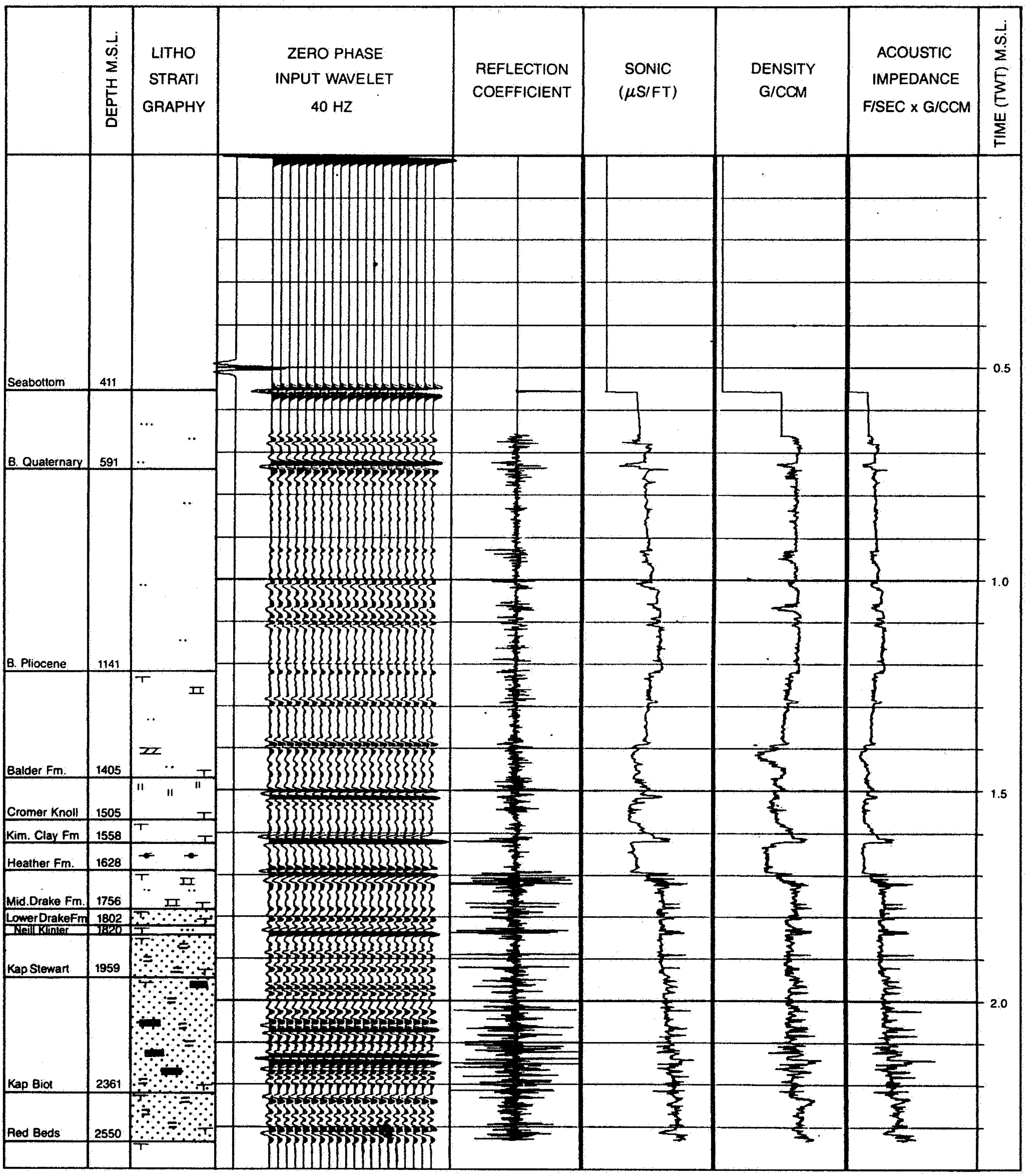
6.8 Conclusions

The total absence of hydrocarbons in Well 6508/5-1, (by the time of drilling the 11th unsuccessful well in the Nordland (Traenabanken) area) seems to confirm the growing impression that commercial hydrocarbon accumulations will not be discovered in this area.

Whilst finding substantially developed good reservoir sands, the gas-prone Upper Jurassic source rock was found to be totally immature, and the smaller hydrocarbon generating potential of the lower Jurassic source rocks is evidently zero at this location.

Until such time as a radically different petroleum geological model can be established, it seems unlikely that any further drilling will be undertaken in this area.

