ESSO Australia Pty Ltd

Scallop-1

WELL SEISMIC PROCESSING REPORT

VSP

FIELD:	Exploration
COUNTRY:	Australia
COORDINATES:	Latitude: 38 12' 48.615" S
:	Longitude: 148 35' 28.879" E
PERMIT:	VIC/RL2
DATE OF SURVEY:	23-FEB-2003
SURVEY TYPE:	Rig Source VSP, Offshore, Airgun
REFERENCE NO:	DS 0403
INTERVAL:	3171 m – 174 m KB

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1 Introduction

A borehole seismic survey was recorded in one run in the vertical offshore Victoria exploration well Scallop-1 on 23 February 2003. This survey included rig source VSP measurements in open and cased hole. The data were acquired using a Dual Combinable Seismic Acquisition Tool (CSAT-B) downhole and an Air gun source deployed from a crane on the rig.

This report describes the VSP processing techniques used, the parameters chosen and presents the results of the data processing.

2 Data Acquisition

The data were acquired in one logging run in both open and cased hole, using a Dual three component Combinable Seismic Acquisition Tool (CSAT-B) fitted with GAC accelerometers. Two 150 cu in G-Gun Airguns were used as the source operating under 2000 psi. The guns were suspended in sea 5m at 45m offset from the wellhead. Two reference hydrophones were positioned at 5m below the guns. Recording was made on the Schlumberger Maxis 500 Unit using DLIS format.

The VSP levels were acquired from 3171 m KB to 174 m KB at 15m intervals. A minimum of 5 good shots were recorded for each level.

Table 1. Survey Parameters

Elevation of KB/DF	25.9 m above MSL
Elevation of GL	-109.6 m
Well Deviation	Max 1.68 deg
Energy Source	2x 150 cu in G-Guns
Reference Sensor	Hydrophone
Source & Hyd. Offset	45 m
Source & Hyd. Azimuth	035 deg
Source Depth	30.9 m below KB
Hydrophone Depth	35.9 m below KB
Tool	Dual CSAT-B
Sensor Type	3-C GAC – Geophone Accelerometer
Sampling Rate	1 ms.
Recording Time	4.0 sec.
Recording Format	DLIS

3 Well Seismic Edit

The initial preparation of the data is called Well Seismic Edit and consists of:

- Load Data
- Edit bad records & Sort Data
- Pick Reference Break times
- Median stack
- Geophone transform
- Pick Break time on Stacked Data

Each shot of the raw GAC data was evaluated and edited to remove bad traces. The hydrophone data were also evaluated for signature changes and timing shifts. The good shots at each level were stacked, using a median stacking technique, to increase the signal to noise ratio of the data. After Stacking the GAC data are transformed to a Geophone response and the transit time of each trace was re-computed.

The following subsections describe the main aspects of the well seismic edit phase.

3.1 Data Quality

The data quality is very good. The source signature is stable indicating a constant gun pressure and gun depth. The horizontal components show some shear energy, but the vertical component data shows good continuity and little shear contamination. Some tube wave energy is visible, but this is not affecting the corridor stack and will be removed for better display. Attenuation (Q) analysis and shear velocity estimation are feasible, but were not requested for this processing project.

3.2 Transit Time Measurement

The measured transit time corresponds to the difference between arrivals recorded by surface and downhole sensors. The reference time (zero time) is the physical recording of the source signal by accelerometers on the gun or sensors positioned near the source. In this case, a hydrophone positioned 5 m below the gun was used as the reference. An inflection point tangent first break picking algorithm was used on both the hydrophone and the geophone data.

3.3 Stacking

After reordering and selecting the raw shots, a median stack was performed on the three component data. In this method of stacking, at each sample time, the amplitudes of the input traces are read and sorted in ascending order. The output is the median amplitude value from this ordering. If an even number of traces is input, the first is dropped and a median calculated. Then the last is dropped and another median found. The final output is the average of these two median values. The surface sensor (hydrophone) breaks are used as the zero time for stacking. The break time of each trace is recomputed after stacking and GAC transform. The X, Y and Z component stacks are presented in Figures 2 ,3 and 4. There is good shear energy observable on the horizontal components.

4 VSP Processing Chain

The vertical component of the VSP data was processed using standard VSP processing techniques. The following subsections describe the main aspects of the VSP processing chain:

- Bandpass Filter
- Spherical Divergence Correction
- Trace Normalization
- Transit time correction to Datum
- Wavefield Separation
- Waveshape Deconvolution
- NMO Correction
- Upgoing Enhancement
- Corridor Stack

4.1 Bandpass Filter

The effective bandwidth of the recorded data is evaluated by examining the amplitude spectrum of the stacked vertical component presented in Figure 1. A wide zero phase Butterworth Bandpass filter was applied to the data limiting the bandwidth to 5-120 Hz.

4.2 Spherical Divergence Correction

To correct the recorded amplitudes for the loss of energy due to the spherical divergence of the wave front, a time varying gain function of the exponential form:

$$Gain(T) = \left(\frac{T}{T_0}\right)^{\alpha}$$

where T is the recorded time, T_0 is the first break time and a = 1.5 was applied.

4.3 Trace Normalization

Trace equalization was applied by normalizing the RMS amplitude of the first break to correct for transmission losses of the direct wave. A normalization window of 200 milliseconds was used. Results are shown in Figure 4a.

4.4 Transit Time Correction to Datum

Seismic Reference Datum (SRD) is at Mean Sea Level. A static shift of 6.6 ms was applied to the data to correct to SRD. This correction to SRD was calculated using a surface velocity of 1524 m/s .

4.5 Wavefield Separation

A velocity filter (coherency) technique was used to separate upgoing and downgoing wavefields.

The downgoing coherent compressional energy is estimated using a 5 level Tuckey trimean velocity filter parallel to the direct arrival curve. The filter array is moved down one level after each computation and the process is repeated level by level over the entire dataset.
The downgoing wavefield is displayed in one-way time (Figure 5).

The residual wavefield is obtained by subtracting the estimated downgoing coherent energy from the total wavefield. The residual wavefield is dominated by reflected compressional events as shown in Figure 6. Some later arriving tube wave energy has been removed from this residual wavefield using a similar velocity filter method.

4.6 Zero Phase Waveshape Deconvolution

The waveshaping process shortens the seismic pulse within traces and centers their amplitude peak on the reflector. This improves the resolution of the seismic data and helps to clarify the correlation of the seismic events. It is also applied to collapse the recorded multiples.

The waveshaping deconvolution operator is a double-sided Wiener-Levinson waveshaping filter. The operator is computed for each level of the downgoing wavefield using a design window length of 2 s starting 5 ms before the picked break times in order to include the wavelet precisely. The designed outputs were chosen to be zero phase with a bandwidth of 5-80 Hz. Once the design is made upon the downgoing wavefield, it is applied to the both downgoing and upgoing wavefields at the same level as displayed in Figures 7 and 8.

4.7 NMO Correction

To correct for the lateral offset of the source position with respect to the downhole receiver in this well, a NMO correction was applied to the zero phase upgoing wavefield. This resulted in small time adjustments to obtain a vertical time referenced to SRD.

4.8 Upgoing Enhancement

A velocity filter (coherency) technique was used to enhance the zero phase upgoing wavefield.

The upgoing coherent compressional energy is estimated using a 3 level Tuckey trimean velocity filter orthogonal to the direct arrival curve. The filter array is moved down one level after each computation and the process is repeated level by level over the entire dataset.
This enhanced upgoing wavefield is displayed in two way time (TWT) in Figure 9.

4.9 Corridor Stack

A corridor stack in two way time (TWT) was computed on the enhanced zero phase upgoing wavefield by designing a constant 100 ms timing window along the two-way time depth curve and stacking the data onto a single trace. The deepest 10 traces are stacked entirely. The resulting trace provides the seismic representation of the borehole in vertical two-way time. This corridor stack is also displayed in Figure 9 along with the enhanced upgoing wavefield in two way time.

A snapshot of the 20 cm/s normal polarity composite display (PLOT-1) is shown in figure 10. A composite display in reverse polarity is included as well (PLOT-2). The polarity convention is explained in Figure 14.

ESSO uses a quad phase wavelet for their seismic interpretation. The corridor stack has been transformed to this standard using a 90 deg phase rotation. Now an increase in acoustic impedance is preceded by a trough and followed by a peak. Figure 11 shows the zero phase and the quad phase corridor stack side-by side.

A comparison of the corridor stack with part of the Skipper 99 surface seismic Inline 1025 was made shown in Figures 12a to 12d. The well location on the surface seismic line is at CDP 1330. Figures 12a and 12b show the unfiltered quad phase corridor stack in the top and bottom half of the section. The frequency is higher and match filtering is recommended. Events correlate very well above app 1.4 s TWT, but below this the surface seismic reflectors come in progressively later. The maximum time shift at TD is approximately 6 ms.

To provide a more ready comparison with the lower frequency surface seismic a filtered Corridor Stack was added. On Plots 1 and 2 additional panels shows the corridor stack with a Band pass Filter of 5-50 Hz and shifted down by 6ms on the surface seismic. Figures 12c and 12d also show this for the top and bottom half of the seismic section. Notice that shifting the data is not correct above 1.4 s TWT.

To investigate if the increased time delay can be explained by a rapid change in raypaths a 3-Component first arrival angle analysis was done. Figure 13 shows the angle the maximum downgoing energy component makes with the horizontal. The angles around 1750m (or 1.4 s TWT) are stable and raypaths are almost vertical.

As the surface seismic reflections at TD come in slightly later it cannot be attributed to TIV anisotropy. This would cause the surface seismic (dominated by the more slant raypaths from offset traces) to be faster than the vertical VSP rays.

Possible mechanisms to investigate are velocity inversion, internal multiples and dip effects on the seismic velocity analysis .

