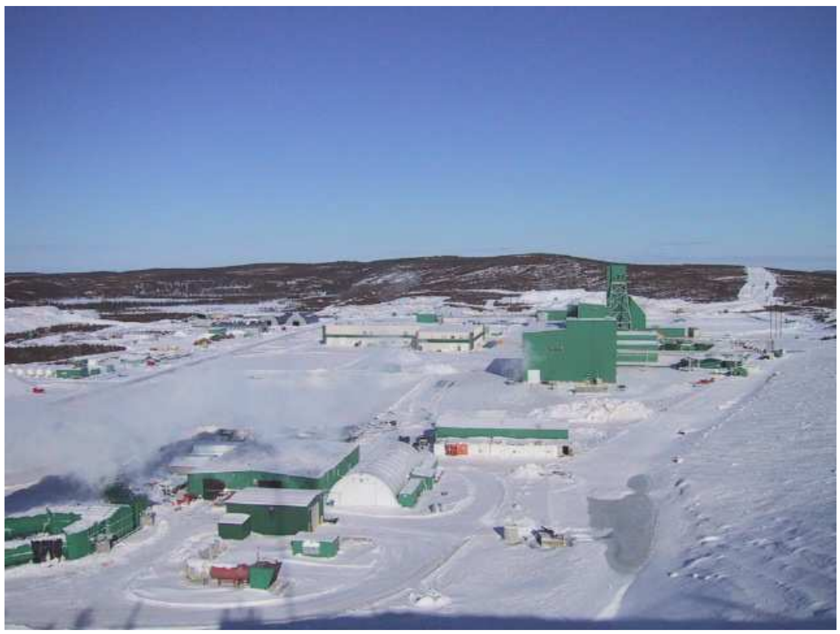
MCARTHUR RIVER MINE (SK)



FIRST PROCESSING OF VSP DATA (2001)

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September 26, 2001

Front page photo by Erick Adam:
McArthur River Mine in February 2001

Contents

Figure 1: *Vibrator during the data acquisition in borehole MC218, McArthur River Mine (Saskatchewan). Photo by Erick Adam, February 2001.*

1 Summary

This report summarizes the processing steps performed on the two McArthur River Mine VSP datasets acquired in borehole MC218 in February 2001.

Both datasets were processed following a similar standard sequence. Some problems occured while trying to remove the downgoing wave energy because of poor signal-to-noise levels. This problem was more severe for vsp01, and thus vsp02 shows better results than vsp01.

As an additional step a corridor stack was created to compare the data with the modelled or surface data.

2 Introduction

This report summarizes the processing steps performed on the VSP datasets acquired in borehole MC218 of the McArthur River Mine (see front page photo) in February 2001.
The **vsp01** dataset was shot from a near offset shotpoint about $27m$ from the borehole, with a receiver spacing of $2.5m$. The **vsp02** was shot from a far offset shotpoint about $326m$ away, with a receiver spacing of $5m$. In both cases the sampling rate was $0.5ms$. Data acquisition was performed with the DSI 4-level tool. Each level contains a three component geophone. A schematic sketch of vertical seismic profiling is shown in Figure 2.

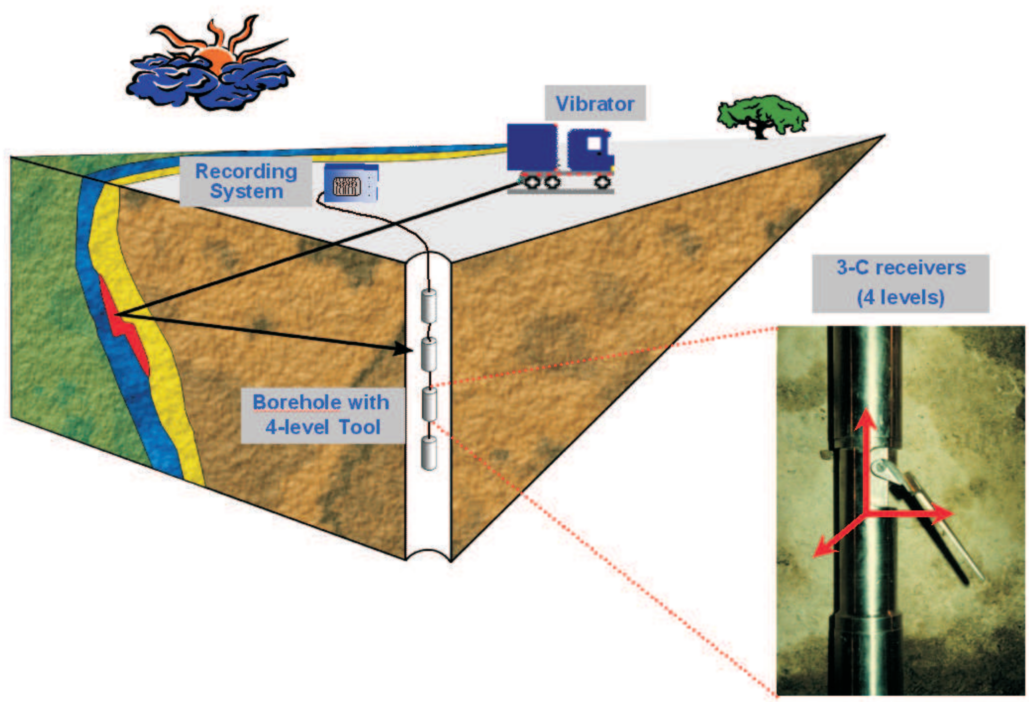

Figure 2: *Components of vertical seimic profiles consist of a borehole, a vibrator as a seismic energy source at the earth's surface, a borehole tool with four levels (each with a three component geophone) that can be clamped to the borehole wall, a digital data recording system and a cable to connect the tool to the surface recorder.*

The vibrator (see Figure 1) generated the source energy, with a sweep of 20 to 300 Hz for vsp01, and a sweep of 20 to 200 Hz for vsp02. Processing was done with DSISoft on a PC and a SPARC platform (Beaty, 2000; Bellefleur, 2000).
A summary of the processing flow is listed in the next section (section 3) followed by a description of the processing steps in detail and problems that occured during

processing (section 4). In section 5 the corridor stack is described and compared to the logging results. Figures of vsp01 for each step are included to illustrate the results. Vsp01 contains 156 traces to cover a range of 386.5m and vsp02 contains only 80 traces to cover a range of 395m. Please note that the depth axis of all figures for vsp01 and vsp02 are at the same scale.
A listing of processing steps, used scripts and data files generated during data processing and new DSISoft modules can be found in appendix one to three (section 9, 10 and 11). Data examples of vsp02 are included in section 12.

3 Processing Flow

In the following section the relevant processing steps are displayed. Most of these steps were applied to both datasets as described below. If not specifically mentioned the steps were performed on both datasets.

Reformatting Data

- both datasets converted from $SEG2$ to the $DSISoftformat$

First Trace Editing

- removing empty traces

Geometry

- setting of all important headerwords i.e. recording component, wireline depth, source position, receiver position etc.

Sort

- sort the data by wireline depth

Trace Editing

- vsp01: removal of double recorded traces
- unnecessary for vsp02 (because of no double traces)

Monofrequency Electrical Noise Removal

- using time domain notch filter to remove specified frequencies
- for both datasets: $61.25, 126.5$ and 183.75 Hz ($+/-1$ Hz)

First Break Picking of Vertical Component and Transfer to Header

Rotation to Maximize Energy in H1

- rotation is based on energy in a specified window
- vsp01and vsp02: window 10 ms before and 10 ms after first breaks

Removal of Downgoing Wave Energy

- median velocity filter
- vsp01: 11 point median filter for downgoing p-wave energy
- vsp02: 9 point median filter for p-wave and s-wave, 7 point median filter for tubewave energy

Removal of Other Downgoing Energy

- f-k velocity filter applied to vsp01 only

Bandpass Filter

- vsp01: $40/70 - 170/200$ Hz
- vsp02: $20/40 - 150/170$ Hz

Gain

- three-component AGC to preserve the amplitude ratio

Corridor Stack

- data shifting to a two way traveltime
- top and bottom mute
- common traveltime stack

4 Processing Steps

In the following the applied processing steps and problems during the application are described. Figures for the vsp01 dataset are included to illustrate the results of each step. Figures for vsp02 can be found in the appendix (see section 12) following the processing scripts. If not explicitly mentioned, the processing steps for vsp02 were the same as for vsp01.

4.1 Data Reformatting, Trace Editing, Geometry and Sorting the Data

The first step consisted of converting the SEG2 data to DSISoft format.
Trace editing was necessary because there were 38 null traces in each file. Just 12 traces (4 levels by 3 components) of each file were used for the next steps.