SYNTHETIC SEISMOGRAM



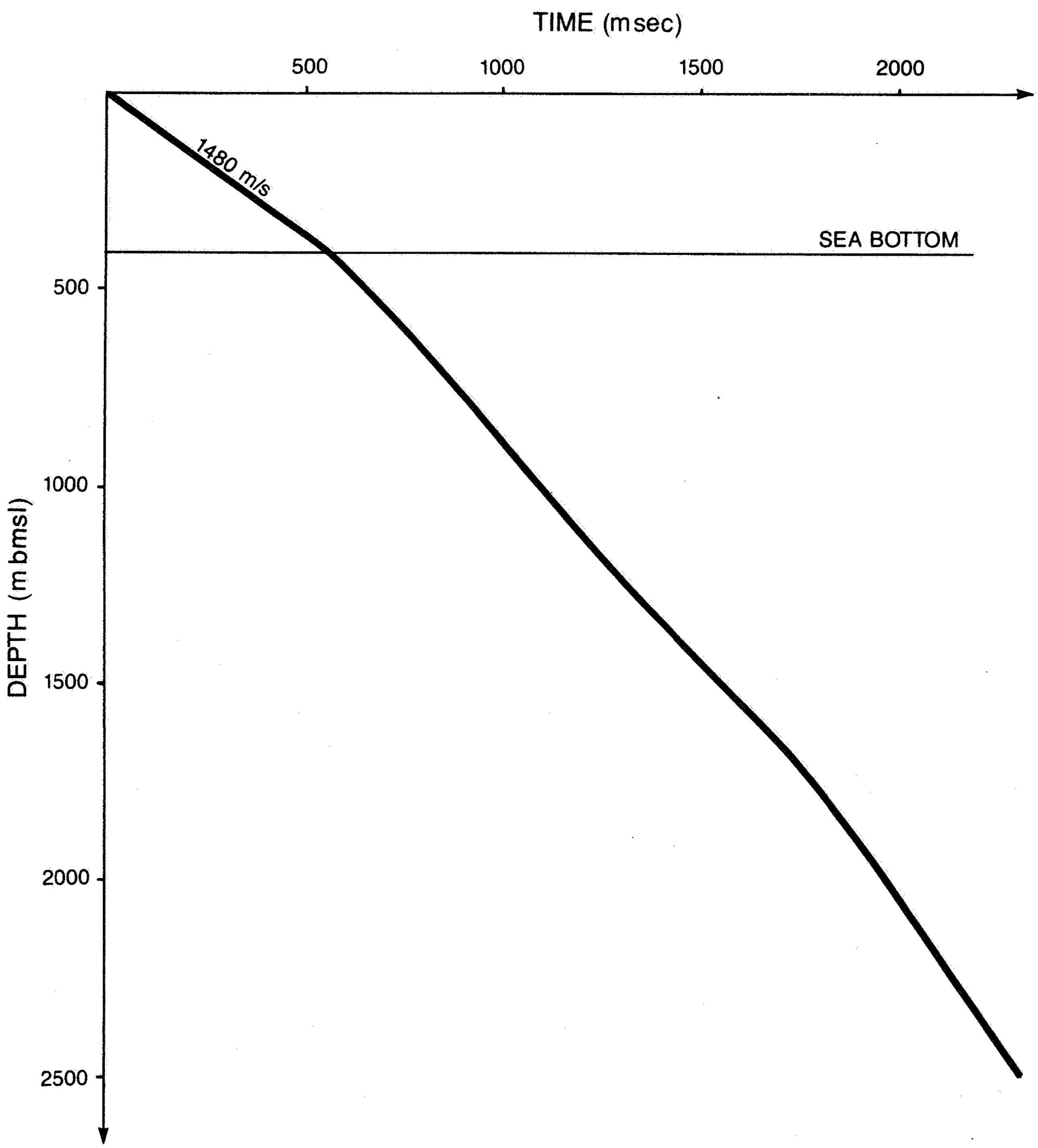
A/S Norske Shell

G. 2652/4

FIG.6.2

6508/5-1

TWO - WAY TIME VERSUS DEPTH



A/S Norske Shell

G. 2652/5

7. PETROPHYSICAL EVALUATION

A summary of the wireline logs run by Schlumberger is presented in Table 7.1. All logs run were of good quality. A plot of the main logs run and the results of the Petrophysical evaluation over the objective interval is attached as Enclosure 6. All sands are interpreted as water-bearing.

One core was taken in the well, the measurements on which are attached as Appendix 2. It was found necessary to depth match the core measurements to the logger's depth by adding 0.75 m to the core depth. The core measurements included in the plot are shown depth corrected (Enclosure 4).

7.1 Porosity Calculation

Porosity was calculated from the density log recorded by the Litho-Density Tool (LDT). A matrix density of 2.65 grams/cc was used for the majority of the sands. A neutron/density technique was used for the sands in the cored interval which exhibit a high gamma ray reading and a high matrix density measured on the core samples.

A fluid density of 1.045 gm/cc was used in the porosity calculation. This gives a good match between core and log data and agrees well with the expected density based on mud filtrate resistivity measurements.

7.2 True Formation Resistivity (Rt)

Due to the low formation resistivity in the sands, the borehole effect corrected Deep-Induction Log was taken as the best measurement of Rt. Borehole correction parameters were taken from log heading information i.e. a stand-off of 1 1/2 inches and a mud resistivity of 0.067 ohm-metres.

7.3 Hydrocarbon Saturation and Formation Water Resistivity

An Archie model was used to evaluate the sand intervals. The cementation factor 'm' was taken as 1.80 and the saturation exponent 'n' was taken as 2.00. The formation water resistivity, Rw, was derived by log analysis. A value of 0.77 ohm-metres was found, which at a bottom hole temperature of $60^{o}C$ implies a formation water salinity of 45,000 ppm NaCl equivalent.