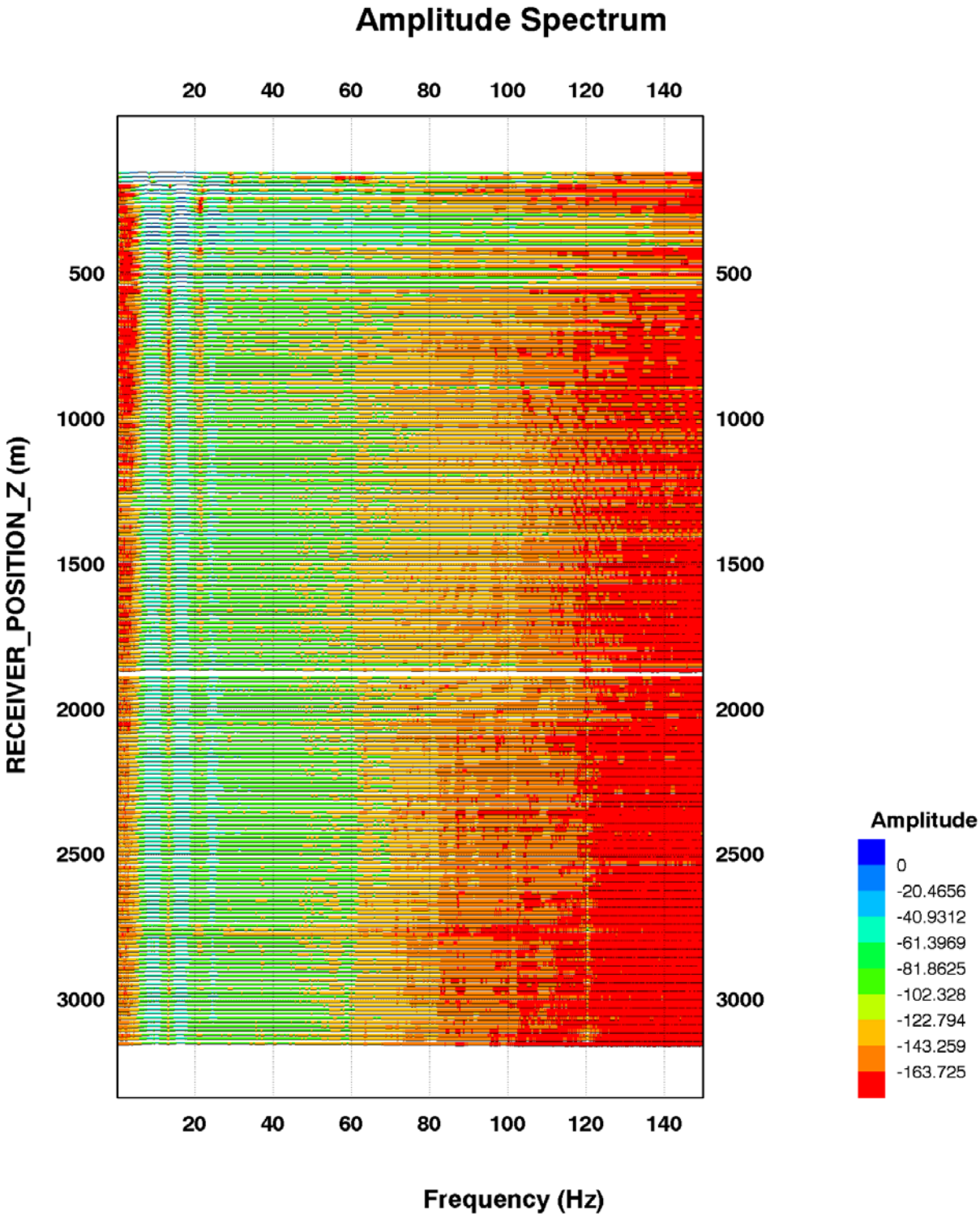

Figure 1. Amplitude Spectrum

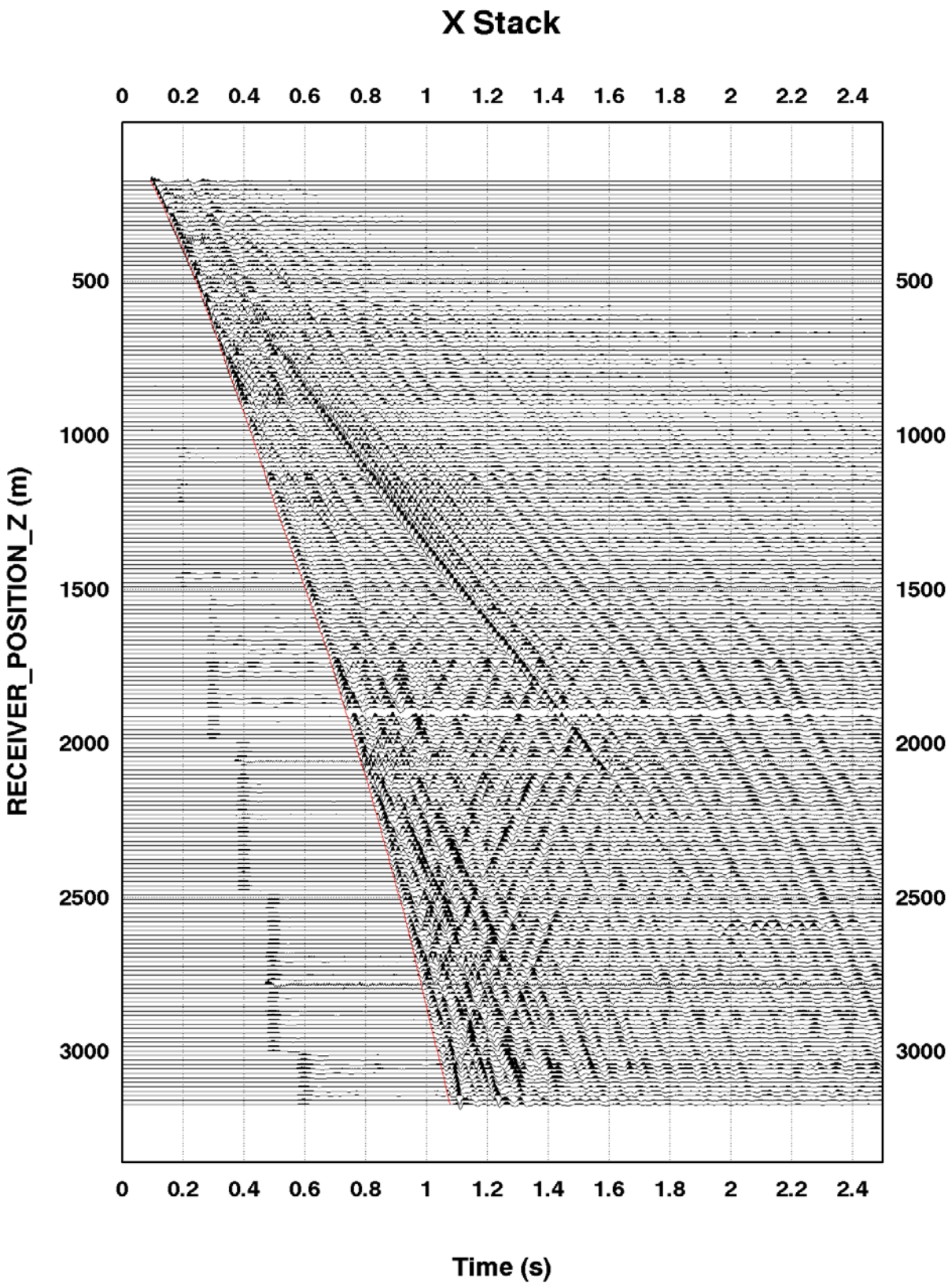

Figure 2. X Component Stack

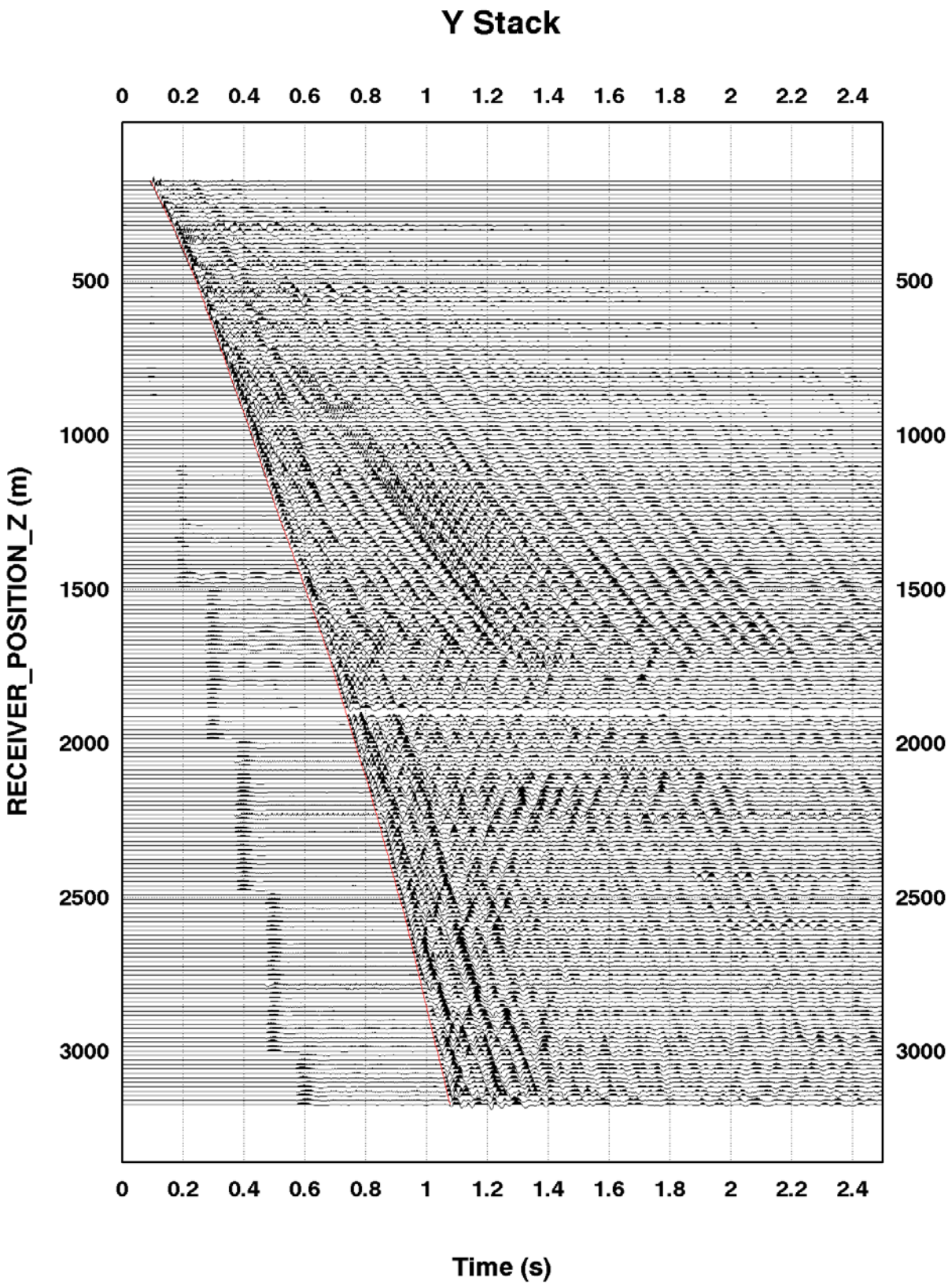

Figure 3. Y Component Stack

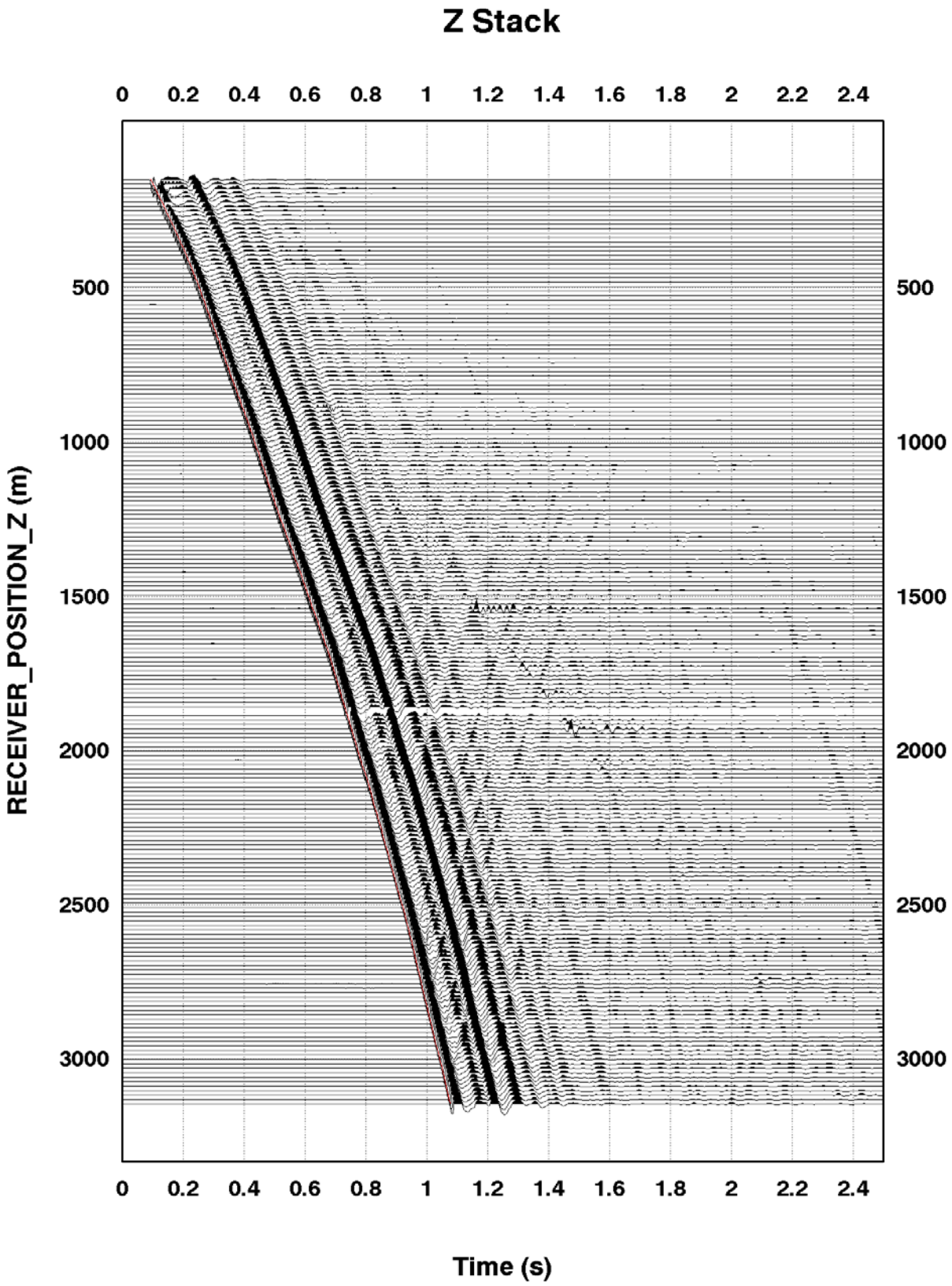

Figure 4. Z Component Stack

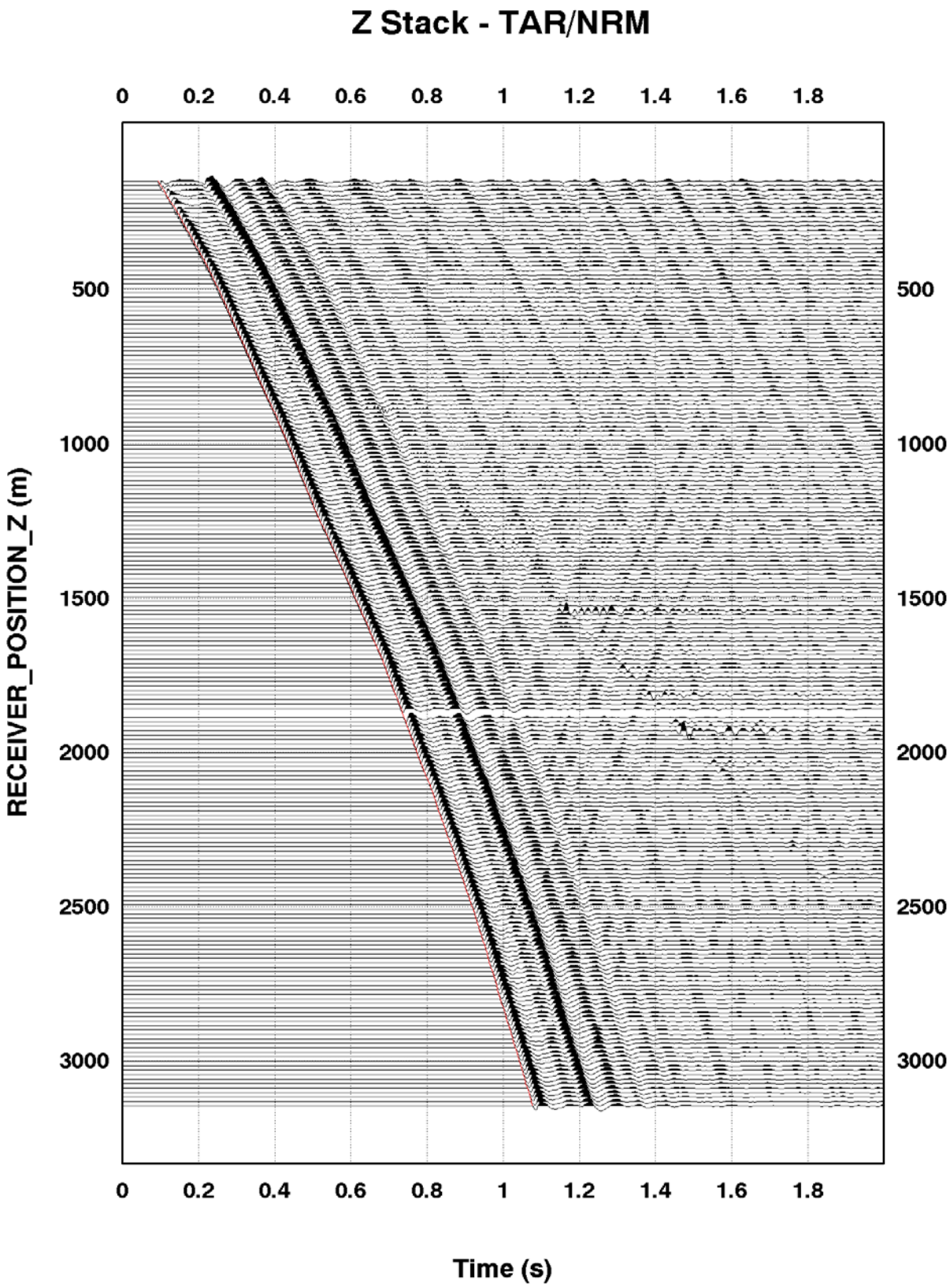