Headerword	Description	Values
4	recording component	1 to 3
29	source northing	vsp01: 6402799.35 m
		vsp02: 6402616.20 m
31	source easting	vsp01: 497540.10 m
		vsp02: 497295.70 m
33	source elevation	vsp01: 545.17 m (ASL)
		vsp02: 540.10 m (ASL)
35	receiver northing	6402797.00 m
37	receiver easting	497567.00 m
38	borehole elevation	545.67 m (ASL)
36	tool level	1 to 4
40	wireline depth	vsp01: 50 to 407.5 m
		vsp02: 50 to 415 m
56	receiver wireline depth	vsp01: 50 to 437.5 m
		vsp02: 50 to 445 m
39	receiver elevation	vsp01: 495.67 to 108.17 m (ASL)
		vsp02: 495.67 to 100.67 m (ASL)
9	shot receiver azimuth	vsp01: 94.9927 degree
		vsp02: 56.3197 degree
53	source to receiver offset	vsp01: 56.386 to 437.8335 m
		vsp02: 329.0385 to 547.1664 m

Table 1: *List of all headerwords as set in the geometry processing step.*

The geometry needed for future processing steps was assigned to each trace header. Table 4.1 shows the header words that define the geometry. Receiver (borehole) position, source position and wireline depth were taken from the observer notes. Resulting values for the level wireline depth, recording component, tool level and real receiver elevation (above sea level) were calculated directly in a script. Shot-receiver azimuth and source to receiver offset are set by DSISoft module *s2r_geom*.

For vsp01 additional trace editing was necessary because of duplicate traces acquired at some depths and non-sequential acquisition order. The duplicate traces had to be selected interactively visually and removed from the dataset. This step was unnecessary for vsp02.

The data were also sorted by components and by wireline depth within components.

Figure 3 shows the raw data for the three components of vsp01 after these steps. Figure 15 in the appendix shows the raw data for vsp02.

4.2 Filtering

Moderate electrical noise contamination was observed in the data. Electrical noise at about 61, 126 and 184 Hz was removed using an adaptive filtering module (DSISoft: *harmon*). This filter modul is a time domain notch filter. Discrete Fourier Transforms are calculated to estimate noise phase and amplitude. The estimated noise is then subtracted from the trace in the time domain (Adam, 1995; Butler, 1993; Nyman, 1983). The data were also filtered with bandpass frequencies between 30/40 and 300/320 Hz.

In Figure 4 the frequency spectra as well as 70 traces of the vertical component of vsp01 data before and after filtering are shown. Note that in the frequency spectra the higher trace numbers are nearest to the shotpoint. Some electrical noise energy still remains as seen in the seismogram after filtering, but for the 61 Hz noise, the filter worked effectively.

Similar figures for vsp02 data are found in Figure 16.

4.3 Rotation

The next step was first break picking of direct p-wave arrivals, necessary to specify the time window for rotation of the horizontal components.

In order to find the orientation of the horizontal components of the tool relative to the shot location direct arriving p-wave energy is maximized on one component (e.g. H1), by applying a rotation. After optimum rotation, the H1 component is parallel to the incoming p-wave ray and thus pointing towards the source. The H2 component is perpendicular to the ray direction and should show no first break

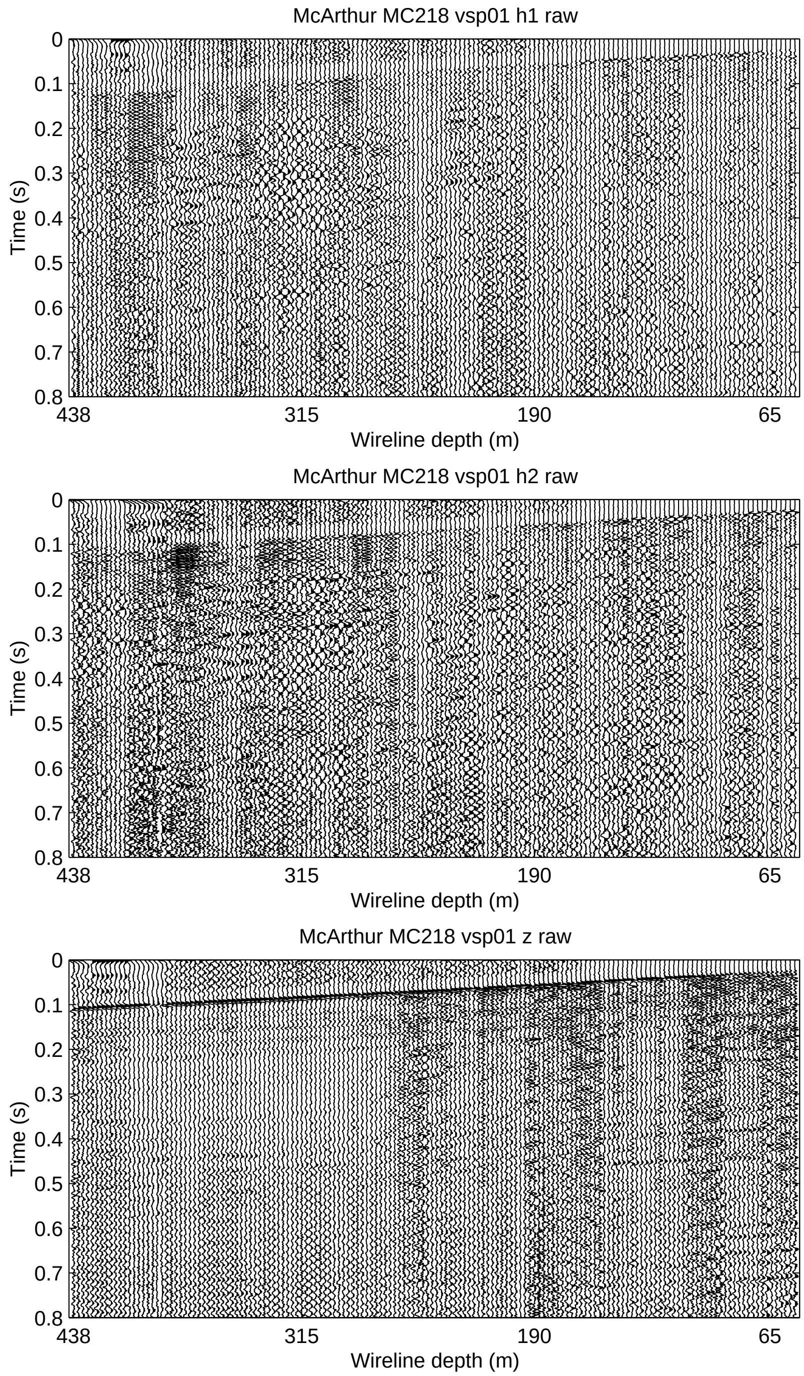

Figure 3: *All three components of raw data of vsp01 after trace editing, geometry assignment and sorting. A three component AGC with a window length of 0.1s has been applied, which preserves the amplitude ratio between the components.*