SHELL

SUMMARY OF LOGGING OPERATIONS WELL 6508/05-01 TABLE 7.1

LOGGING CONTRACTOR: SCHLUMBERGER RIG: WEST VANGUARD DFE: 22 M

DEPTH CASING M AHBDF	DEPTH DRILLER M AHBDF	BIT SIZE INCHES	LOG TYPE	RUN NO.	INTERVAL LOGGED M AHBDF	DATE	REMARKS
519	975	12.25	ISF/LSS/GR	1	972-519	26.04.87	Logging in
			LDL/CNL/GR	1	975-519	26.04.87	pilot hole
960	1603	17.50	ISF/LSS/GR	2	1603-961	05.05.87	
			LDL/CNL/NGL	2	1605-961	05.05.87	
			ISF/LSS/GR/MSFL	3	2580-1590	19.05.87	
1589	2586	12.25	LDL/CNL/GR/NGT	3	2580-1590	19.05.87	
			SHDT	1	2581-1590	19.05.87	
			RFT	1	13 PRESSURES	19.05.87	
			SWS	1	REC. 81	20.05.87	
			SAT	1		20.05.87	
			CBL/VDL	1		20.05.87	(13-3/8"CSG)

8. WIRELINE FORMATION TESTS

The objective of the Repeat Formation Tester (RFT) survey was to obtain pressures and gradients in sandstones of the Middle Drake, Neill Klinter, Kap Stewart and Kap Biot Formations. Thirteen RFT pressure measurements were made in the well. The pressure readings were interpreted as being representative of the formation. No attempts were made to take any formation fluid samples. Table 8.1 lists the pressures obtained in this well.

The formation fluid gradent was estimated to be 0.439 psia/ft (1.013 /cc) and the formation pressure was 3,120 psia (215 bara) at a depth of 7,100 ft BRKB (2,164 m BRKB). Mud gradient was 0.568 psia/ft (1.36 g/cc). Figure 8.1 is a plot of the formation pressures and the mud pressures.