Figure 4a. Z Component Stack after Amplitude Recovery and Normalisation

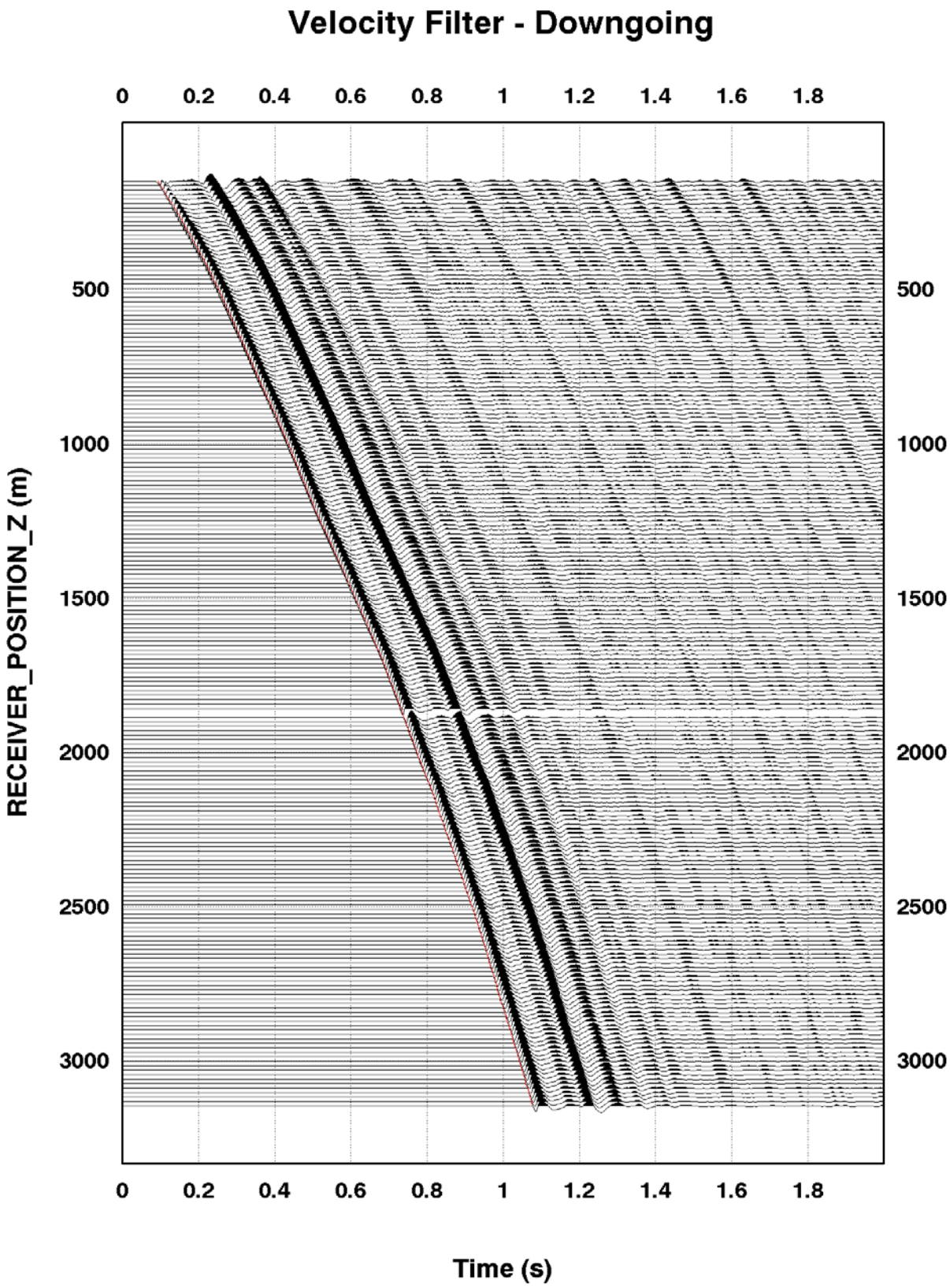

Figure 5. Downgoing Wavefield after Wavefield Separation

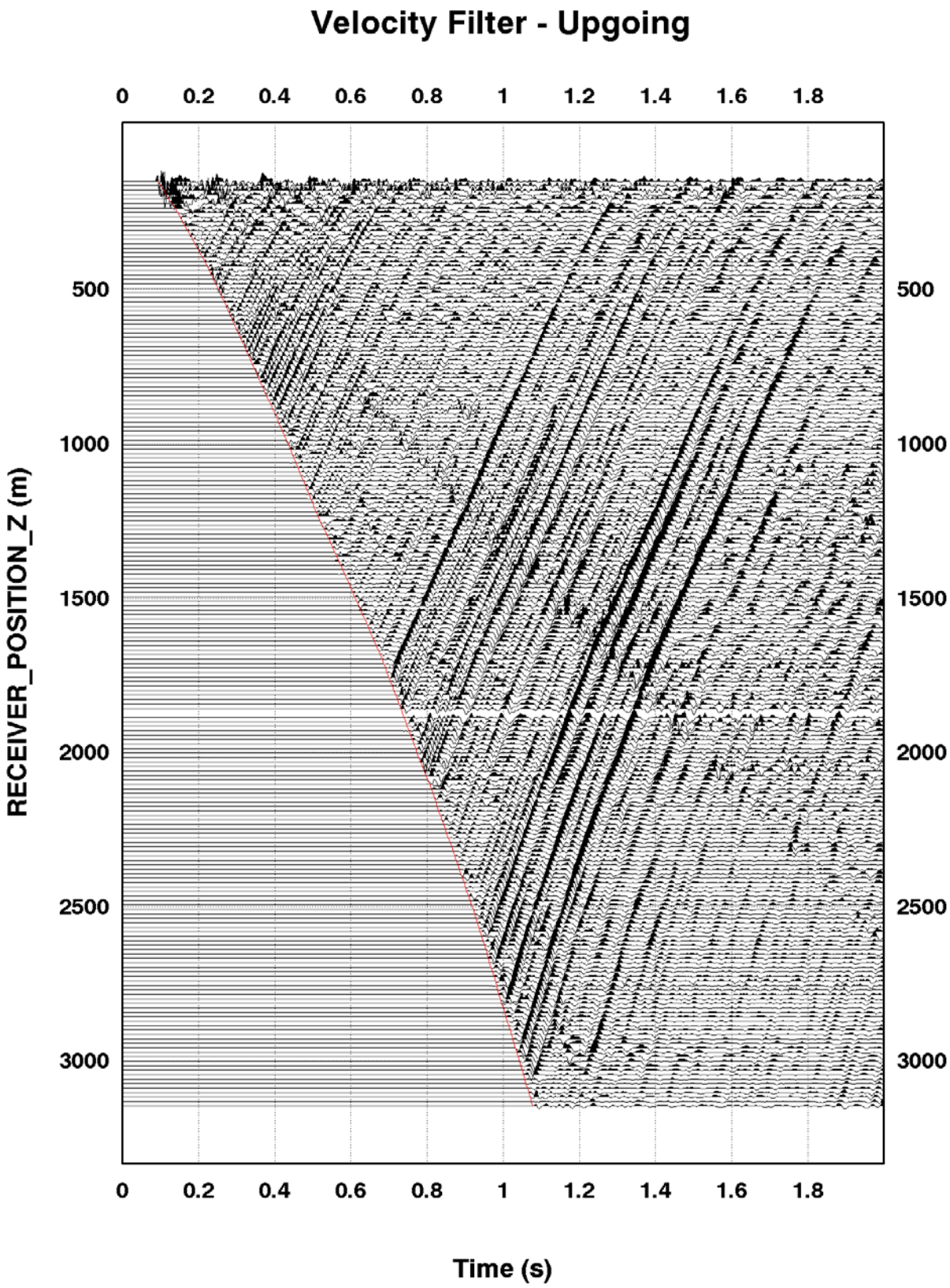

Figure 6. Upgoing Wavefield after Wavefield Separation

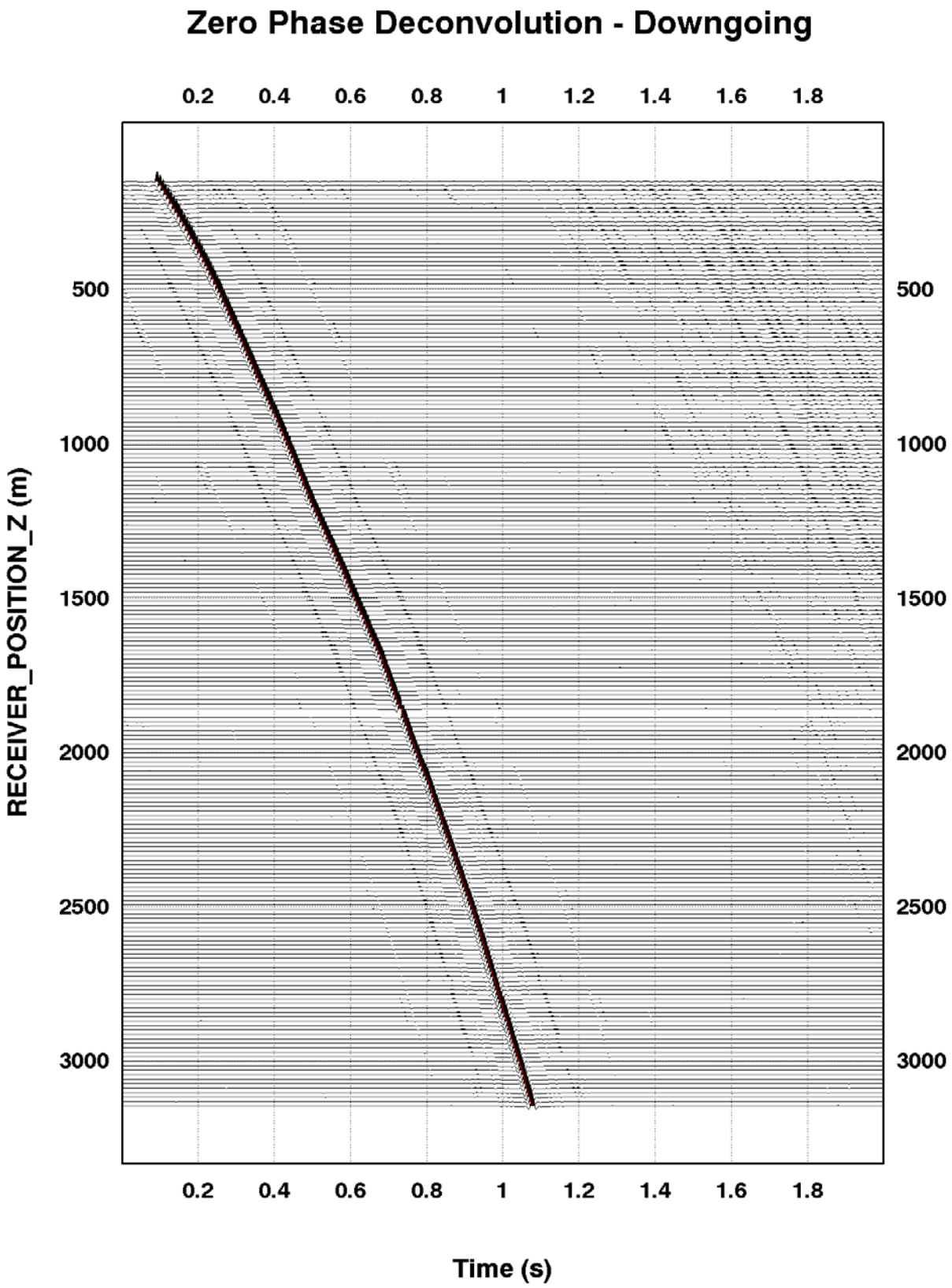

Figure 7. Downgoing Wavefield after Waveshaping Deconvolution

