Seismograph Service (England) Limited

AIRGUN WELL VELOCITY SURVEY AND CALIBRATED LOG DATA

FROM SCHLUMBERGER SONIC LOGS

COMPANY NORSK HYDRO A/S

WELL 31/3-2

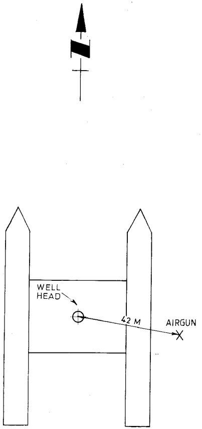
FIELD TROLL

COUNTRY NORWAY NORTH SEA

DATE OF LOGGING 10/3/84 18/3/84 31/3/84 **SONIC LOGS**

DATE OF WELL VELOCITY SURVEY 2/4/84

M5580



WELL : 31/3-2

RIG DIAGRAM

RIG NAME: TREASURE SEEKER

RECORD NOS.

1-21

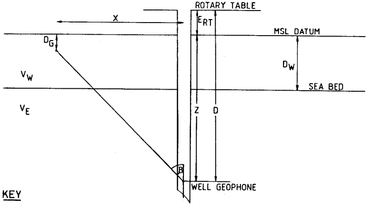
22

WELL: 31/3-2

MONITOR RECORD FORMAT

TRACE:	FUNCTION:
1	Read After Write gun hydrophone
2	R.A.W. Vertical well geophone
3-4	R.A.W. Horizontal well geophone
5	Gun hydrophone
6	Vertical well geophone
7-8	Horizontal well geophone
9	TB
1	Stacked gun hydrophone
2	Stacked well geophone
3-8	Unused traces
9	TB

SCHEMATIC CROSS-SECTION



KEY

RT - Rotary Table
D - Depth of Well Geophone below RT
E_{RT} - Elevation of RT above datum
Z - Depth of Well Geophone below datum
D_G - Depth of Gun below M.S.L.
H - Distance between Gun and Gun Hydrophone
D_W - Depth of Water
V_W - Water Velocity
V_E - Elevation Velocity
X - Horizontal distance from Well to Gun
β - Incident angle at Well Geophone levels
T - Observed travel-time between Gun Hydrophone and Well Geophone
T_V - Travel-time from Gun to Well Geophone corrected to the vertical, $(T + \frac{H}{V_W}) \cos \beta$
T_E - Travel-time correction from Gun to datum
T_C - $T_V + T_E$
ΔZ - Interval distance
ΔT_C - Interval travel-time
V_A - Z/T_C (Average velocity)
V_I - $\Delta Z/\Delta T_C$ (Interval velocity)

COMPANY: NORSK HYDRO A/S
WELL: 31/3-2 (RIG SOURCE)
AIRGUN COMPUTATION

E_{RT}
V_W

RECORD NO	D'	D	Z
	M	M	M
21	1120.0	1120.0	1099.0
20	1195.0	1195.0	1174.0
19	1285.0	1285.0	1264.0
18	1340.0	1340.0	1319.0
17/2	1450.0	1450.0	1429.0
16	1475.0	1475.0	1454.0
15	1515.0	1515.0	1494.0
14	1540.0	1540.0	1519.0
13	1575.0	1575.0	1554.0
12	1600.0	1600.0	1579.0
11	1620.0	1620.0	1599.0
9	1725.0	1725.0	1704.0
8/3	1770.0	1770.0	1749.0
7	1830.0	1830.0	1809.0

SEISMOGRAPH SERVICE (ENGLAND) LTD.