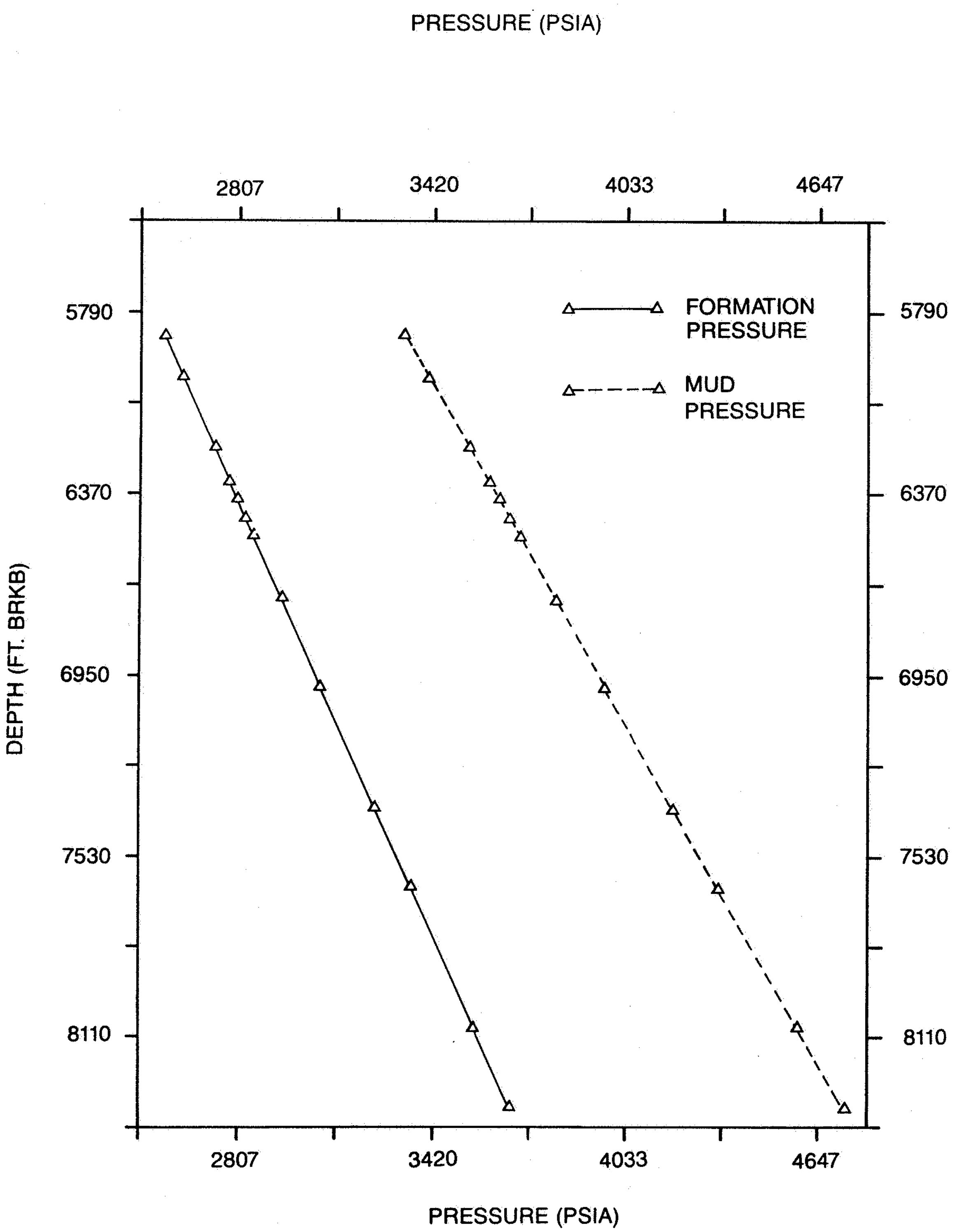
Table 8.1

R F T S U R V E Y

Well name : 6508/5-1 Survey date: 19-05-87

Depth (FT.BRKB)	Formation Pressure (Psia)	Formation Gradient (Psia/ft)	Mud Pressure (Psia)	Mud Gradient (Psia/ft)
5859.58	2575.20	0.439	3326.30	0.568
5995.73	2630.30	0.439	3403.15	0.568
6223.75	2734.70	0.439	3533.65	0.568
6328.74	2781.10	0.439	3593.10	0.568
6384.51	2804.30	0.439	3626.45	0.568
6446.85	2830.40	0.439	3658.35	0.567
6502.62	2856.50	0.439	3691.70	0.568
6706.04	2946.40	0.439	3807.70	0.568
6988.19	3069.65	0.439	3965.75	0.567
7375.33	3239.30	0.439	4186.15	0.568
7631.23	3355.30	0.440	4332.60	0.568
8077.43	3549.60	0.439	4583.45	0.567
8339.89	3664.15	0.439	4729.90	0.567

RFT FORMATION PRESSURE DATA



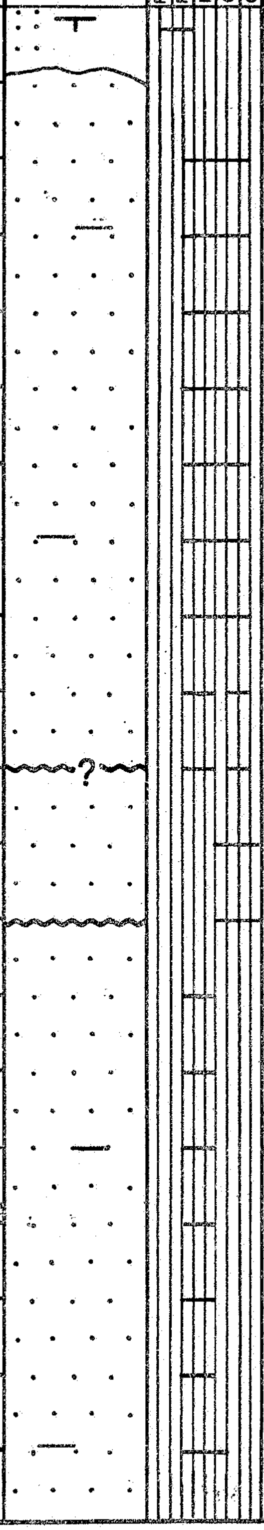
A/S Norske Shell	Well: 6508/5-1	Core No. 1

CORE DESCRIPTION

Cored from: 1786 to 1804 Recovered: 12.2 m 68 % Core size: 5 1/4"

Formation: MIDDLE DRAKE Date: 04.08.87 Described by: JAN STENLØKK Corehead: 12 1/4"x8 1/2"

Sheet: 1 of 6



DEPTH & SAMPLES	SEDIMENTARY STRUCTURES & FEATURES	COLOUR	COMPOSITION (& ACCESSORY MINERALS)	CMT	ESTIMATED Ø %	HYDROCARBON INDICATIONS (SMPL FLU / CUT COL / CUT FLU)	GAS %	REMARKS (OIL BLEED DIPS FRACTURES ETC.)
1786	= mm	dk gy	SLTST: fSL-fSU arg.	MODERATE SILICA CEM.	GOOD POROSITY AND PERMEABILITY	NO SHOWS		
	= horizontal; low ang cm-mm	lt gy (brn)	SST: med with crs. Sand horizonts ang. subang mod. srt.					
	cm-mm ((=)) low ang. discont.	lt -						
	(=)							
1786.5		(med) gy	SST: a/a well srt.					
	≠							
1787	?							
	( )		SST: qz crs SU- (med SL) poorly srt. ang - (rnd) (elong)					
	erosion surface = cm horizontal							
	discont, cm							
1787.5			SST: qz fSU-fSL very well srt (rnd) - ang					
	= cm. hor. beds and crossbeds discont.							
1788	=							