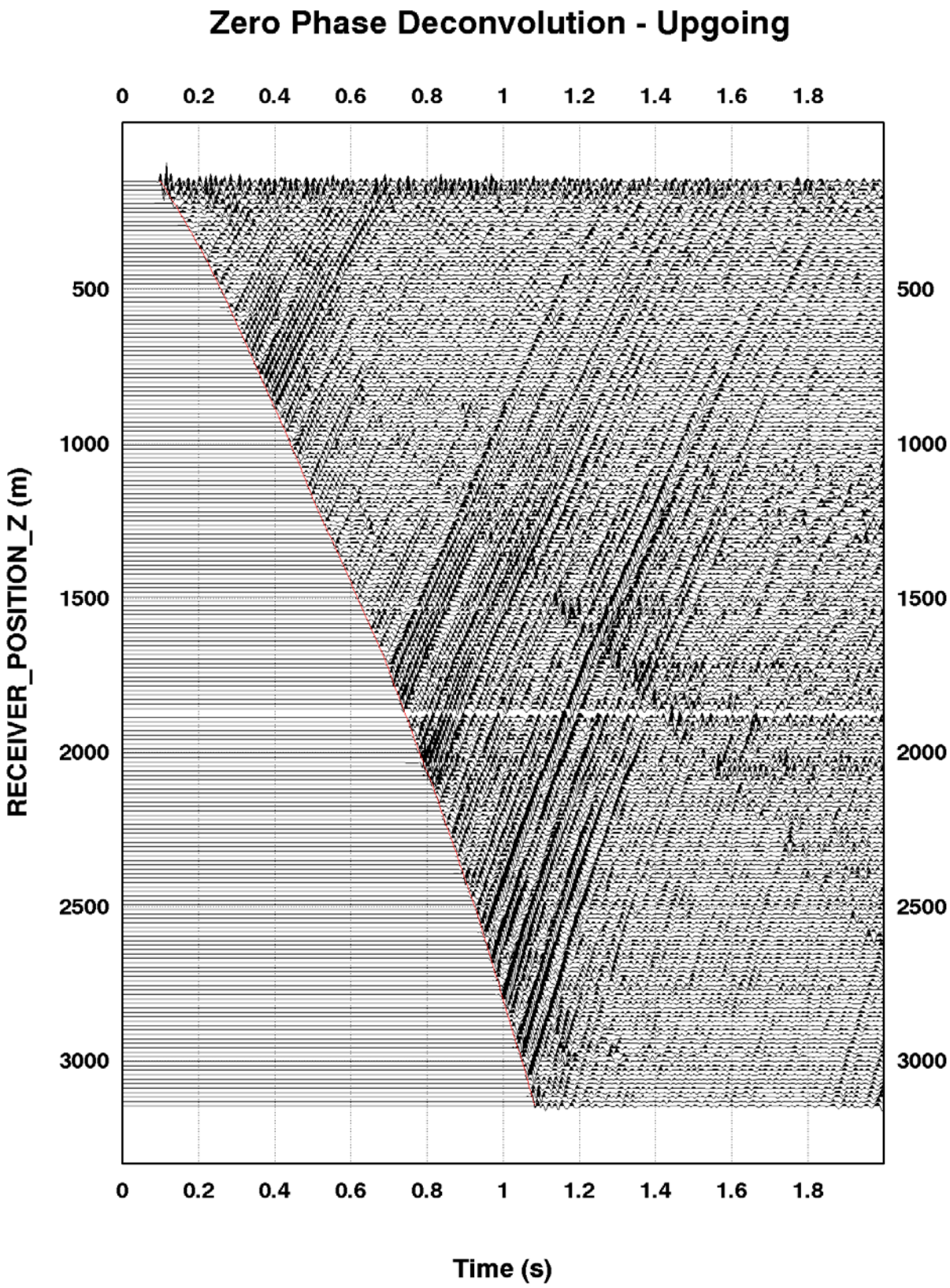

Figure 8. Upgoing Wavefield after Waveshaping Deconvolution

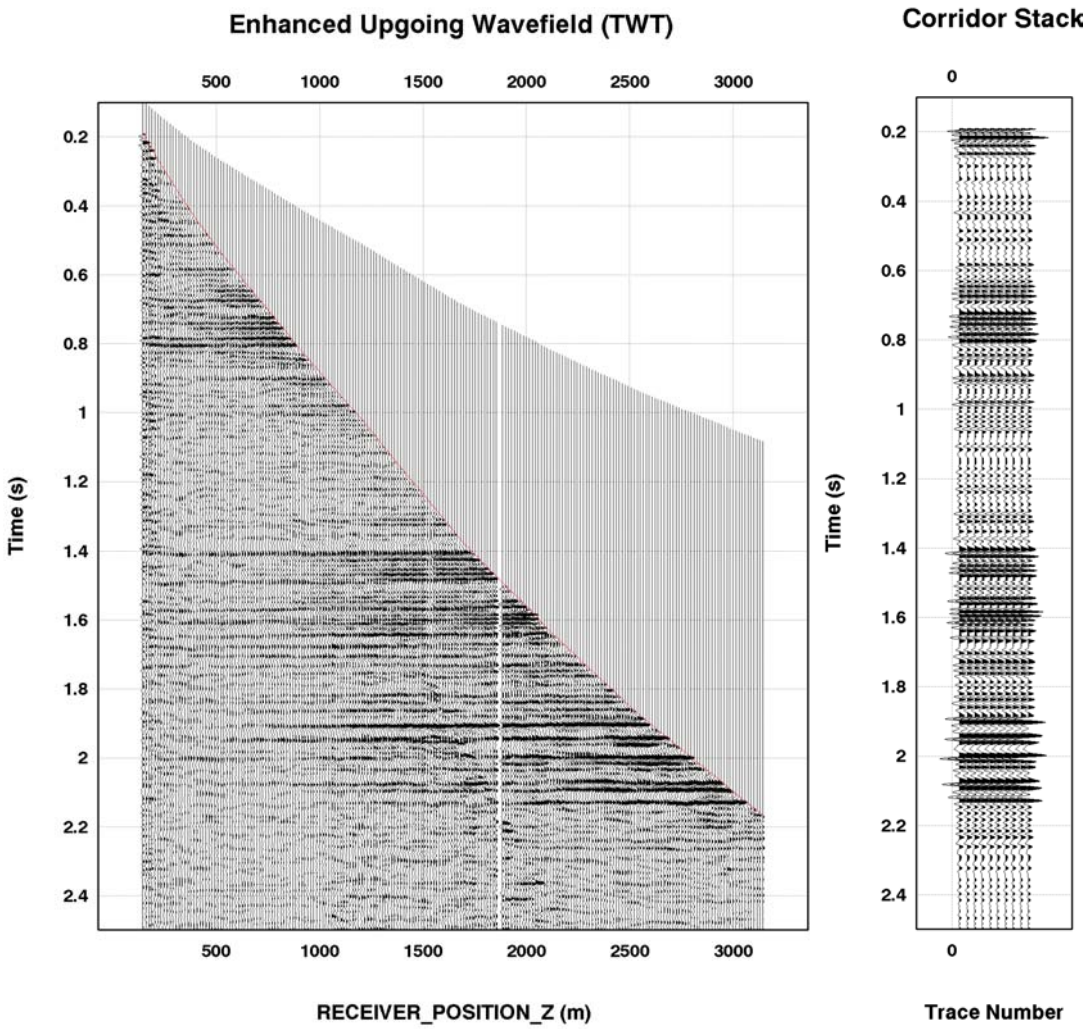

Figure 9. Enhanced Upgoing Zero Phase Wavefield and Corridor Stack in TWT

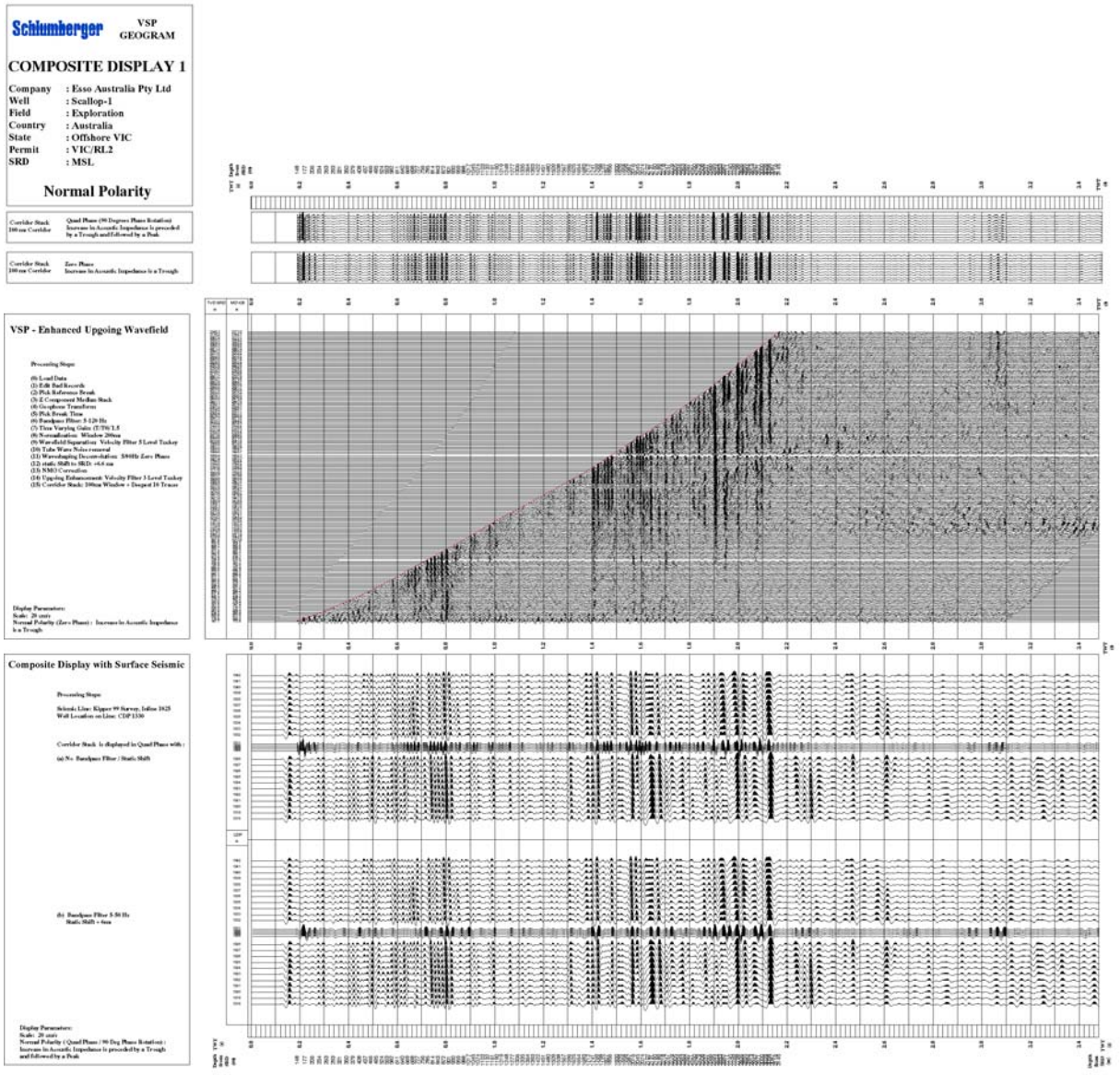

Figure 10. Composite Display (See Plot 1)