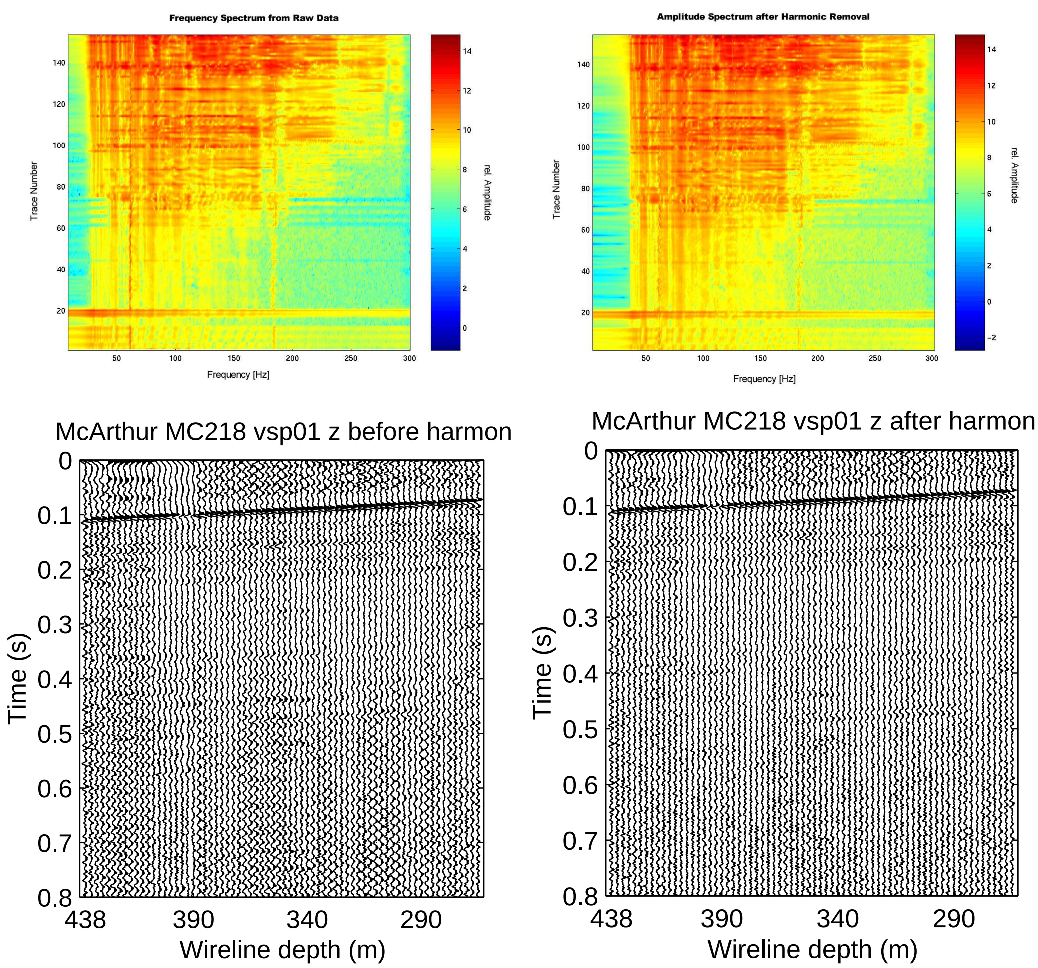

Figure 4: *Frequency spectra from the vsp01 raw dataset (upper left) and after removal of the monofrequency noise (upper right). Both lower figures show a portion of the z component of the dataset, again on the left hand side before filtering and on the right hand side after filtering. Notice that the energy about 61 Hz is much lower after filtering than the energy about 180 Hz.*

p-wave energy. The third component (vertical component before and after rotation) remains unchanged. The efficiency of rotation depends on the amount of first break energy on the two horizontal components.

The DSISoft function *rot3c* rotates the horizontal components for borehole data into radial and transverse components. It is done by performing 1 degree increments in rotation and then checking for the best rotation. The function *rot3c_eig* rotates components using a matrix eigenvalue algorithm.

Both functions were applied to the datasets with a window length of 10 ms before and after the first breaks. The results show that the eigenvalue algorithm did not work well for these data. No improvement was achieved by applying energy bal-

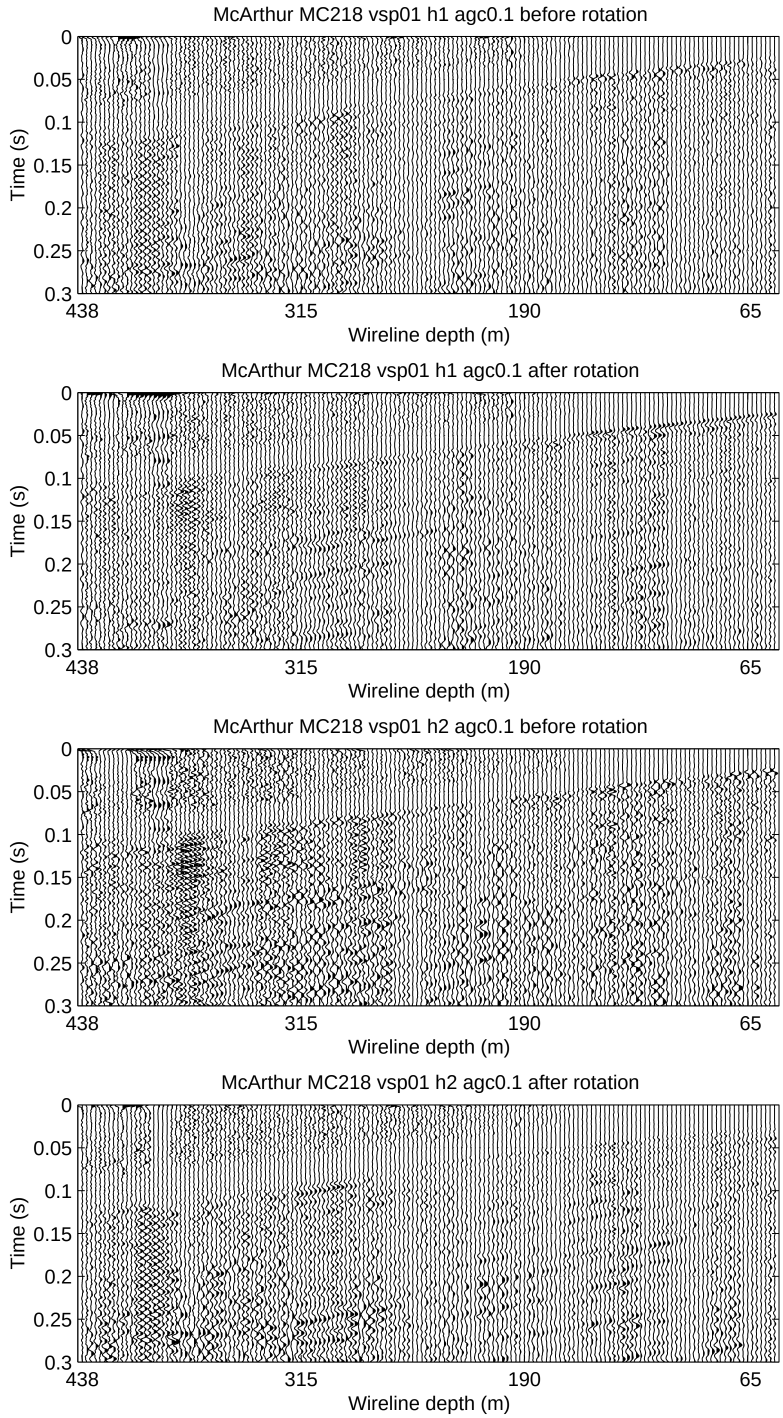

Figure 5: *Horizontal component 1 and 2 before and after rotation to maximize the horizontal energy in H1 (vsp01). Gain functions are different for each subfigure. It was difficult to maximize the weak first break energy on the first component and the result is not satisfactory.*

ancing in advance.
Figure 5 for vsp01 and Figure 17 for vsp02 show the horizontal components before and after rotation. The shot point with larger offset (vsp02) provided stronger first break energy on the horizontal components before rotation than the vsp01 data. This is expected due to the larger horizontal component of the ray-parallel first break particle motion for the larger offset source. Therefore the rotation for this data works very well in contrast with the vsp01 data. It can also be observed that there is still noise in the deeper part of the seismograms. The amplitudes between the single figures are not comparable because of different gain functions.

4.4 Median Filtering of Downgoing Energy

To remove the downgoing wave, median filtering was applied (Duncan, 1995a; Duncan, 1995b; Hardage, 1985; Kommedal, 1989). The data were flattened according to the velocity of the wave to be removed or according to first break pick times. The flattened data were then median filtered by taking the user specified number of traces (window) and setting the middle trace points equal to the median values of the group. The median was then subtracted from the flattened data and the result shifted back to the normal travel times.

P-Wave Energy
The median filter method, to remove the p-wave energy, could be used for both datasets. First breaks were aligned by using manually picked traveltimes stored in header 15. The average p-wave velocity for vsp01 calculated by first breaks is 4605 m/s, for vsp02 it is 4650 m/s. A median filter with a filter width of 11 traces was applied to the vsp01 data. For vsp02 the filter width was 9 traces.
In Figure 6 a sequence of the filter method is displayed for the z-component. The upper left hand figure shows the input data and next to it, the data with first breaks aligned. In the middle the median filtered data are shown on the left and on the right the filtered data. As seen in the lower left hand side of Figure 6 no significant residual amplitudes from the original first breaks are observed after the application of the filter. The same sequence for vsp02 can be found in Figure 18.

S-Wave Energy
Because of the lack of clear s-wave arrivals, the median filter could not be applied to vsp01. For vsp02 the s-wave energy can be clearly observed in the transverse component (H2 after rotation). The average s-wave velocity is estimated to 3290 m/s. A median filter with a filter width of 9 traces was applied to these data to remove the s-wave energy.