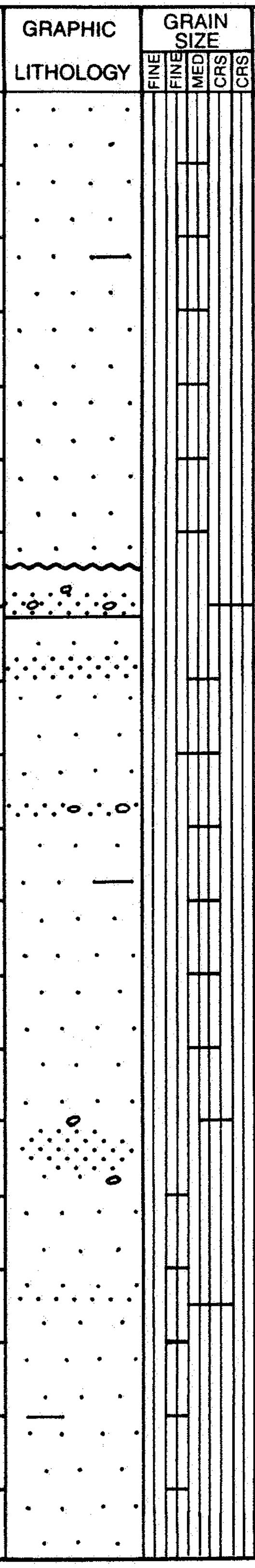
A/S Norske Shell | Well: 6508/5-1 | Core No. 1

CORE DESCRIPTION

Cored from: 1786 to 1804 Recovered: 12.2 m 68 % Core size: 5 1/4"

Formation: MIDDLE DRAKE Date: 04.08.87 Described by: JAN STENLØKK Corehead: 12 1/4"x8 1/2"

Sheet: 2 of 6



DEPTH & SAMPLES	SEDIMENTARY STRUCTURES & FEATURES	COLOUR	COMPOSITION (& ACCESSORY MINERALS)	CMT	ESTIMATED Ø %	HYDROCARBON INDICATIONS (SMPL FLU / CUT COL / CUT FLU)	GAS %	REMARKS (OIL. BLEED DIPS FRACTURES ETC.)
1788	= cm		SST: qz mSL (rnd) - ang very well srt.					
	more disturbed x-beds							
	= cm med-mod. ang							
1788.5								
	≠	lt	SST: qz crs SU mod srt. (rnd) - ang (elong)					
	= very dist. alternating parallel and ang x-beds wavy	(med) gy						
1789	black clay lam							
	wavy ripples occ. 1/2 cm. pebbles		SST: qz fSU - (mSL) very well srt (rnd) - ang.					
1789.5	= wavy x-beds							
	ripples x-beds broken and dist.							
1790								

CMT: MOD. TO POORLY SILICA CEM.

ESTIMATED Ø %: GOOD POROSITY AND PERMEABILITY

HYDROCARBON INDICATIONS: NO SHOWS

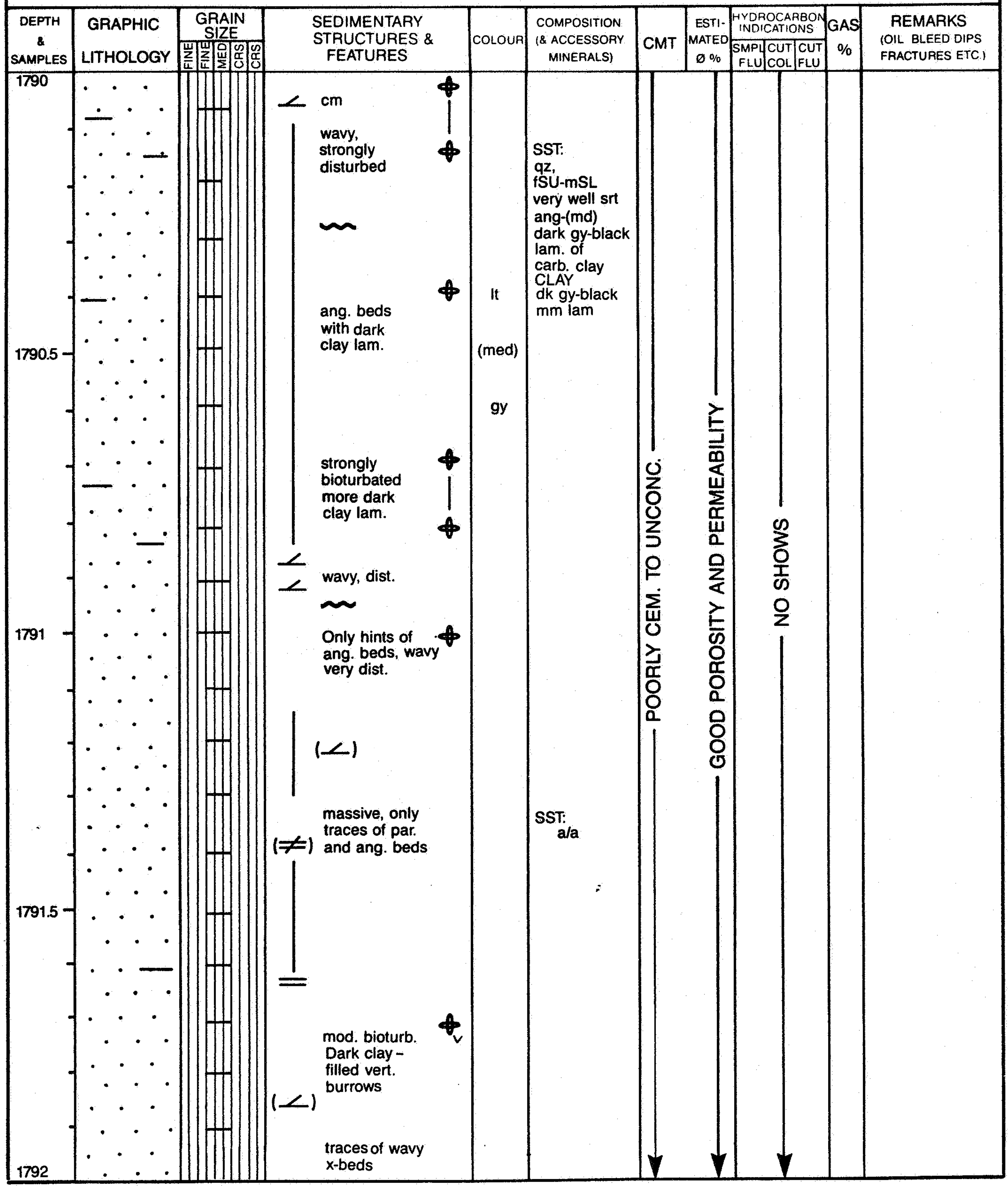
A/S Norske Shell | Well: 6508/5-1 | Core No. 1