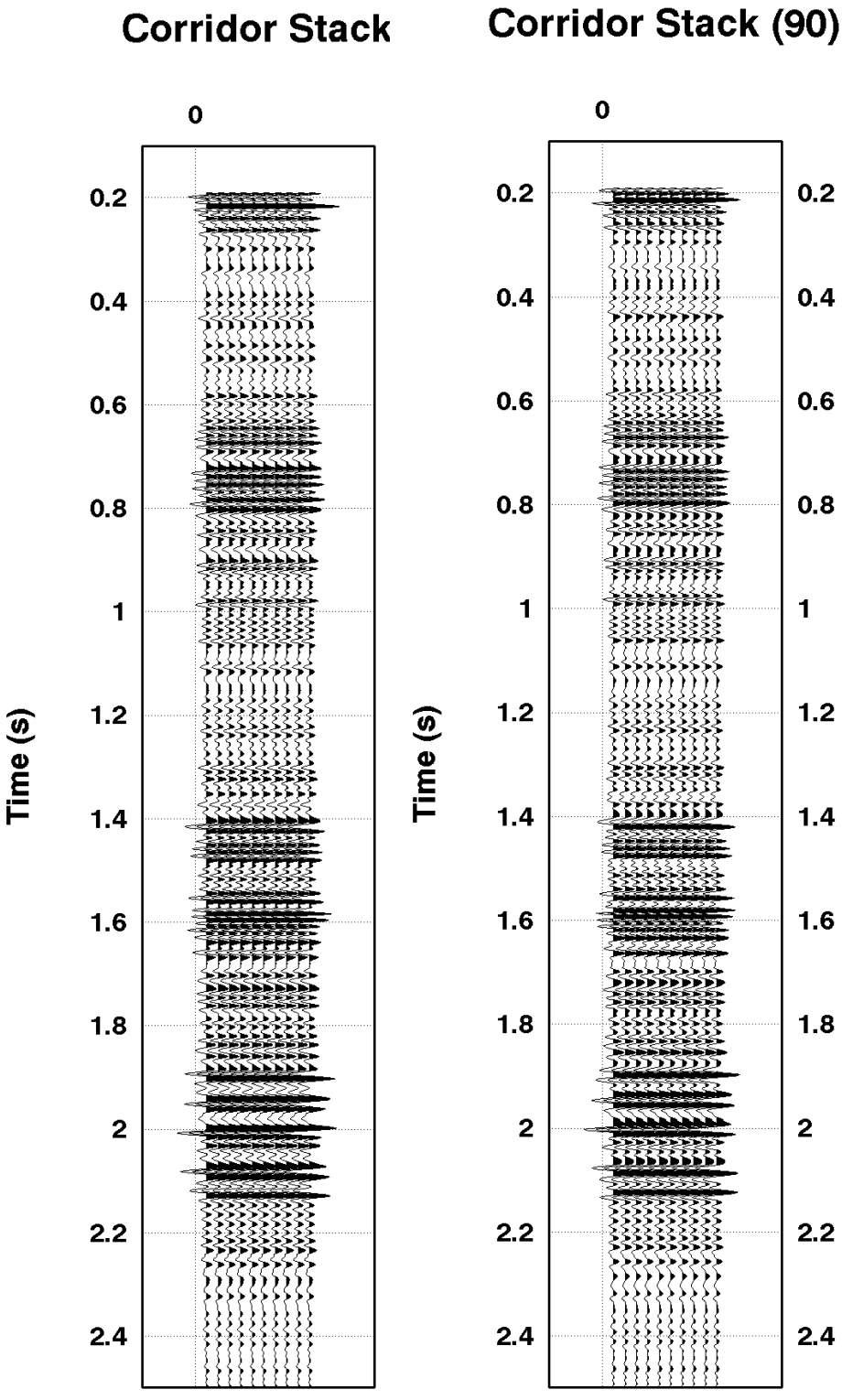

Figure 11. Corridor Stack : (1) Zero Phase (2) Quad Phase – Normal Polarity

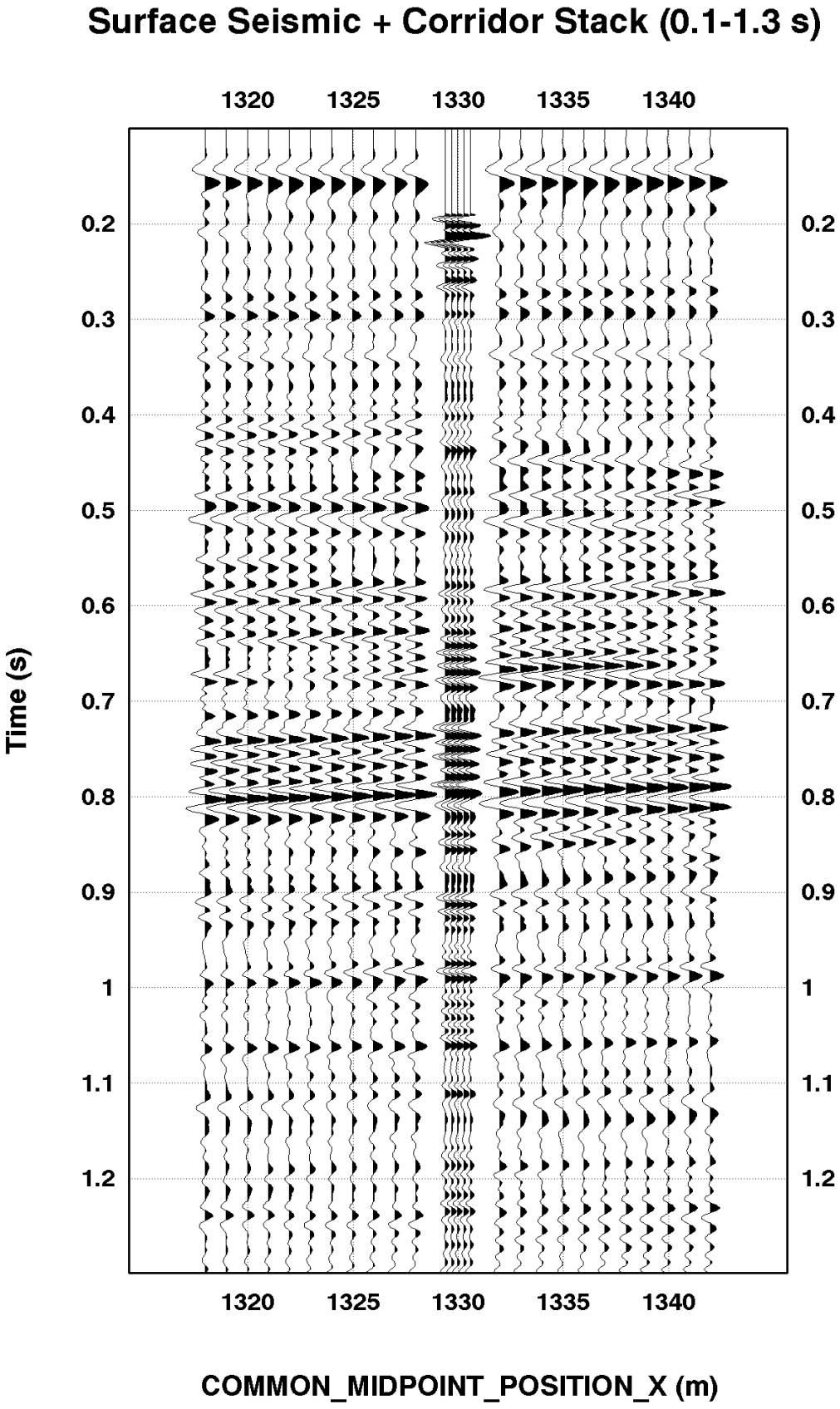

Figure 12a. Composite Display of Surface Seismic and Corridor Stack (Top)

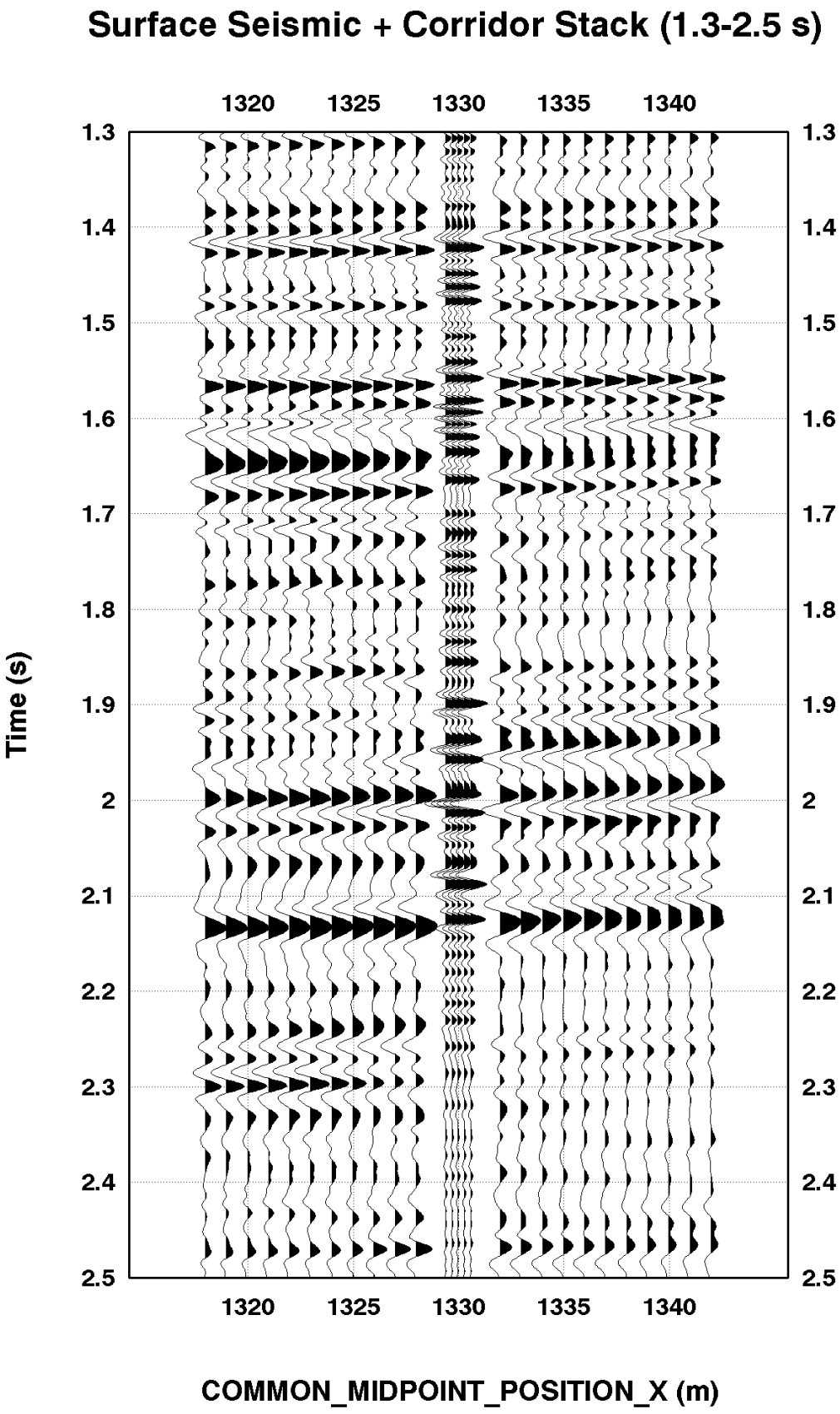

Figure 12b. Composite Display of Surface Seismic and Corridor Stack (Bottom)