Tube Wave Energy
Tube wave energy could not be removed from the vsp01 dataset. All trials to

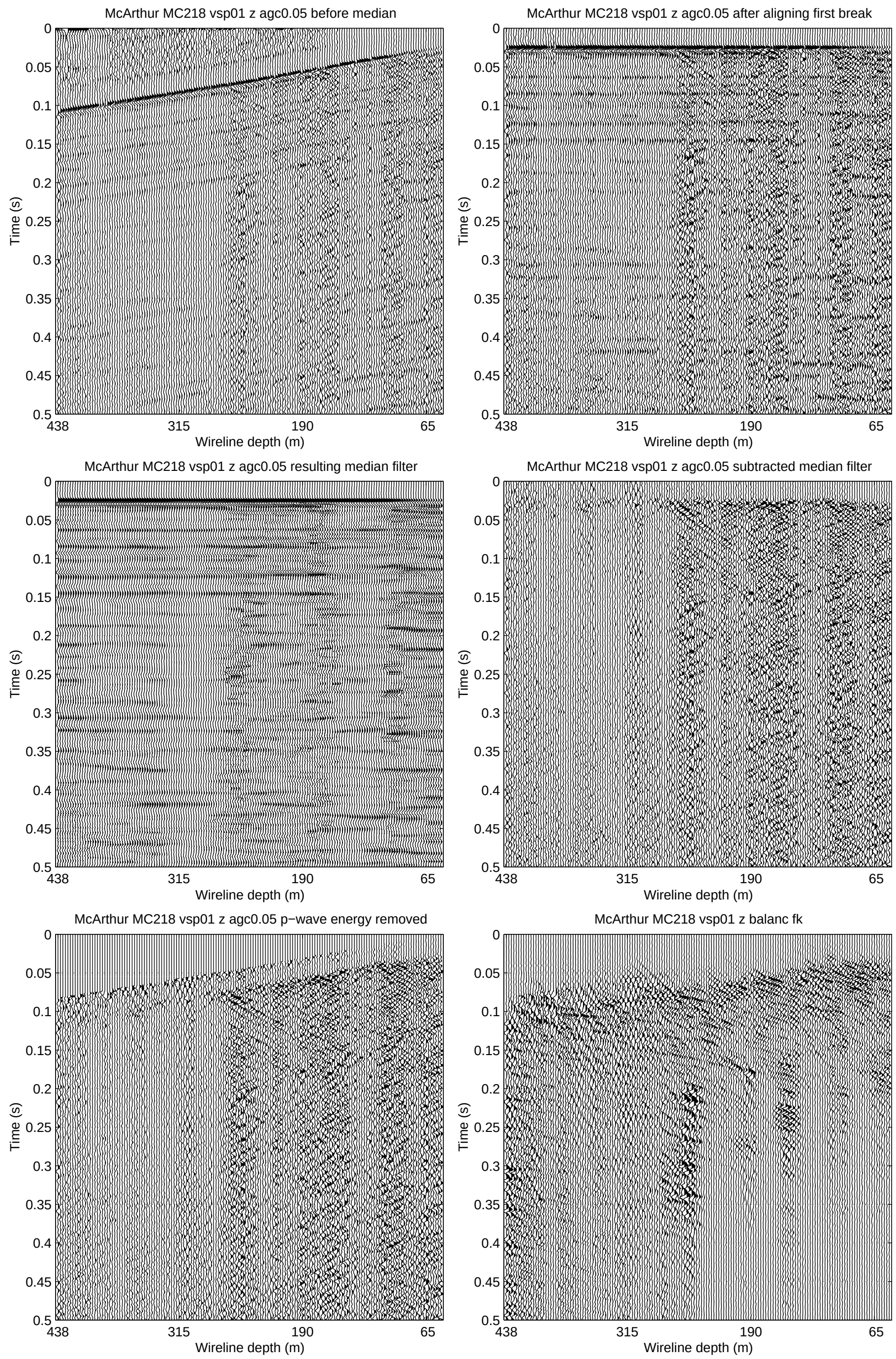

Figure 6: *Figures from upper left to lower right: z-component before removal of p-wave energy, data aligned at first break, resulting median filtered data, median subtracted from aligned data, result of median filtered data and data after fk filtering (vsp01).*

remove this energy with different estimated velocities were unsatisfactory.
For the vsp02 dataset, the tube wave energy could be removed with a velocity of 1250 m/s and a filter width of 7 traces. Two passes of median filtering were necessary to remove the upgoing and downgoing tube wave energy, respectively. The result is shown in Figure 18, in the lower right hand figure.

4.5 F-k Filtering of Other Downgoing Energy

A striking feature in the vsp01 data is a tube wave at about 270 m depth (see Figure 6, lower left hand figure). After removing the downgoing p-wave, the downgoing part of this tube wave became visible. Different polygons for f-k filters were created, to remove all downgoing wave energy and then to remove the upgoing tube wave energy. For tube waves velocities between 900 and 1400 m/s were assumed. The data for vsp01 after f-k filtering are shown in Figure 6, in the lower right hand figure. The vsp02 dataset was not f-k filtered.

For both datasets the removal of downgoing p-wave energy worked very well. After finally removing of all downgoing energy with an f-k filter for vsp01 and median a filter for vsp02, a few reflections can be observed, but the signal-to-noise ratio is very low and could not be improved.

4.6 Frequency Analysis, Bandpass Filtering and Gain

A bandpass filter and an AGC were applied to the filtered data. The upper and lower limits of the bandpass filter were selected from a frequency analysis of the up-going wavefield (Figure 7 for vsp01, Figure 19 for vsp02.). It can be observed that the important reflection energy in the far offset survey (vsp02) is found in lower frequencies than for the near offset survey (vsp01). Therefore different frequency limits were selected. For vsp01 the bandpass was $40/70$ and $170/200$ Hz with linear tapers. An AGC with a windowlength of 0.15 s was applied to this dataset shown in Figure 8. For vsp02 the bandpass frequencies were $20/40 - 150/170$ Hz and an AGC was applied (Figure 20). Note that this AGC destroys the amplitude ratio between the three components and for further processing procedures it must be left out.

4.7 Semblance Filtering

As a further step to enhance the quality of the data a semblance filter was applied to both datasets. This step was performed with *ITA/INSIGHT* by Don White. Figure 9 shows the vertical component of vsp01 before (upper panel) and after (lower panel) semblance filtering. The result shows more coherent events and can now

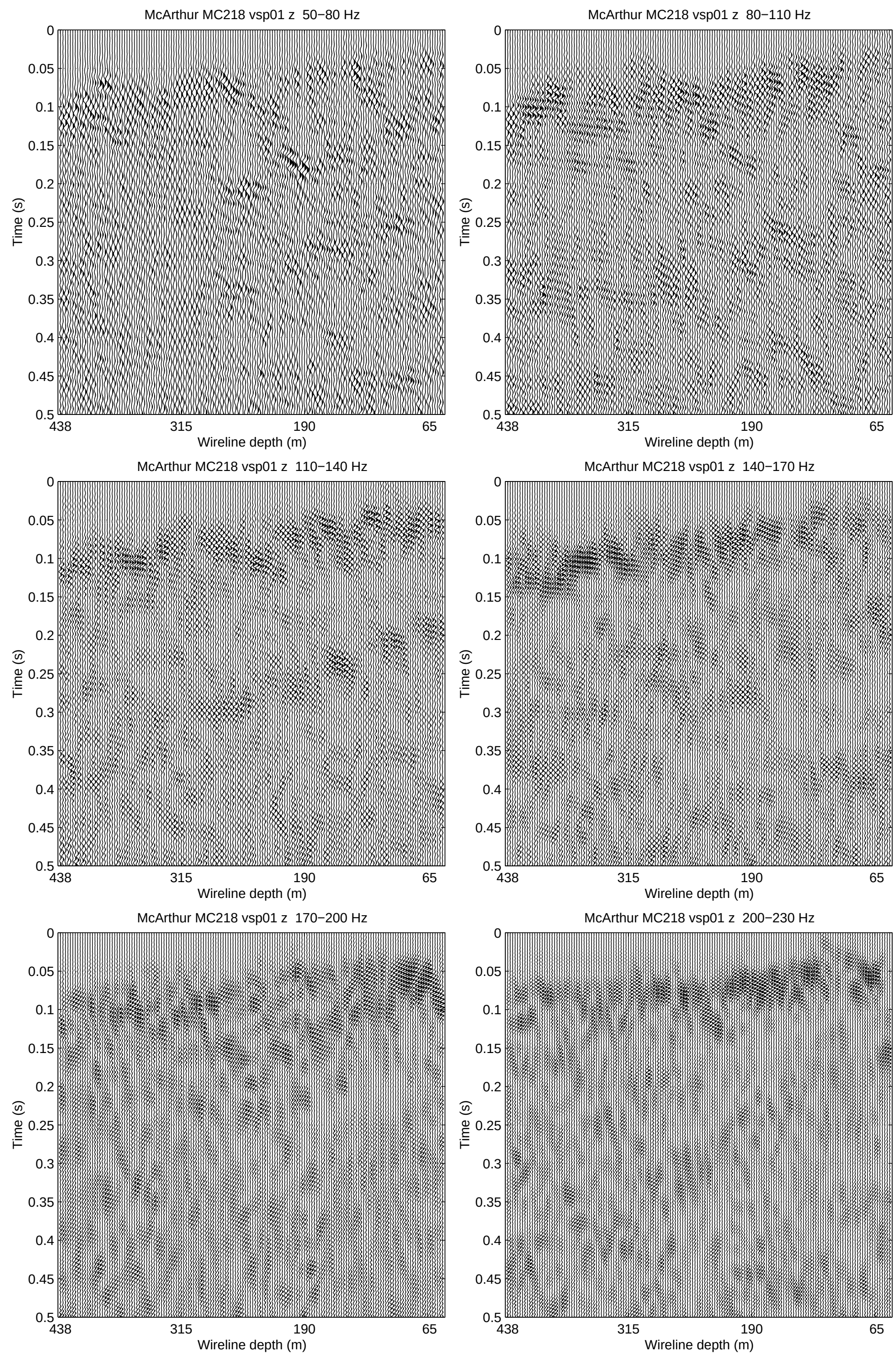

Figure 7: *Different bandpass filters were applied to the z-component of the dataset vsp01 in order to find optimum bandpass filter parameters.*