CORE DESCRIPTION

Cored from: 1786 to 1804 Recovered: 12.2 m 68 % Core size: 5 1/4"

Formation: MIDDLE DRAKE Date: 04.08.87 Described by: JAN STENLØKK Corehead: 12 1/4" x 8 1/2"

Sheet: 3 of 6



A/S Norske Shell | Well: 6508/5-1 | Core No. 1

CORE DESCRIPTION

Cored from: 1786 to 1804 Recovered: 12.2 m 68 % Core size: 5 1/4"

Formation: MIDDLE DRAKE Date: 04.08.87 Described by: JAN STENLØKK Corehead: 12 1/4"x 8 1/2"

Sheet: 4 of 6

DEPTH & SAMPLES	GRAPHIC LITHOLOGY	GRAIN SIZE (FINE, FINE, MED, CRS, CRS)	SEDIMENTARY STRUCTURES & FEATURES	COLOUR	COMPOSITION (& ACCESSORY MINERALS)	CMT	ESTIMATED Ø %	HYDROCARBON INDICATIONS (SMPL FLU, CUT COL, CUT FLU)	GAS %	REMARKS (OIL. BLEED DIPS FRACTURES ETC.)
1792			wavy, broken		SST: qz, ang-(rnd) Very well srt fSU-mSL	POORLY CEM. TO UNCONC.	GOOD POROSITY AND PERMEABILITY	NO SHOWS		
1792.5			mm. black clay lam. in homogenous ss.	lt- (med) gy						
1793			strongly deformed and dist. x-beds	slightly darker grey						
			cracks, small faults parallel: cm							infilled cracks and fractures. Small faults with cm. throws.
1793.5			alt. beds of diff. grainsize		SST: a/a, alt. beds (cm) of fine-mod and mod. grains.					
			dist. wavy x-beds	alt. lt gy and dk gy beds (cm)						
1794			homogenous strongly disturbed		SST: fSU very well srt (micaceous)					

A/S Norske Shell	Well: 6508/5-1	Core No. 1

CORE DESCRIPTION

Cored from: 1786 to 1804 Recovered: 12.2 m 68 % Core size: 5 1/4"

Formation: MIDDLE DRAKE Date: 04.08.87 Described by: JAN STENLØKK Corehead: 12 1/4"x8 1/2"

Sheet: 5 of 6

DEPTH & SAMPLES	GRAPHIC LITHOLOGY	GRAIN SIZE (FINE, FINE, MED, CRS, CRS)	SEDIMENTARY STRUCTURES & FEATURES	COLOUR	COMPOSITION (& ACCESSORY MINERALS)	CMT	ESTIMATED Ø %	HYDROCARBON INDICATIONS (SMPL FLU, CUT COL, CUT FLU)	GAS %	REMARKS (OIL BLEED DIPS FRACTURES ETC)
1974			(∠) strongly bioturbated.			UNCONSOLIDATED	GOOD POROSITY AND PERMEABILITY	NO SHOWS		
			Parts of black clay/ coal lam.	lt						
1974.5			((=))	(med) gy	SST: qz, fSL-fSU very well srt ang- (rnd) (micaceous)					
			more or less homogenous							
			hints of x-beds mm-cm							
1975			(=)							
			dk gy clay filled vertical burrows							
			((∠))		COAL: abundant dist. mm lam.					
1975.5			parts of dark clay lam. dist. and broken							
			strongly bioturbated							
1976			(∠) slightly less dist. wavy ang. beds		COAL: black, britte layered					