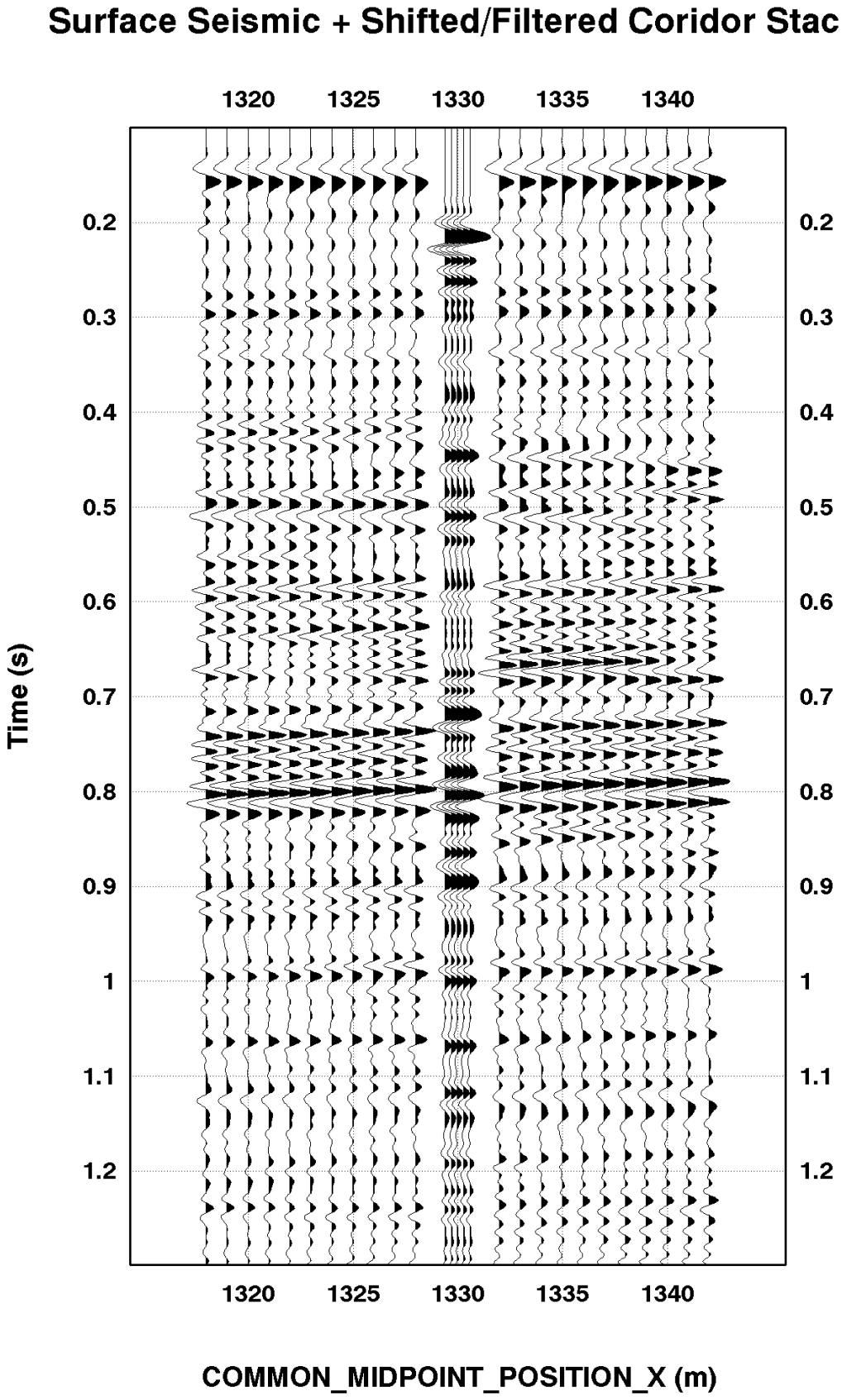

Figure 12c. Composite of Surface Seismic and shifted 5-50 Hz Corridor Stack (Top)

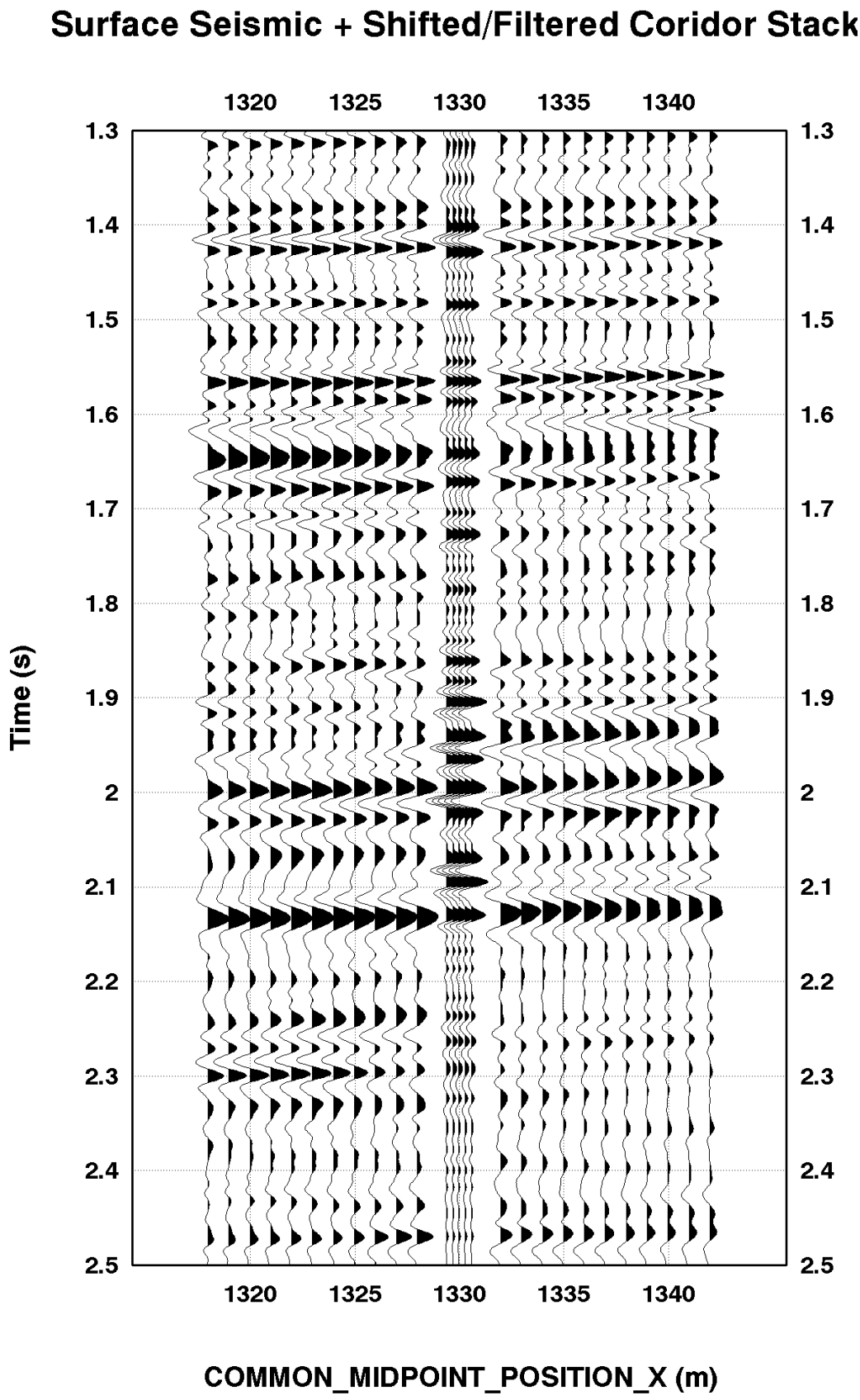

Figure 12d. Composite of Surface Seismic and shifted 5-50 Hz Corridor Stack (Bottom)

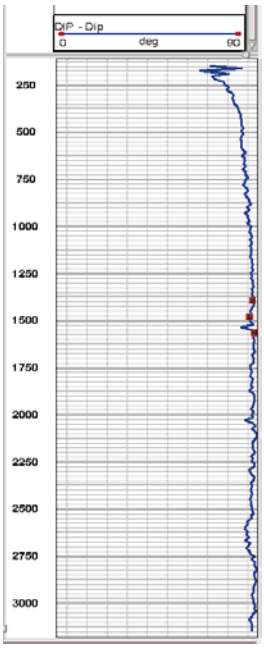

Figure 13. 3-C Polarization Analysis: First arriving energy (down P) angle w.r.t. Horizontal

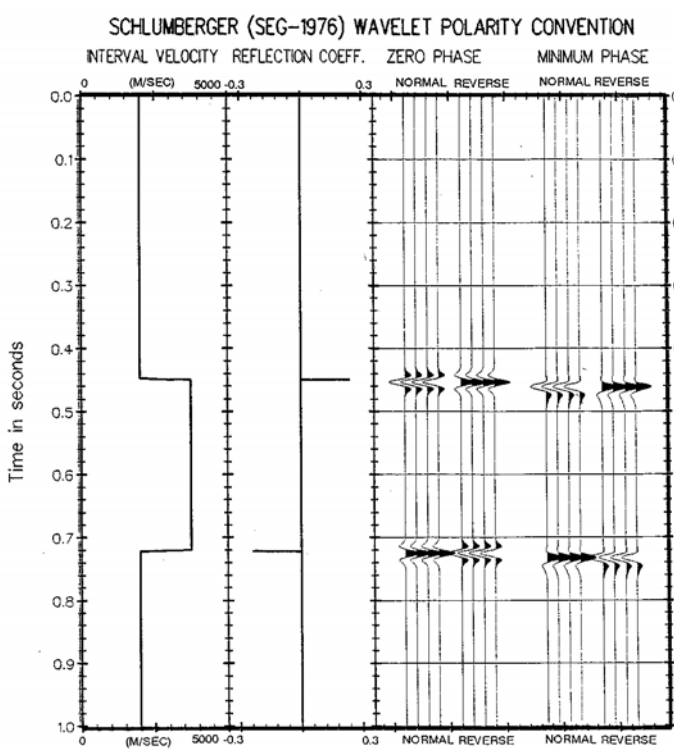

Figure 14. Schlumberger Wavelet Polarity Convention

Attachment 1: Summary of Geophysical Listings

One geophysical data listing is appended to this report. A1 is included in the report and is also provided in electronic form on the CD-ROM. Following is a brief description of the format.

A1 Check Shot Data

1. Level number: the level number starting from the top level (includes any imposed shots).

2. Vertical depth form SRD: *dsrd*, the depth in meters from seismic reference datum.

3. Measured depth from KB: *dkb*, the depth in meters from KB.

4. Observed travel time HYD to GEO: *tim*0, the transit time picked form the stacked data by subtracting the surface sensor first break time from the downhole sensor first break time.