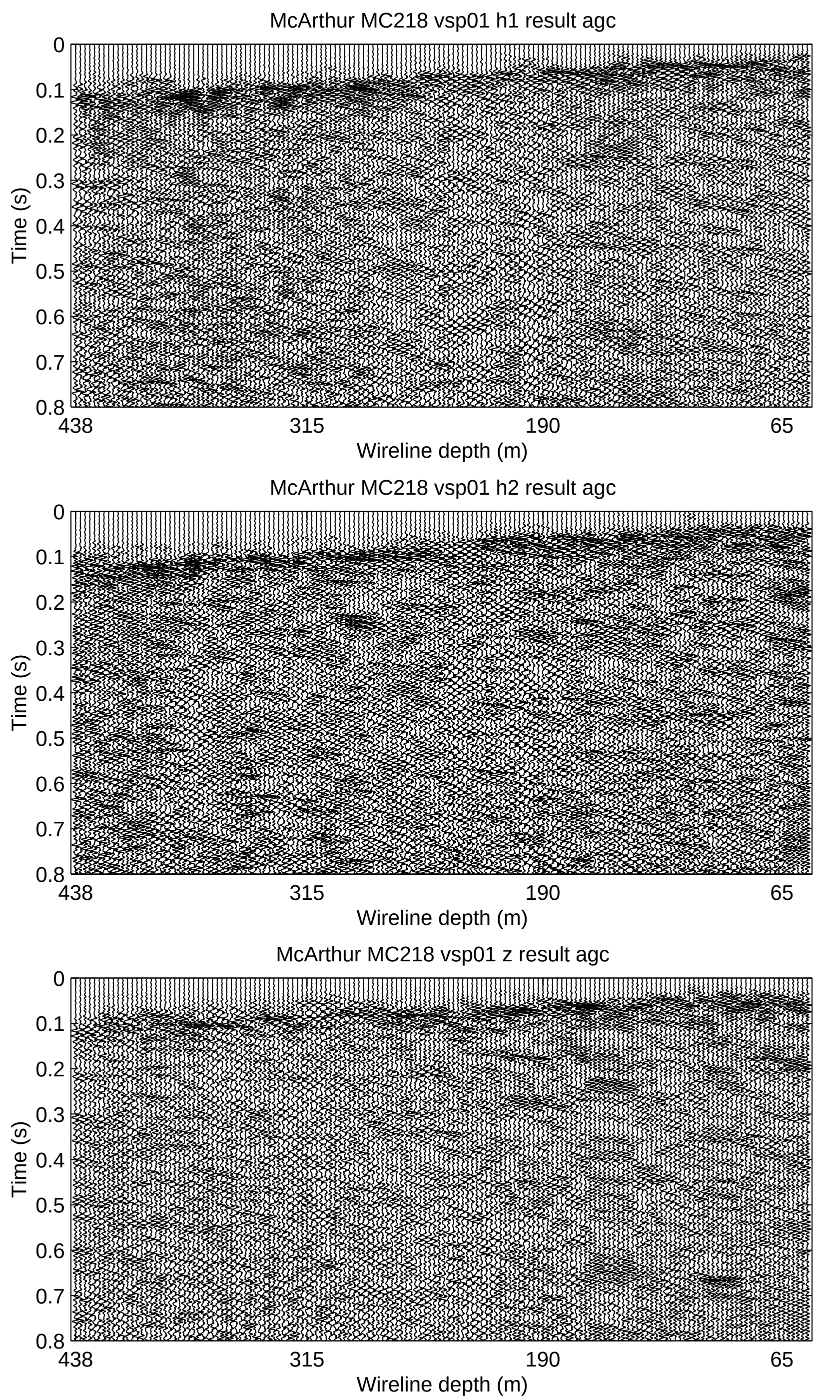

Figure 8: *All components of vsp01 after bandpass filtering (40/70-170/200 Hz) and AGC (windowlength=0.15s).*

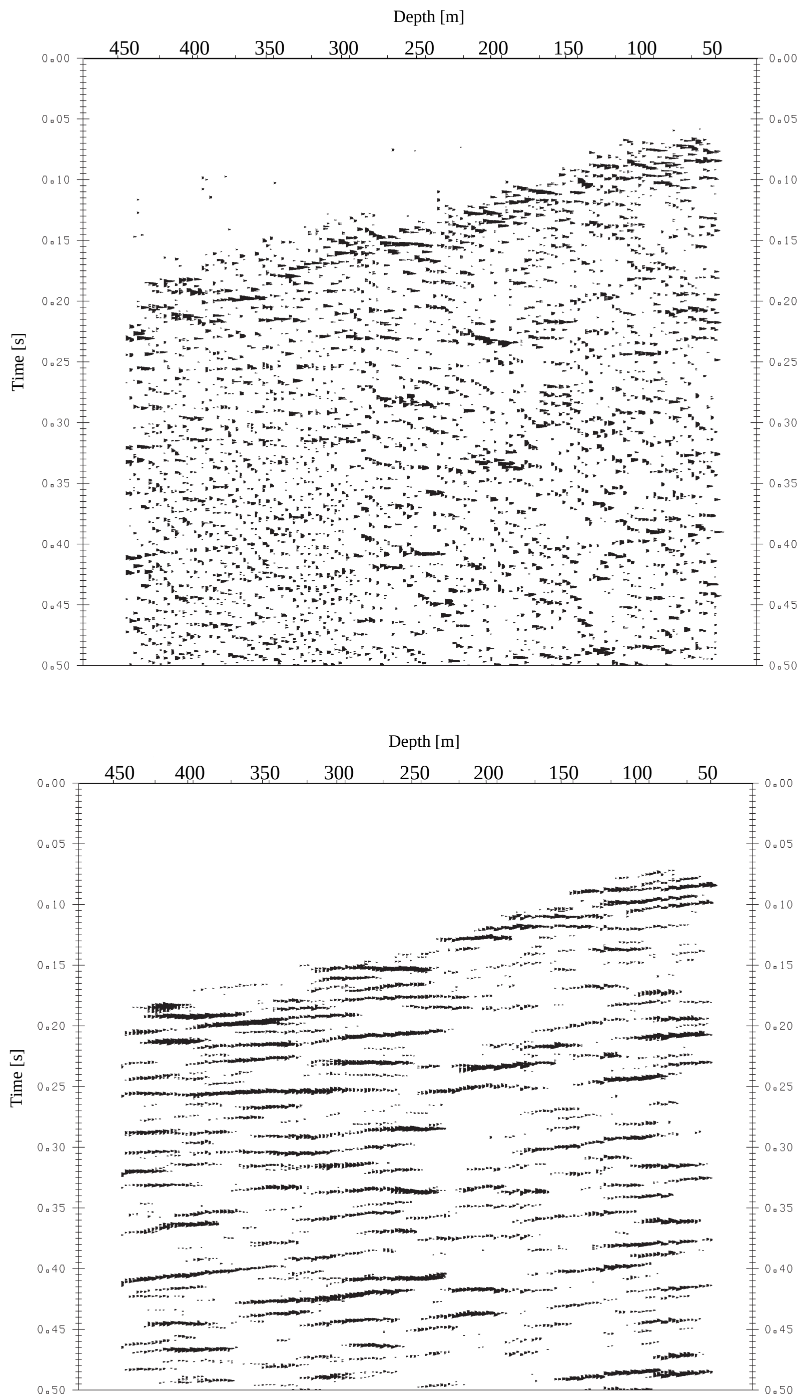

Figure 9: *The vertical component of vsp01 before (upper panel) and after semblance filtering (lower panel).*