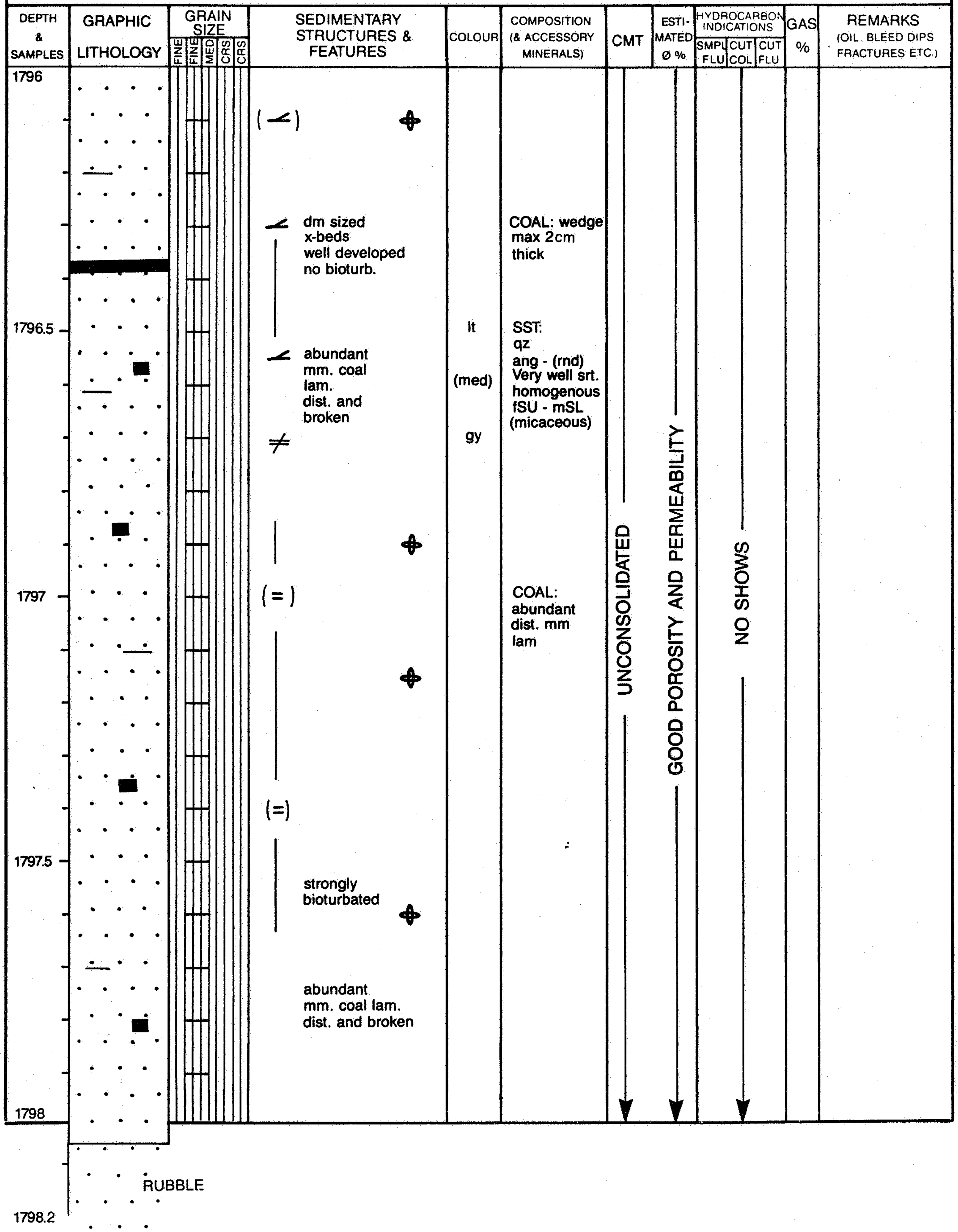
A/S Norske Shell	Well: 6508/5-1	Core No. 1

CORE DESCRIPTION

Cored from: 1786 to 1804 Recovered: 12.2 m 68 % Core size: 5 1/4"

Formation: MIDDLE DRAKE Date: 04.08.87 Described by: JAN STENLØKK Corehead: 12 1/4"x8 1/2"

Sheet: 6 of 6



APPENDIX 2

SIDEWALL SAMPLE DESCRIPTION

WELL 6508/5 - 1

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APPENDIX 2

1	misfire	(2476 m)
2	lost	(1739.5 m, 2355.5 m)
3	empty	(1616 m, 2196 m, 2409.2 m)
3	poor samples/not paid for	(1623 m, 2115 m, 2289.8 m)
81	samples paid for	
90	samples total	