5. Vertical travel time SRD to GEO: *shtm*, is *timv* – vertical time, corrected for the vertical distance between source and datum.

6. Delta depth between shots: Δ*depth*, the vertical distance between each level.

7. Delta time between shots: Δ*time*, difference in vertical travel time (*shtm*) between each level.

8. Interval velocity between shots: average velocity between each level, Δ*depth*/Δ*time*

9. Average velocity SRD to GEO: average velocity from datum to the checkshot level, shtm/dsrd

Attachment 2: A-1 Well Seismic Report

Client and Well Information

Country	**Australia**
State	**Offshore Victoria**
Logging Date	**23-Feb-2003**
Company	**ESSO Australia Pty Ltd**
Field	**Exploration VIC/RL2**
Well	**Scallop-1**

Check Shot Data (Continued)

LEVEL NUMBER	VERTICAL DEPTH FROM SRD m	MEASURED DEPTH FROM KB m	OBSERVED TRAVEL TIME s	VERTICAL TRAVEL TIME SRD (OWT) s	DELTA DEPTH m	DELTA TIME s	ACOUSTIC INTERVAL VELOCITY m/s	ACOUSTIC AVERAGE VELOCITY m/s
1	0.0			0.0000				
							1558	
2	147.7	173.6	0.0927	0.0948				1558
					14.5	0.0081	1788	
3	162.2	188.1	0.1004	0.1029				1576
					14.4	0.0078	1835	
4	176.6	202.5	0.1079	0.1108				1594
					14.5	0.0073	1990	
5	191.1	217.0	0.1148	0.1181				1619
					14.5	0.0074	1958	
6	205.6	231.5	0.1219	0.1255				1639
					14.5	0.0074	1969	
7	220.1	246.0	0.1291	0.1328				1657
					14.4	0.0078	1841	
8	234.5	260.4	0.1367	0.1407				1667
					14.5	0.0071	2055	
9	249.0	274.9	0.1436	0.1477				1686
					14.5	0.0070	2068	
10	263.5	289.4	0.1504	0.1547				1703
					14.5	0.0068	2118	
11	278.0	303.9	0.1571	0.1616				1721
					14.6	0.0070	2096	
12	292.6	318.5	0.1640	0.1685				1736
					14.5	0.0070	2085	
13	307.1	333.0	0.1708	0.1755				1750
					14.4	0.0068	2130	
14	321.5	347.4	0.1775	0.1823				1764
					14.5	0.0064	2255	
15	336.0	361.9	0.1838	0.1887				1781
					14.5	0.0068	2117	

LEVEL NUMBER	VERTICAL DEPTH FROM SRD m	MEASURED DEPTH FROM KB m	OBSERVED TRAVEL TIME s	VERTICAL TRAVEL TIME SRD (OWT) s	DELTA DEPTH m	DELTA TIME s	ACOUSTIC INTERVAL VELOCITY m/s	ACOUSTIC AVERAGE VELOCITY m/s
16	350.5	376.4	0.1906	0.1955				1793
					14.5	0.0066	2203	
17	365.0	390.9	0.1971	0.2021				1806
					14.3	0.0067	2144	
18	379.3	405.2	0.2037	0.2088				1817
					14.5	0.0064	2254	
19	393.8	419.7	0.2101	0.2152				1830
					14.5	0.0061	2367	
20	408.3	434.2	0.2161	0.2213				1845
					14.5	0.0060	2411	
21	422.8	448.7	0.2221	0.2274				1860
					14.6	0.0059	2480	
22	437.4	463.3	0.2279	0.2332				1875
					14.4	0.0055	2611	
23	451.8	477.7	0.2334	0.2388				1892
					14.5	0.0060	2411	
24	466.3	492.2	0.2394	0.2448				1905
					14.5	0.0059	2456	
25	480.8	506.7	0.2452	0.2507				1918
					14.5	0.0057	2553	
26	495.3	521.2	0.2509	0.2564				1932
					14.4	0.0060	2412	
27	509.7	535.6	0.2568	0.2623				1943
					14.5	0.0056	2606	
28	524.2	550.1	0.2623	0.2679				1957
					14.5	0.0054	2677	
29	538.7	564.6	0.2677	0.2733				1971
					14.5	0.0050	2896	
30	553.2	579.1	0.2727	0.2783				1988
					14.5	0.0054	2710	
31	567.7	593.6	0.2780	0.2837				2001
					14.5	0.0053	2715	
32	582.2	608.1	0.2833	0.2890				2014
					14.5	0.0055	2652	
33	596.7	622.6	0.2888	0.2945				2026
					14.4	0.0055	2598	
34	611.1	637.0	0.2943	0.3000				2037
					14.5	0.0055	2657	
35	625.6	651.5	0.2997	0.3055				2048
					14.5	0.0053	2758	
36	640.1	666.0	0.3049	0.3107				2060
					14.5	0.0052	2790	
37	654.6	680.5	0.3101	0.3159				2072
					14.4	0.0053	2693	
38	669.0	694.9	0.3154	0.3213				2082
					14.5	0.0053	2750	
39	683.5	709.4	0.3207	0.3265				2093
					14.5	0.0051	2823	
40	698.0	723.9	0.3258	0.3317				2104

LEVEL NUMBER	VERTICAL DEPTH FROM SRD m	MEASURED DEPTH FROM KB m	OBSERVED TRAVEL TIME s	VERTICAL TRAVEL TIME SRD (OWT) s	DELTA DEPTH m	DELTA TIME s	ACOUSTIC INTERVAL VELOCITY m/s	ACOUSTIC AVERAGE VELOCITY m/s
					14.5	0.0051	2838	
41	712.5	738.4	0.3309	0.3368				2116
					14.4	0.0055	2616	
42	726.9	752.8	0.3364	0.3423				2124
					14.5	0.0050	2878	
43	741.4	767.3	0.3414	0.3473				2135
					14.4	0.0052	2784	
44	755.8	781.7	0.3466	0.3525				2144
					14.5	0.0051	2825	
45	770.3	796.2	0.3517	0.3576				2154
					14.6	0.0054	2687	
46	784.9	810.8	0.3571	0.3631				2162
					14.4	0.0055	2626	
47	799.3	825.2	0.3626	0.3686				2169
					14.5	0.0054	2710	
48	813.8	839.7	0.3679	0.3739				2176
					14.4	0.0054	2689	
49	828.2	854.1	0.3733	0.3793				2184
					14.6	0.0054	2689	
50	842.8	868.7	0.3787	0.3847				2191
					14.5	0.0054	2700	
51	857.3	883.2	0.3840	0.3901				2198
					14.5	0.0055	2619	
52	871.8	897.7	0.3896	0.3956				2204
					14.5	0.0049	2953	
53	886.3	912.2	0.3945	0.4005				2213
					14.4	0.0060	2414	
54	900.7	926.6	0.4004	0.4065				2216
					14.5	0.0050	2881	
55	915.2	941.1	0.4054	0.4115				2224
					14.5	0.0050	2881	
56	929.7	955.6	0.4105	0.4165				2232
					14.5	0.0050	2906	
57	944.2	970.1	0.4154	0.4215				2240
					14.4	0.0050	2852	
58	958.6	984.5	0.4205	0.4266				2247
					14.5	0.0049	2989	
59	973.1	999.0	0.4253	0.4314				2256
					14.5	0.0052	2785	
60	987.6	1013.5	0.4305	0.4366				2262
					14.5	0.0050	2919	
61	1002.1	1028.0	0.4355	0.4416				2269
					14.5	0.0050	2912	
62	1016.6	1042.5	0.4405	0.4466				2276
					14.5	0.0048	3018	
63	1031.1	1057.0	0.4453	0.4514				2284
					14.2	0.0050	2820	
64	1045.3	1071.2	0.4503	0.4564				2290
					14.4	0.0050	2907	

LEVEL NUMBER	VERTICAL DEPTH FROM SRD m	MEASURED DEPTH FROM KB m	OBSERVED TRAVEL TIME s	VERTICAL TRAVEL TIME SRD (OWT) s	DELTA DEPTH m	DELTA TIME s	ACOUSTIC INTERVAL VELOCITY m/s	ACOUSTIC AVERAGE VELOCITY m/s
65	1059.7	1085.6	0.4552	0.4614				2297
					14.8	0.0050	2935	
66	1074.5	1100.4	0.4603	0.4664				2304
					14.5	0.0047	3082	
67	1089.0	1114.9	0.4650	0.4711				2311
					14.4	0.0048	3023	
68	1103.4	1129.3	0.4697	0.4759				2319
					14.5	0.0049	2961	
69	1117.9	1143.8	0.4746	0.4808				2325
					14.5	0.0049	2963	
70	1132.4	1158.3	0.4795	0.4857				2332
					14.4	0.0048	3004	
71	1146.8	1172.7	0.4843	0.4905				2338
					14.6	0.0048	3042	
72	1161.4	1187.3	0.4891	0.4953				2345
					14.4	0.0045	3199	
73	1175.8	1201.7	0.4936	0.4998				2353
					14.5	0.0051	2830	
74	1190.3	1216.2	0.4987	0.5049				2358
					14.5	0.0049	2965	
75	1204.8	1230.7	0.5036	0.5098				2363
					14.5	0.0053	2731	
76	1219.3	1245.2	0.5089	0.5151				2367
					14.5	0.0051	2854	
77	1233.8	1259.7	0.5140	0.5202				2372
					14.4	0.0055	2602	
78	1248.2	1274.1	0.5195	0.5257				2374
					14.5	0.0053	2759	
79	1262.7	1288.6	0.5247	0.5310				2378
					14.5	0.0056	2610	
80	1277.2	1303.1	0.5303	0.5365				2381
					14.5	0.0054	2670	
81	1291.7	1317.6	0.5357	0.5420				2383
					14.5	0.0056	2587	
82	1306.2	1332.1	0.5413	0.5476				2385
					14.5	0.0053	2761	
83	1320.7	1346.6	0.5466	0.5528				2389
					14.4	0.0054	2683	
84	1335.1	1361.0	0.5519	0.5582				2392
					14.5	0.0054	2698	
85	1349.6	1375.5	0.5573	0.5636				2395
					14.5	0.0053	2714	
86	1364.1	1390.0	0.5626	0.5689				2398
					14.5	0.0051	2835	
87	1378.6	1404.5	0.5678	0.5740				2402
					14.3	0.0053	2680	
88	1392.9	1418.8	0.5731	0.5793				2404
					14.5	0.0052	2782	
89	1407.4	1433.3	0.5783	0.5846				2408

LEVEL NUMBER	VERTICAL DEPTH FROM SRD m	MEASURED DEPTH FROM KB m	OBSERVED TRAVEL TIME s	VERTICAL TRAVEL TIME SRD (OWT) s	DELTA DEPTH m	DELTA TIME s	ACOUSTIC INTERVAL VELOCITY m/s	ACOUSTIC AVERAGE VELOCITY m/s
					14.5	0.0055	2655	
90	1421.9	1447.8	0.5838	0.5900				2410
					14.5	0.0051	2851	
91	1436.4	1462.3	0.5888	0.5951				2414
					14.6	0.0052	2825	
92	1451.0	1476.9	0.5940	0.6003				2417
					14.5	0.0050	2908	
93	1465.5	1491.4	0.5990	0.6053				2421
					14.3	0.0051	2810	
94	1479.8	1505.7	0.6041	0.6103				2425
					14.5	0.0051	2819	
95	1494.3	1520.2	0.6092	0.6155				2428
					14.5	0.0054	2670	
96	1508.8	1534.7	0.6146	0.6209				2430
					14.5	0.0051	2819	
97	1523.3	1549.2	0.6198	0.6261				2433
					14.5	0.0053	2713	
98	1537.8	1563.7	0.6251	0.6314				2435
					14.3	0.0052	2760	
99	1552.1	1578.0	0.6303	0.6366				2438
					14.7	0.0056	2637	
100	1566.8	1592.7	0.6359	0.6422				2440
					14.5	0.0051	2861	
101	1581.3	1607.2	0.6409	0.6472				2443
					14.5	0.0053	2730	
102	1595.8	1621.7	0.6462	0.6525				2446
					14.4	0.0050	2867	
103	1610.2	1636.1	0.6513	0.6576				2449
					14.4	0.0052	2787	
104	1624.6	1650.5	0.6564	0.6627				2451
					14.5	0.0051	2845	
105	1639.1	1665.0	0.6615	0.6678				2454
					14.6	0.0053	2738	
106	1653.7	1679.6	0.6669	0.6732				2457
					14.4	0.0051	2829	
107	1668.1	1694.0	0.6719	0.6783				2459
					14.5	0.0051	2816	
108	1682.6	1708.5	0.6771	0.6834				2462
					14.4	0.0049	2915	
109	1697.0	1722.9	0.6820	0.6883				2465
					14.6	0.0045	3215	
110	1711.6	1737.5	0.6866	0.6929				2470
					14.4	0.0043	3351	
111	1726.0	1751.9	0.6909	0.6972				2476
					14.6	0.0042	3440	
112	1740.6	1766.5	0.6951	0.7014				2482
					14.4	0.0045	3191	
113	1755.0	1780.9	0.6996	0.7059				2486
					14.5	0.0041	3537	