WELL SURVEY DIVISION

= 21.0M
= 1478M/S

RT= 21.0M AMSL
E_D = MSL

GUN DEPTH 10.0M
GUN HYDROPHONE DEPTH 13.0M
GUN OFFSET 42.0M

X	T	T_V	T_E	T_C	AVERAGE VELOCITY	INTERVAL DEPTH	INTERVAL TIME	INTERVAL VELOCITY
M	S	S	S	S	M/S	M	S	M/S
42.0	0.6410	0.6425	0.0068	0.6493	1693			
						75.0	0.0330	2270
42.0	0.6740	0.6756	0.0068	0.6824	1720			
						90.0	0.0420	2141
42.0	0.7160	0.7176	0.0068	0.7244	1745			
						55.0	0.0270	2036
42.0	0.7430	0.7446	0.0068	0.7514	1755			
						110.0	0.0520	2114
42.0	0.7950	0.7967	0.0068	0.8035	1779			
42.0	0.8040	0.8057	0.0068	0.8125	1790			
						65.0	0.0270	2406
42.0	0.8220	0.8237	0.0068	0.8305	1799			
						25.0	0.0090	2775
42.0	0.8310	0.8327	0.0068	0.8395	1809			
42.0	0.8480	0.8497	0.0068	0.8565	1814			
42.0	0.8570	0.8587	0.0068	0.8655	1824			
						80.0	0.0330	2423
42.0	0.8640	0.8657	0.0068	0.8725	1833			
						105.0	0.0340	3086
42.0	0.8980	0.8997	0.0068	0.9065	1880			
						45.0	0.0120	3747
42.0	0.9100	0.9117	0.0068	0.9185	1904			
						60.0	0.0190	3156
42.0	0.9290	0.9307	0.0068	0.9375	1930			

RECORD NO	D'	D	Z
	M	M	M
6	1935.0	1935.0	1914.0
5	1965.0	1965.0	1944.0
4	2075.0	2075.0	2054.0

T IS THE TIME MEASURED FROM THE FI

A TIME CORRECTION FOR THE DISTANCE

TV IS THE TIME FROM THE GUN TO THE

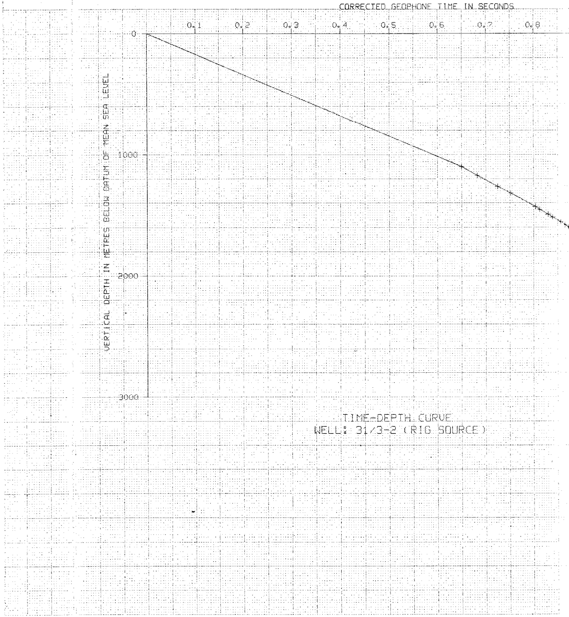
$$TE = \frac{\text{GUN DEPTH}}{VW}$$

X	T	T_V	T_E	T_C	AVERAGE VELOCITY	INTERVAL DEPTH	INTERVAL TIME	INTERVAL VELOCITY
M	S	S	S	S	M/S	M	S	M/S
42.0	0.9620	0.9638	0.0068	0.9706	1972			
						135.0	0.0410	3291
42.0	0.9700	0.9716	0.0068	0.9706	1987			
						110.0	0.0320	3436
42.0	1.0020	1.0038	0.0068	1.0106	2032			

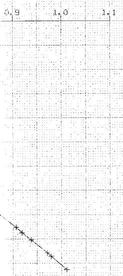
RST TROUGH ON THE GUN HYDROPHONE SIGNAL TO THE FIRST TROUGH ON THE WELL GEOPHONE SIGNAL.

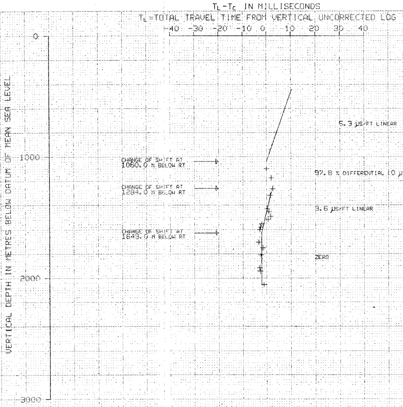
BETWEEN GUN AND GUN HYDROPHONE AT WATER VELOCITY IS ADDED TO T BEFORE CORRECTION TO THE VERTICAL.

WELL GEOPHONE CORRECTED TO THE VERTICAL.