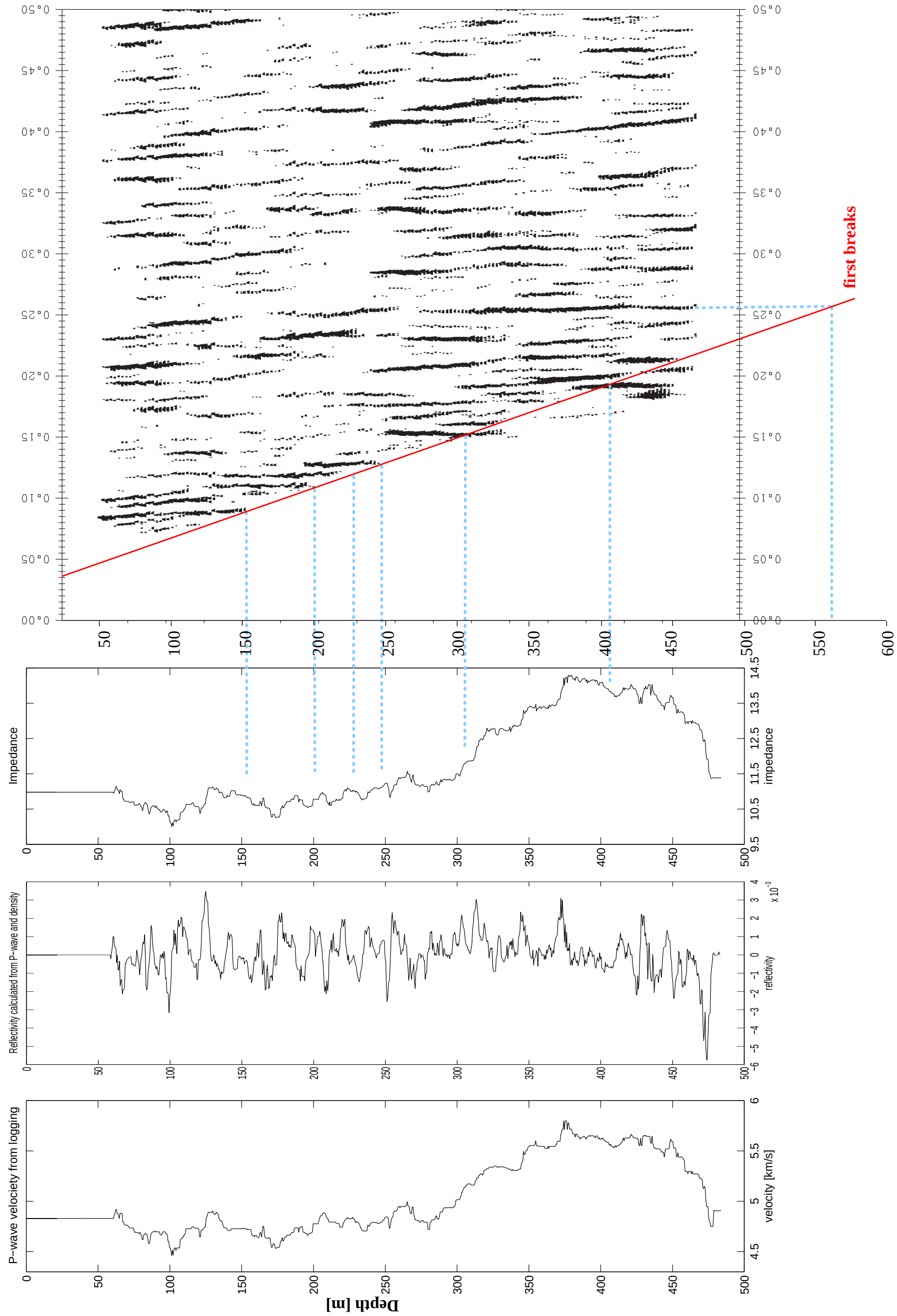

Figure 10: *Semblance filtered z component of vsp01 compared with p-wave velocity from logging and resulting reflectivity and impedance. The data are shifted with first breaks (red line) to a two-way travel time. A few events are marked with dotted blue lines. The deeper reflection would cross the first break line at about* 560 *m possibly originated from the unconformity.*

be compared to logging traces. In the upper panel of Figure 10 data shifted by the first break traveltime are shown. The red line indicates the travel time of the first breaks. In the lower panel for comparison the p-wave velocity, reflectivity and impedance from the borehole are shown. Where first breaks and stronger reflections meet, dotted blue lines are plotted to simplify the comparison to impedance variations. A prominent continuous reflection event meets the first break at about 560 m, possibly originating from the unconformity (not logged).
The corresponding figures for vsp02 are shown in Figure 21 and Figure 22, respectively.

5 Corridor Stack and Modelled Trace

To emphasize upgoing events, a numerical procedure known as corridor stack, composite trace or vertical summation can be applied to the data (Ellis, 1987; Hardage, 1985). This contains a simple vertical summation of vsp traces which have upgoing reflections from horizontal events aligned and downgoing energy misaligned. The alignment can be achieved by shifting each trace by its first break time.
In order to create a trace that contains only primary reflections the data must be restricted to a portion which is least affected by multiples. This can be done by a visual inspection. All data outside the chosen part are muted. Figure 11 shows all three components of the muted data from vsp01. The lowest figure shows the z-component with an AGC as used for the composite trace. The vertical summation will result in a composite trace and serves as an accurate estimation of all upgoing primary reflections. This process assumes that the reflectors are flat and horizontal. Reflections from dipping events will not be aligned by delaying with first break times and thus can not be summed. To enhance the result one could try a statical adjustment in time before summing.
In Figure 12 the composite traces of all three components of vsp01 are shown. An AGC with a windowlength of 100 ms was applied before stacking. Travel times have been converted to depth using the average p-wave velocity of 4605 m/s. The resultant trace has been duplicated a number of times for easy visual comparison. It is now comparable to a surface seismic section and can be spliced into a seismic section in the vicinity of the borehole. In Figure 13 three different results of corridor stacks are shown. The left one without any gain, the middle one with an AGC of 100 ms length and the right one was stacked after semblance filtering.
The composite trace can also be compared to a modelled trace as shown in Figure 14. During a summer fieldwork in 2000, borehole MAC218 at the McArthur River Mine was geophysically logged. The full waveform sonic log provides the compressional velocity (v_p) and the density (Mwenifumbo et al., 2000). Both parameters were used to calculate the impedance and afterwards the reflectivity from

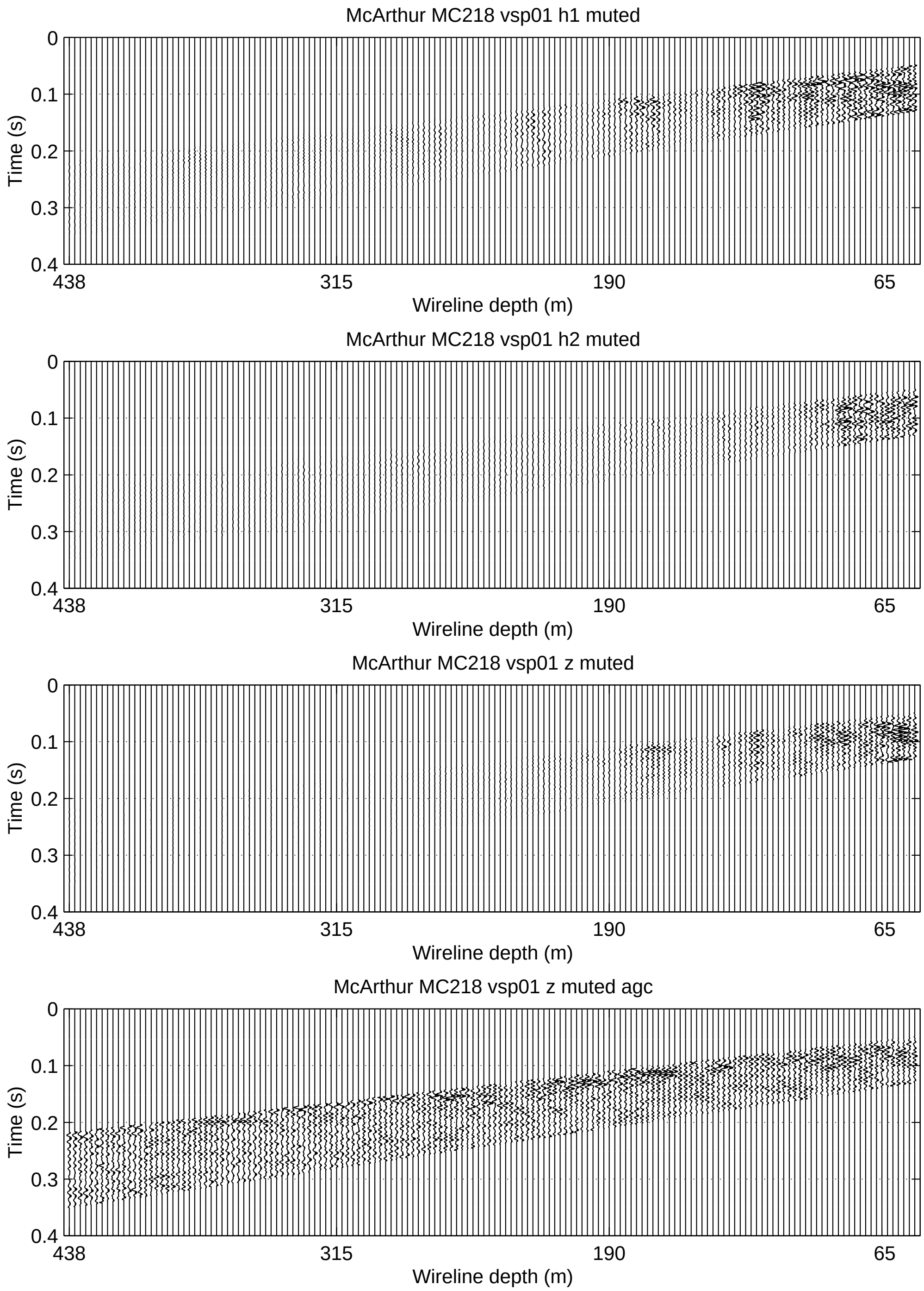

Figure 11: *Muted data of all three components for vsp01 with any gain (three upper figures). The lowest panel shows the z-component of muted data with AGC, as used for the corridor stack.*

the different formations intersected by the borehole. In Figure 14 the density (b), the p-wave velocity (c), the calculated impedance (d) and the resulting reflectivity (e) are shown. The modelled trace is generated by convolving a synthetic seismic signal with the reflectivity trace. A Ricker wavelet with a central frequency of 100 Hz was used to represent a typical seismic wavelet to generate the synthetic seismogram for figure 14 f). For Figure 14 g) the correlated sweep of 20 to 300 Hz from the survey was used to model the trace. Both figures show that the applied wavelet and the comprised frequencies play a decisive role for the result.