LEVEL NUMBER	VERTICAL DEPTH FROM SRD m	MEASURED DEPTH FROM KB m	OBSERVED TRAVEL TIME s	VERTICAL TRAVEL TIME SRD (OWT) s	DELTA DEPTH m	DELTA TIME s	ACOUSTIC INTERVAL VELOCITY m/s	ACOUSTIC AVERAGE VELOCITY m/s
114	1769.5	1795.4	0.7037	0.7100				2492
					14.5	0.0044	3316	
115	1784.0	1809.9	0.7081	0.7144				2497
					14.5	0.0045	3252	
116	1798.5	1824.4	0.7125	0.7189				2502
					14.4	0.0048	2990	
117	1812.9	1838.8	0.7173	0.7237				2505
					14.5	0.0044	3296	
118	1827.4	1853.3	0.7217	0.7281				2510
					14.5	0.0046	3177	
119	1841.9	1867.8	0.7263	0.7326				2514
					14.5	0.0043	3360	
120	1856.4	1882.3	0.7306	0.7370				2519
					28.9	0.0086	3364	
121	1885.3	1911.2	0.7392	0.7456				2529
					14.5	0.0046	3166	
122	1899.8	1925.7	0.7438	0.7501				2533
					14.5	0.0043	3394	
123	1914.3	1940.2	0.7481	0.7544				2537
					14.5	0.0042	3481	
124	1928.8	1954.7	0.7522	0.7586				2543
					14.5	0.0042	3455	
125	1943.3	1969.2	0.7564	0.7628				2548
					14.4	0.0041	3513	
126	1957.7	1983.6	0.7605	0.7669				2553
					14.5	0.0043	3388	
127	1972.2	1998.1	0.7648	0.7711				2557
					14.4	0.0044	3249	
128	1986.6	2012.5	0.7692	0.7756				2561
					14.5	0.0043	3411	
129	2001.1	2027.0	0.7735	0.7798				2566
					14.5	0.0045	3200	
130	2015.6	2041.5	0.7780	0.7844				2570
					14.5	0.0044	3292	
131	2030.1	2056.0	0.7824	0.7888				2574
					14.5	0.0045	3255	
132	2044.6	2070.5	0.7869	0.7932				2578
					14.5	0.0052	2815	
133	2059.1	2085.0	0.7920	0.7984				2579
					14.5	0.0051	2844	
134	2073.6	2099.5	0.7971	0.8035				2581
					14.5	0.0053	2750	
135	2088.1	2114.0	0.8024	0.8087				2582
					14.4	0.0043	3352	
136	2102.5	2128.4	0.8067	0.8130				2586
					14.5	0.0044	3315	
137	2117.0	2142.9	0.8110	0.8174				2590
					14.4	0.0039	3646	
138	2131.4	2157.3	0.8150	0.8214				2595

LEVEL NUMBER	VERTICAL DEPTH FROM SRD m	MEASURED DEPTH FROM KB m	OBSERVED TRAVEL TIME s	VERTICAL TRAVEL TIME SRD (OWT) s	DELTA DEPTH m	DELTA TIME s	ACOUSTIC INTERVAL VELOCITY m/s	ACOUSTIC AVERAGE VELOCITY m/s
					14.6	0.0040	3653	
139	2146.0	2171.9	0.8190	0.8254				2600
					14.5	0.0037	3884	
140	2160.5	2186.4	0.8227	0.8291				2606
					14.5	0.0040	3618	
141	2175.0	2200.9	0.8267	0.8331				2611
					14.4	0.0040	3578	
142	2189.4	2215.3	0.8307	0.8371				2615
					14.4	0.0044	3238	
143	2203.8	2229.7	0.8352	0.8416				2619
					14.5	0.0040	3638	
144	2218.3	2244.2	0.8392	0.8456				2623
					14.5	0.0040	3628	
145	2232.8	2258.7	0.8432	0.8496				2628
					14.5	0.0042	3421	
146	2247.3	2273.2	0.8474	0.8538				2632
					14.5	0.0044	3274	
147	2261.8	2287.7	0.8518	0.8582				2635
					14.5	0.0040	3630	
148	2276.3	2302.2	0.8558	0.8622				2640
					14.4	0.0042	3435	
149	2290.7	2316.6	0.8600	0.8664				2644
					14.5	0.0043	3379	
150	2305.2	2331.1	0.8643	0.8707				2648
					14.6	0.0038	3808	
151	2319.8	2345.7	0.8681	0.8745				2653
					14.4	0.0041	3474	
152	2334.2	2360.1	0.8723	0.8787				2656
					14.5	0.0039	3691	
153	2348.7	2374.6	0.8762	0.8826				2661
					14.5	0.0040	3610	
154	2363.2	2389.1	0.8802	0.8866				2665
					14.5	0.0039	3751	
155	2377.7	2403.6	0.8841	0.8905				2670
					14.4	0.0041	3547	
156	2392.1	2418.0	0.8881	0.8945				2674
					14.5	0.0042	3458	
157	2406.6	2432.5	0.8923	0.8987				2678
					14.5	0.0037	3941	
158	2421.1	2447.0	0.8960	0.9024				2683
					14.4	0.0038	3743	
159	2435.5	2461.4	0.8999	0.9063				2687
					14.5	0.0042	3462	
160	2450.0	2475.9	0.9040	0.9105				2691
					14.6	0.0041	3567	
161	2464.6	2490.5	0.9081	0.9145				2695
					14.5	0.0042	3472	
162	2479.1	2505.0	0.9123	0.9187				2698
					14.4	0.0043	3324	

LEVEL NUMBER	VERTICAL DEPTH FROM SRD m	MEASURED DEPTH FROM KB m	OBSERVED TRAVEL TIME s	VERTICAL TRAVEL TIME SRD (OWT) s	DELTA DEPTH m	DELTA TIME s	ACOUSTIC INTERVAL VELOCITY m/s	ACOUSTIC AVERAGE VELOCITY m/s
163	2493.5	2519.4	0.9166	0.9231				2701
					14.5	0.0042	3445	
164	2508.0	2533.9	0.9209	0.9273				2705
					14.5	0.0039	3716	
165	2522.5	2548.4	0.9248	0.9312				2709
					14.5	0.0040	3667	
166	2537.0	2562.9	0.9287	0.9351				2713
					14.4	0.0035	4171	
167	2551.4	2577.3	0.9322	0.9386				2718
					14.4	0.0038	3822	
168	2565.8	2591.7	0.9359	0.9423				2723
					14.6	0.0038	3890	
169	2580.4	2606.3	0.9397	0.9461				2727
					14.5	0.0037	3894	
170	2594.9	2620.8	0.9434	0.9498				2732
					14.5	0.0034	4290	
171	2609.4	2635.3	0.9468	0.9532				2738
					14.4	0.0040	3592	
172	2623.8	2649.7	0.9508	0.9572				2741
					14.5	0.0033	4444	
173	2638.3	2664.2	0.9541	0.9605				2747
					14.4	0.0033	4350	
174	2652.7	2678.6	0.9574	0.9638				2752
					14.6	0.0035	4204	
175	2667.3	2693.2	0.9608	0.9673				2758
					14.4	0.0033	4431	
176	2681.7	2707.6	0.9641	0.9705				2763
					14.5	0.0037	3945	
177	2696.2	2722.1	0.9678	0.9742				2768
					14.5	0.0037	3899	
178	2710.7	2736.6	0.9715	0.9779				2772
					14.5	0.0037	3924	
179	2725.2	2751.1	0.9752	0.9816				2776
					14.5	0.0037	3890	
180	2739.7	2765.6	0.9789	0.9853				2781
					14.5	0.0036	4008	
181	2754.2	2780.1	0.9825	0.9889				2785
					14.4	0.0029	4998	
182	2768.6	2794.5	0.9854	0.9918				2791
					14.5	0.0035	4097	
183	2783.1	2809.0	0.9889	0.9954				2796
					14.5	0.0032	4573	
184	2797.6	2823.5	0.9921	0.9985				2802
					14.5	0.0038	3826	
185	2812.1	2838.0	0.9959	1.0023				2806
					14.4	0.0040	3588	
186	2826.5	2852.4	0.9999	1.0063				2809
					14.5	0.0033	4359	
187	2841.0	2866.9	1.0032	1.0097				2814

LEVEL NUMBER	VERTICAL DEPTH FROM SRD m	MEASURED DEPTH FROM KB m	OBSERVED TRAVEL TIME s	VERTICAL TRAVEL TIME SRD (OWT) s	DELTA DEPTH m	DELTA TIME s	ACOUSTIC INTERVAL VELOCITY m/s	ACOUSTIC AVERAGE VELOCITY m/s
					14.5	0.0036	4010	
188	2855.5	2881.4	1.0068	1.0133				2818
					14.5	0.0031	4707	
189	2870.0	2895.9	1.0099	1.0164				2824
					14.5	0.0038	3865	
190	2884.5	2910.4	1.0137	1.0201				2828
					14.5	0.0036	3988	
191	2899.0	2924.9	1.0173	1.0237				2832
					14.5	0.0036	4073	
192	2913.5	2939.4	1.0209	1.0273				2836
					14.4	0.0036	4040	
193	2927.9	2953.8	1.0244	1.0309				2840
					14.4	0.0031	4685	
194	2942.3	2968.2	1.0275	1.0339				2846
					14.6	0.0039	3750	
195	2956.9	2982.8	1.0314	1.0378				2849
					14.4	0.0039	3669	
196	2971.3	2997.2	1.0353	1.0418				2852
					14.5	0.0034	4300	
197	2985.8	3011.7	1.0387	1.0451				2857
					14.5	0.0038	3818	
198	3000.3	3026.2	1.0425	1.0489				2860
					14.5	0.0038	3847	
199	3014.8	3040.7	1.0463	1.0527				2864
					14.5	0.0035	4198	
200	3029.3	3055.2	1.0497	1.0562				2868
					14.5	0.0036	4066	
201	3043.8	3069.7	1.0533	1.0597				2872
					14.5	0.0033	4415	
202	3058.3	3084.2	1.0566	1.0630				2877
					14.4	0.0027	5258	
203	3072.7	3098.6	1.0593	1.0657				2883
					14.5	0.0036	4010	
204	3087.2	3113.1	1.0629	1.0694				2887
					14.5	0.0038	3843	
205	3101.7	3127.6	1.0667	1.0731				2890
					14.5	0.0034	4301	
206	3116.2	3142.1	1.0701	1.0765				2895
					14.4	0.0034	4269	
207	3130.6	3156.5	1.0734	1.0799				2899
					14.5	0.0031	4679	
208	3145.1	3171.0	1.0765	1.0830				2904

Attachment 3: Listing of Deliverables (CD-ROM)

Report:

SC1_VSP_report	VSP/Geogram Processing Report	PDF

Graphics Displays:

SC1_comp1	Plot 1. Composite Display 1– Normal Polarity	PDF / PDS / CGM
SC1_comp2	Plot 2. Composite Display 2 – Reverse Polarity	PDF / PDS / CGM

Data files plus Verification (.txt) listings:

SC1_rawx.sgy	raw x axis downhole data	SEGY
SC1_rawy.sgy	raw y axis downhole data	SEGY
SC1_rawz.sgy	raw z axis downhole data	SEGY
SC1_rawh.sgy	surface sensor data	SEGY
SC1_xstk.sgy	stacked x axis data	SEGY
SC1_ystk.sgy	stacked y axis data	SEGY
SC1_zstk.sgy	stacked z axis data	SEGY
SC1_upp.sgy	Zero Phase upgoing wavefield TWT	SEGY
SC1_corstk.sgy	Zero phase corridor stack	SEGY
SC1_corstk90.sgy	Quad Phase corridor stack	SEGY

Listings:

A1	Well_Seismic_Report	EXCEL / PDF