TIME-DEPTH CURVE
WELL: 31/3-2 (RIG SOURCE)





T_L	T_C	$T_L - T_C$
0.6493	0.6493	0.0000
0.6843	0.6924	0.0020
0.7269	0.7244	0.0025
0.7529	0.7514	0.0015
0.8037	[illegible]	0.0003
0.8134	[illegible]	0.0010
[illegible]	[illegible]	0.0012
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	-0.0028
0.9034	0.9065	-0.0031
0.9170	0.9185	-0.0015
0.9353	0.9375	-0.0022
0.9528	0.9706	-0.0027
0.9760	0.9786	-0.0025
1.0095	1.0106	-0.0011

LOG CALIBRATION CURVE
WELL: 31/3-2 (RIG SOURCE)

Linear Shifts are calculated using the formula:-

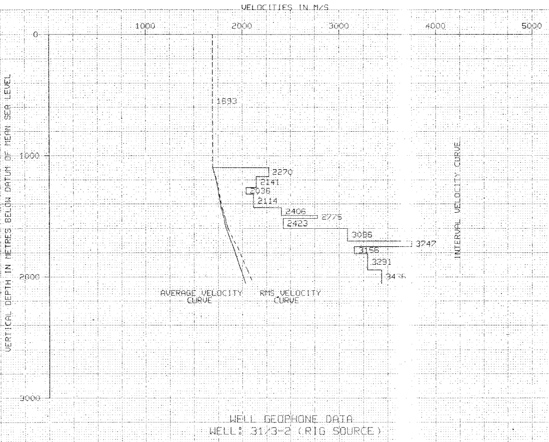
$$\frac{(t_L - t_c)_2 - (t_L - t_c)_1}{Z_1 - Z_2}$$

where t_L and t_c are the travel times to adjacent check levels measured from the velocity log and geophone records respectively. The result is expressed in µs/ft. The linear shifts are applied only when the correction is negative as the log error in this case is assumed to be instrumental in origin.

Differential Shifts are calculated using the formula:-

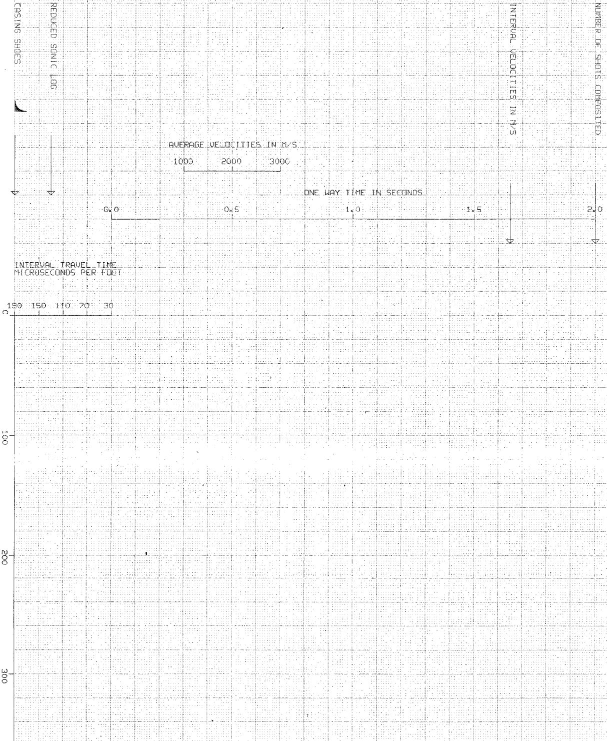
$$\frac{t_{c_2} - t_{c_1}}{t_{L_2} - t_{L_1}} \times 100\%$$