6 Interpretation of Corridor Stacks

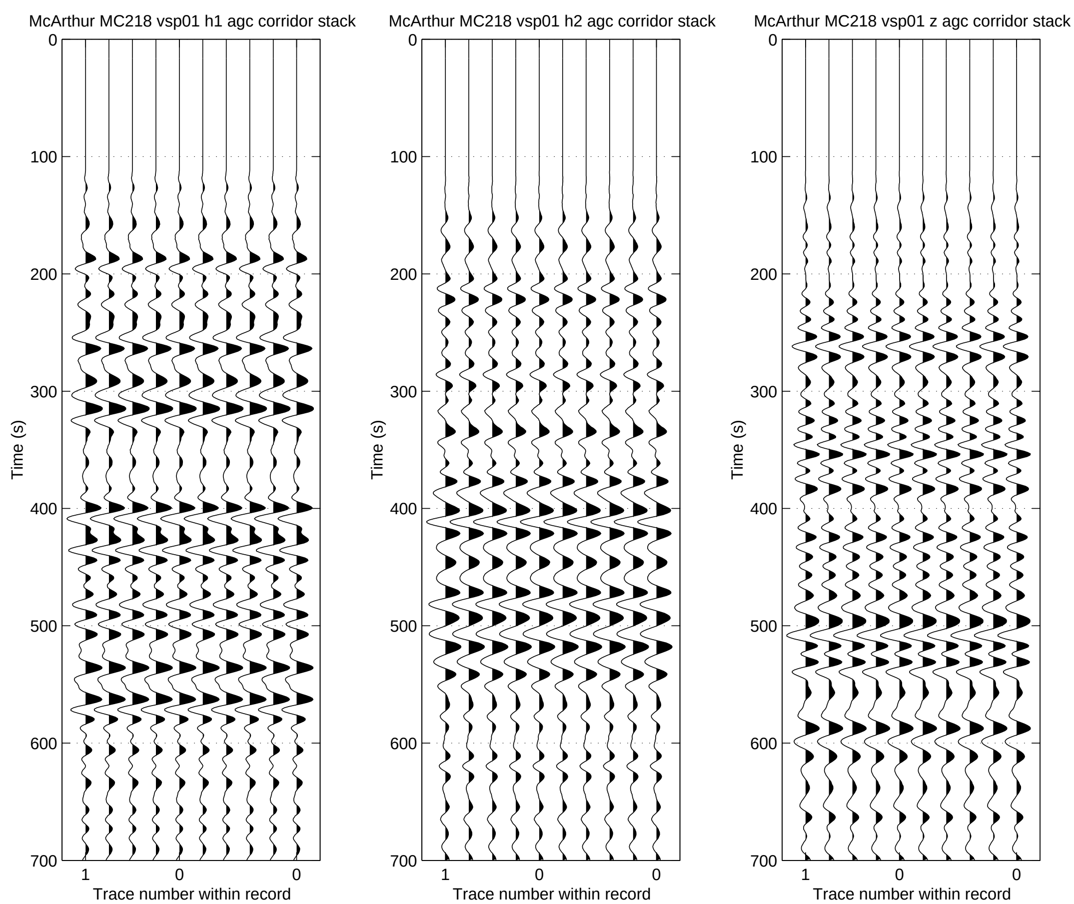

Figure 12: *Corridor stack of all three components for vsp01. The depth is calculated for an estimated average p-wave velocity of* 4605 *m/s. Before stacking an AGC with* 100 *ms length was applied as in Figure 11 (lower panel).*

The correspondence between the reflectivity or synthetic trace (Figure 14 f, Ricker wavelet synthetic trace) and the corridor stack (Figure 14 h for vsp01) is not convincing. Only a few of the observed events can be correlated. The impedance contrasts between geological units are not prominent. Strong impedance contrasts are only observed within the units as it is the case e.g. for the "Manitou Fall D" at $100m$. The sudden drop in sonic logging velocity can probably be explained by local cracks or faults in the vicinity of the borehole.

In order to obtain a better correspondence with the corridor stacks a new synthetic seismogram was generated using the correlated source signal instead of a Ricker wavelet (see figure 14 g). Again, this correspondence could not be demonstrated. A number of reasons for this discrepance is discussed below:

The corridor stack method is strickly valid only for the case of layered media which mainly show an impedance contrast controlled by density where velocities do not change significantly with depth. As can be seen from the McArthur logs velocity changes with depth especially in the lower regions of the borehole. It is thus not surprising that we find poor correspondence between the synthetic trace and the corridor stacks. However, strong local heterogenities, e.g. generated by cracks and local faults would also explain the discrepancy between the synthetic trace and the corridor stack. This is in very good agreement with the geophysical logging report (Mwenifumbo et al., 2000). The impedance contrasts between geological units are not prominent. Strong impedance contrasts are only observed within the units as it is the case e.g. for the "Manitou Fall D". The sudden drop in sonic logging velocity can again be explained by local cracks or faults in the vicinity of the borehole.

The high negative amplitudes near $500m$ depth in the synthetic traces (fig. 14 f,g) result from rapidly dropping impedance towards the transition zone (Fanglomerate, see fig. 14 d). This event can not be seen in the corridor stacked data. The reflectivity of the basement can not be calculated because of the lack of logging values in greater depth than $\sim 480m$. The expected reflection of the basement should appear atabout $500m$ ($\pm 50m$ transition zone), but can not be observed in the stacked data for vsp01 (Figure 12). Only a weak reflection in one of the horizontal components at about $500m$ for vsp01 is visible.

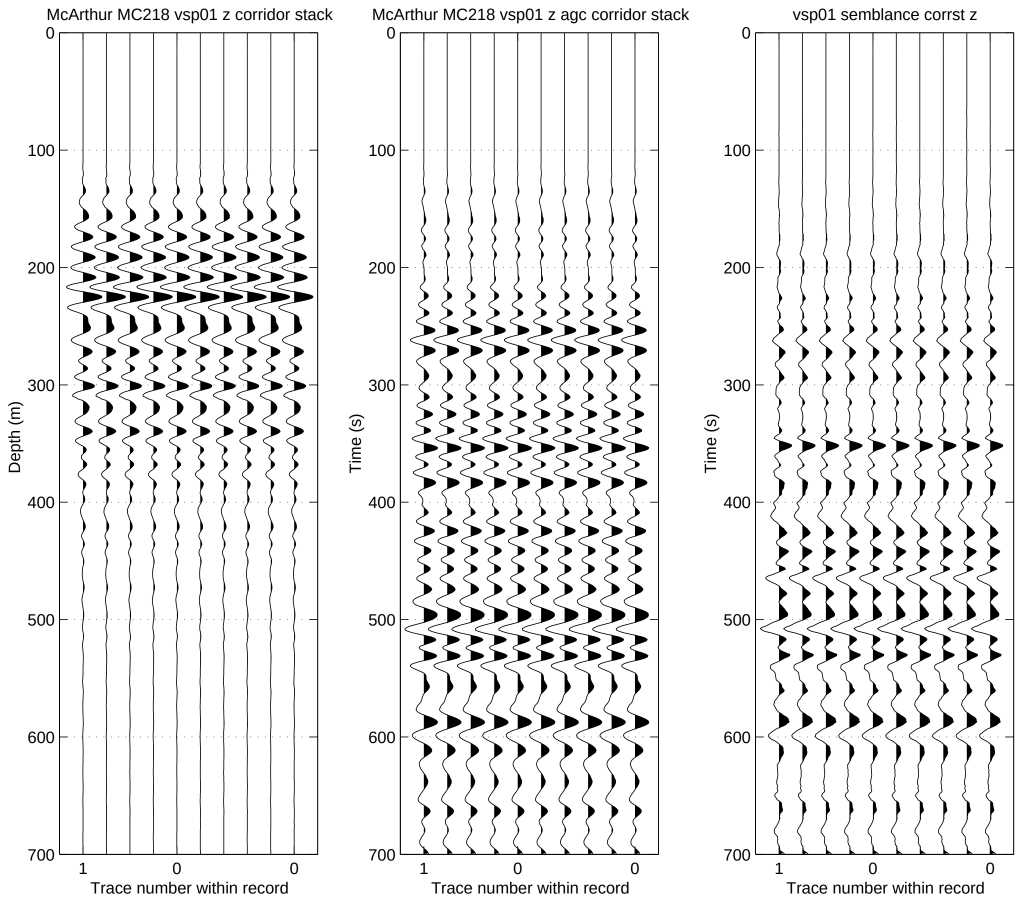

Figure 13: *Corridor stacks for vsp01 from vertical component only. The left stack is without any gain, the middle panel has an AGC of* 100 *ms length and the right panel is stacked after semblance filtering.*