Recovery 90%

DEPTH	RECOVERY MM	LITHOLOGY	SAMPLE FLUORESCENCE	COLOUR OF CUT	CUT FLUORESCENCE
1597	50	CLST: dk gy, (slty)	No	Purple	Yes
1607	32	CLST: a/a	No	Purple	Yes
1611	50	CLST: a/a	No	Purple	Yes
1616	EMPTY				
1623	15	CLST: a/a	No	Purple	Yes
1630	40	CLST: a/a	No	Purple	Yes
1635.5	45	CLST: a/a	No	Purple	Yes
1642	50	CLST: a/a	No	Purple	Yes
1648	52	CLST: dk gy, slty	No	Purple	Yes
1659	40	CLST: med gy, (slty)	No	Purple	Yes
1665	40	CLST: med gy	No	Purple (weak)	Yes
1675	50	CLST: a/a	No	Purple (weak)	Yes
1687	45	CLST: med-dk gy, slty	No	Purple (weak)	Yes
1699.8	44	SLTST: med-dk gy, arg	No	Purple (weak)	Yes
1710	42	CLST: med-dk gy, slty	No	Purple (weak)	Yes
1719.8	41	CLST: a/a	No	Purple (weak)	Yes
1730	43	SLTST: med gy, arg	No		No
1735.2	40	SLTST: a/a	No		No
1739.5	LOST				
1748	40	SLTST: a/a	No		No
1755	40	SLTST: lt-med gy, arg	No		No
1765	45	CLST: med gy, slty	No	Purple (V.weak)	Yes
1755	42	CLST: med gy, slty	No	"	Yes
1806	45	SST: lt gy, f, w.srtd, dk spots, por	No		No
1817	39	SLTST: med gy, arg (thin lam)	No		No
1823	35	SLTST: a/a	No		No
1830.5	35	SLTST: lt gy, sndy (f sand)	No		No
1839	50	CLST: med gy, slty	No		No
1850	38	SLST: lt gy, sndy (f sand)	No		No
1860	42	SLTST: a/a	No		No
1869	40	SST: wh-lt gy, f, w srtd, por	No		No
1880	30	SST/SLTST: gy-wh, lam (f sst)	No		No
1890	26	SST/SLTST: a/a	No		No
1894	32	SST/CLST: (1 cm lam), sst: , clst:gy, slty	No		No

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DEPTH	RECOVERY MM	LITHOLOGY	SAMPLE FLUORESCENCE	COLOUR OF CUT	CUT FLUORESCENCE
1902	32	SST: lt gy, f, slty, por	No		No
1912	40	SST: a/a	No		No
1919.5	26	SLTST: med gy, (arg)	No		No
1930.2	30	SST/CLST: (1 cm lam), sst:f, clst:dk gy	No		No
1940.2	40	SST/SLTST: med gy-lt gy lam, sst: f	No		No
1948	35	CLST: med gy, slty	No		No
1957.5	50	SST: lt gy, f, slty, por	No		No
1965.0	35	SST: lt gy-lt brn, med w.srtd, por	No		No
1975.5	40	SST: ltgy, f, w srtd, slty	No		No
1982.0	45	SST: lt gy, med, w srtd, coal part, por	No		No
1986.5	45	SLTST: lt-med gy, sndy	No		No
1995.0	39	SLTST: a/a	No		No
2007.3	50	SST: lt gy, f-med, mod srtd, slty, por	No		No
2026	40	CLST: med gy, slty	No		No
2051	45	SST: lt gy, f, w srtd, por	No		No
2071.2	31	CLST: med gy, slty	No		No
2074	35	SLTST: lt gy, sndy	No		No
2078	22	COAL: bk, hd, brit	No		No
2084	51	SST: lt gy, f, slty, coal particles, por	No		No
2100	52	SST: a/a	No		No
2115	15	CLST/COAL: small pieces	No		No
2120	42	CLST: med gy, slty	No		No
2140	40	CLST: a/a	No		No
2146	52	SST: lt gy, f, slty, carb part, por	No		No
2156	28	SLTST: med gy	No		No
2170.5	38	SLTST: med gy, arg, carb part	No		No
2178	30	COAL/CARB SH: bk, (brittle)	No		No
2180.8	30	COAL: bk, brittle, v.pyritic	No		No
2185.5	40	COAL: bk-brn, brittle, hd	No		No
2196	EMPTY				
2199.8	51	CLST: med gy, slty, coal part	No		No
2209.3	30	COAL: bk-brn, brittle, hd	No		No
2177.7	24	SLTST: med gy, v.pyr, coal part, sndy	No		No
2229.0	32	COAL: bk-brn, brittle, hd	No		No

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DEPTH	RECOVERY MM	LITHOLOGY	SAMPLE FLUORESCENCE	COLOUR OF CUT	CUT FLUORESCENCE
2273	36	CLST: med gy, slty	No		No
2276	43	COAL: bk, brittle	No		No
2286.0	57	SLST: med gy, arg	No		No
2289.8	24	CLST: med gy, coal pieces	No		No
2304	30	CLST: med gy, slty	No		No
2338	36	SLTST: med gy, coal part, sndy	No		No
2345	34	SLTST: a/a	No		No
2355.5	LOST				
2373.5	30	SLTST: a/a	No		No
2382	53	CLST: med gy, slty	No		No
2409.2	EMPTY				
2425	45	CLST: med gy slty	No		No
2440	30	SH: med gy, slty lam	No		No
2451.5	50	CLST: med gy, slty	No		No
2459	45	CLST: med-dk gy, slty	No		No
2476	MISFIRE				
2490.2	33	CLST: med gy, slty	No		No
2500.5	32	SLTST: med gy, arg, hd	No		No
2521	50	CLST: med gy, slty	No		No
2530	30	SH: med gy-dk brn, slty, hd	No		No
2546.2	40	SH/CLST: med gy, slty	No		No
2556.1	35	SH/CLST: med gy-(gn)gy, slty	No		No