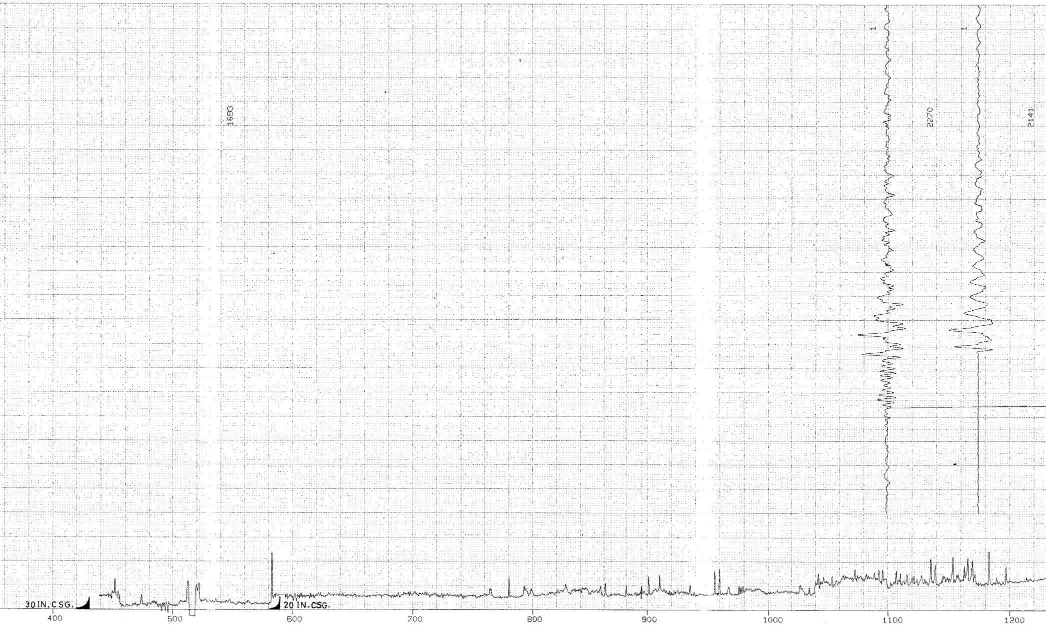
They are applied whenever the calibration data indicates a shift towards higher velocities. Because the lower velocities are assumed to have contributed more transit time error than higher velocities due to caving, and other borehole effects, lower velocity sections of log receive larger corrections than higher velocity sections.

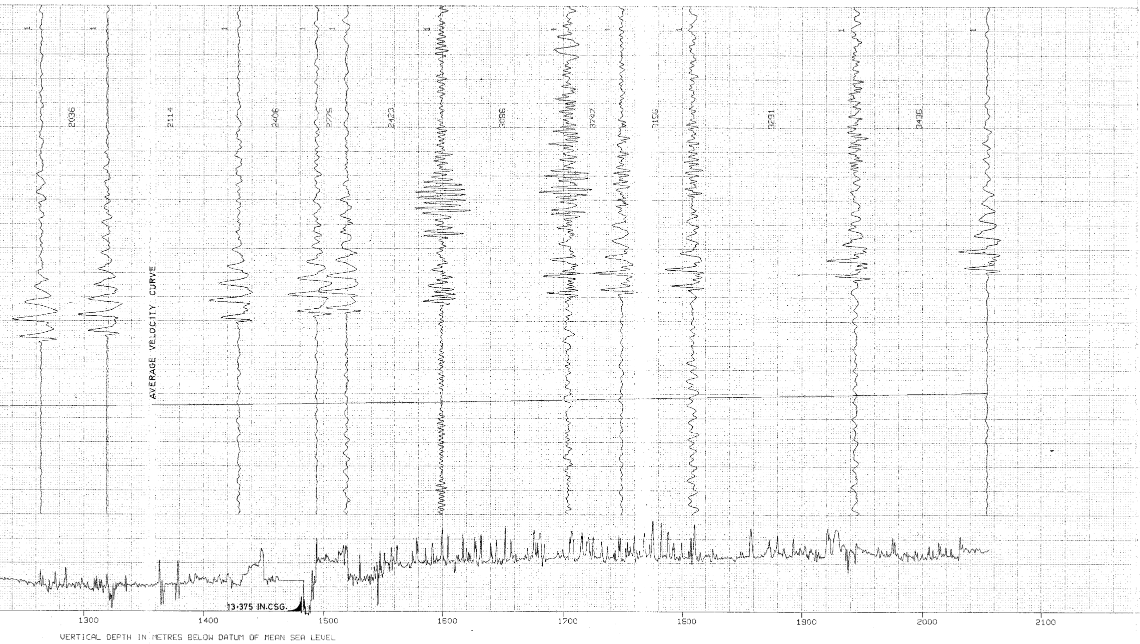


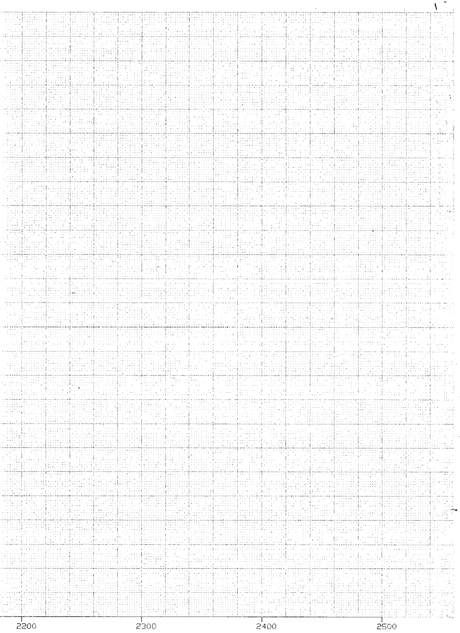
SECTIONAL DISPLAY OF WELL GEOPHONE SIGNALS

RECORDING PARAMETERS	PROCESSING PARAMETERS
GUN SIZE : 80 IN^3	SCALE : HORIZONTAL 10 CM = 1 S VERTICAL 1 CM = 20 M
GUN PRESSURE : 2000 LB/IN^2	DATUM : MEAN SEA LEVEL
GUN DEPTH : 10.0 M	SAMPLING INTERVAL : 1 MS
	FILTER : LP 50-90 HZ
	OTHER TECHNIQUES : NONE
	JOB NUMBER 539143 DATE 25/4/84









WELL: 31/3-2

COMMENT

A Rig Source Survey and two Long Offset Source Surveys were conducted simultaneously for this well.

WELL GEOPHONE SURVEY (Rig Source Survey):

A total of 20 levels were surveyed between 1000 and 2075 m below RT and are represented by records 1-23. There are no monitor records for the levels labelled 23 or 12 (1000 and 1600 m below RT) and so these have been timed from the tape data. The levels at 1000, 1450 and 1770 m below RT were shot more than once during the course of the survey and are represented by records 1, 23 and 2,18 and 3 and 8 respectively. The well geophone signals for the levels at 1000 and 1060 m below RT are distorted and after examination of the filtered tape data compatible times could not be picked and therefore these levels have been omitted from the computations. Both records 2 and 18 yielded a time of .795s while records 3 and 8 yielded a time of .910s and these times were used in the computations.

The level at 1502 m below RT was shot as a tool check shot in casing. Although the signal is of good quality a time compatible with the surrounding levels could not be obtained. It is thought that this discrepancy is due to a possible depth error and after examination of the preliminary calibration curve this level has also been omitted from the computations.

The check levels at 1475, 1575, 1600 and 1935 m below RT have not been included for calculation of interval velocities, nor for the sectional display of the well geophone signals, for which the filtered tape data has been used, due to the close proximity to nearby check levels.

SONIC LOGS:

Both short (DT) and long (DTL) sonic logs were recorded. Where they differ the curve showing the higher velocity has been preferred, except where such higher velocities are considered unreliable. The logs have been generally well recorded and have been edited for any noise spikes or cycle skipping and re-integrated before calibration. There are gaps of 5 and 19 m between sonic runs 1A and 2B and 2B and 4C respectively. Straight lines have been drawn across these gaps at the general velocity of the adjacent log and the log has been treated as continuous for calibration purposes.

/Contd.....

SONIC LOG CALIBRATION:

The log above 1120 m below RT is uncontrolled by check level data. A linear shift to lower velocities has been applied between the top of the log and 1060 m below RT so that the velocity after calibration between seabed and the top of the log (193.7 μs/ft) is approximately equal to the velocity of the top section of the log. After application of this shift the interface at 1060 m below RT has been increased.

The calibration has been formulated by following the general trends of the points on the calibration curve. This results in some scatter of the check levels about the chosen curve but only the check level at 1475 m below RT lies more than 2 ms from the chosen calibration curve. The scatter in the region of 1500-1600 m below RT may be partly due to refraction effects.

The shifts applied to the log are considered to be the best interpretation of the available data.

Approved by:	Processed by:
L.D. Clough	John P. Vassallo
P. Kennett Manager, Well Survey Division	J. P. Vassallo

26th April 1984

MS/H