7 Conclusions

The processing sequence employed to both datasets was nearly the same.
For dataset vsp01 problems occur during geometry assignment, rotation to maximize first break energy on one horizontal component and filtering of downgoing energy. Apart from the geometry, these problems were mainly caused by a low signal-to-noise ratio.
For vsp02 the signal-to-noise ratio is a little better so that e.g. the rotation worked satisfactory. Also removing the downgoing energy was easier and successful, but the result still has a high contamination of noise.
A few reflections can be observed in the datasets, but hardly correlate with the geologic formations, impedance contrasts or synthetic traces.
During the processing two DSISoft modules were written. The first one, *plotspecmatr.m*, to get a complete f-k spectrum, the second one, *corrstack.m*, to create a composite trace of a dataset, see appendix three (11). Problems during processing also appear from a few ineffective DSISoft modules.
For further processing, using all three components, e.g. migration, it is necessary to preserve the amplitude ratio between the components. Thus it is required to use only multicomponent modules for processing.
The processing steps as well as used scripts can be found in appendix one and two (section 9 and 10).

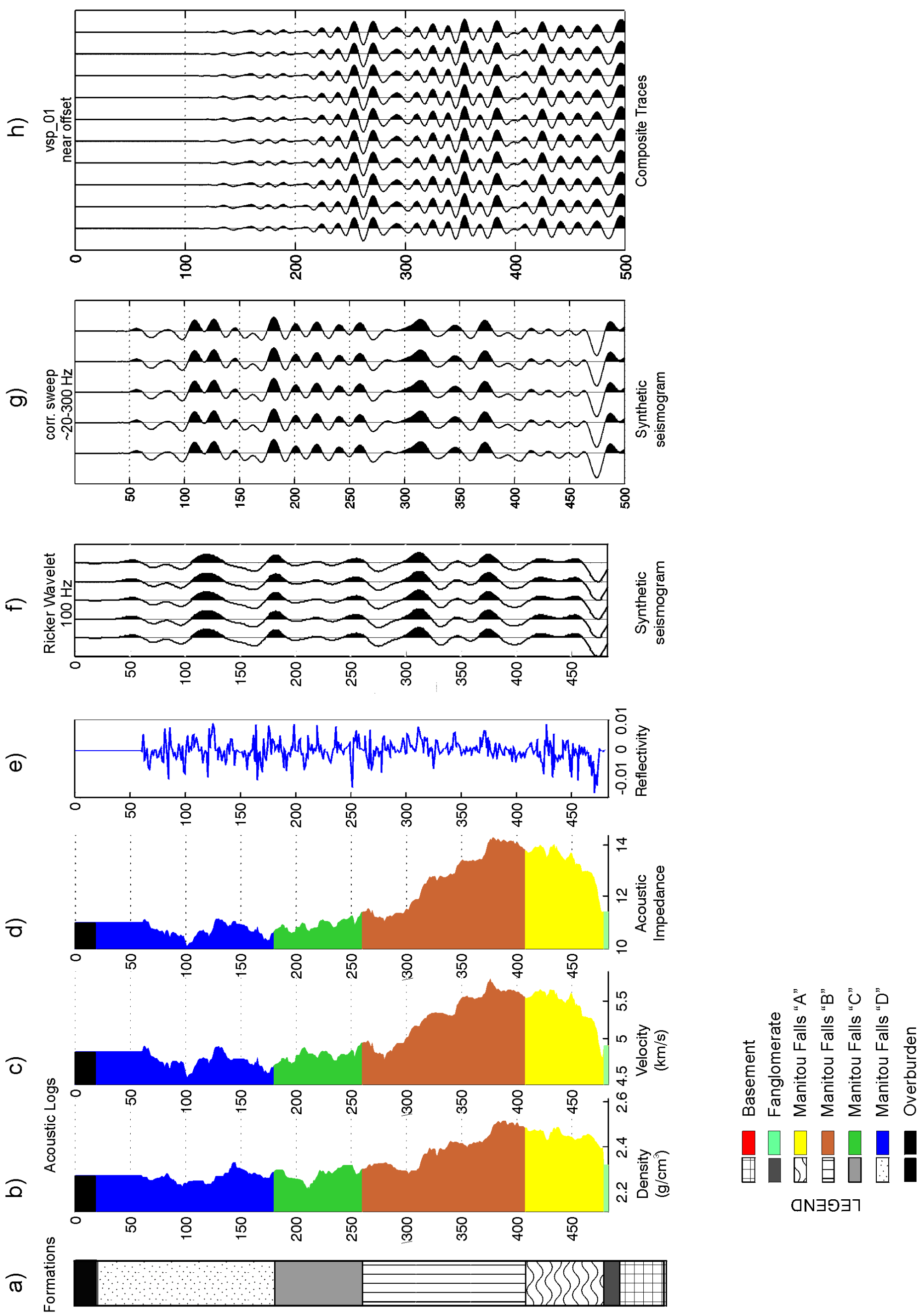

Figure 14: *Comparison between geologic formations (a), acoustic logs (b: density, c: p-wave velocity), acoustic impedance (d), reflectivity (e) and modelled traces from borehole MAC218 (f: Ricker wavelet, g: correlated sweep) with composite trace (z component) of vsp01 (h).*

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9 Appendix One - Processing Steps

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   Processing steps for VSP'01 data of McArthur River Mine Data 2001

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______________________________________
Step #1 --> convert SEG2 to DSI format

The list of input files is: mc218_vsp_01_list.txt
Input files: the file*.dat in the ./raw directory
Script: convert_01.m
_______________________________
Step #2 --> first trace editing
sets bad flag to kill empty traces and kills flagged traces
Script: edit1_01.m
________________________
Step #3 --> set geometry
sets all important headerwords
Script: setheader_01.m
_________________________
Step #4 --> trace editing
chooses traces, who will NOT end in the SEISMOGRAM with DSISoft dispseis
writes a vector with the bad tracenumbers and kills the traces
Script: edit2_01.m
Save: vsp_01_raw.mat
______________________
Step #5 --> first plot
applies agc before plotting and plots eps file
Script: plot1_01.m
__________________________________
Step #6 --> harmonic noise removal
wide bandpass and harmonic filter
Script: harmon_01.m
Save: vsp_01_filt.mat
__________________________________________________
Step #7 --> pick first breaks and set headerwords
picks first break with pick1comp and writes values to all records
Script: firstbreak_01.m
Save: fb_z_vsp_01.txt
_____________________
Step #8 --> rotation
rotates two horizontal components with rot3c
Script: rotaion_01.m
Save: vsp_01_rot3c.mat
_______________________________________
Step #9 --> removal of downgoing P-wave
removes downgoing p-wave with median filter
Script: remove_p_01.m
Save: vsp_01_wo_p.mat
______________________________________________
Step #10 --> removal of other downgoing energy
removes downgoing s-wave and tube wave with f-k filter
Script: remove_all_01.m
Save: vsp_01_fk.mat
______________________________________________
Step #11 --> bandpasstest, bandpass and gain
tests different bandpass filters and applies different agc's and energy balancy
Script: bandpass_01.m
Save: bandpass_test_vsp_01_z.mat
vsp_01_bp.mat
vsp_01_end_agc.mat
vsp_01_end_agc3c.mat
vsp_01_end_bal.mat
___________________________
Step #12 --> corridor stack
produces a corridor satck (composite trace)
Script: corridor_01.m
Save: vsp_01_corrst.mat
```

All plot scripts which were used for the report are numbered consecutively (i.e. plot1'01.m, plot2'01.m, etc.).

```
=================================================================
```

Processing steps for VSP˙02 data of McArthur River Mine Data 2001

```
=================================================================

______________________________________
Step #1 --> convert SEG2 to DSI format

The list of input files is: mc218_vsp_02_list.txt
Input files: the file*.dat in the ./raw directory
Script: convert_02.m
_______________________________
Step #2 --> first trace editing
sets bad flag to kill empty traces and kills flagged traces
Script: edit1_02.m
________________________
Step #3 --> set geometry
sets all important headerwords
Script: setheader_02.m
Save: vsp_02_raw.mat
_________________________
Step #4 --> trace editing
for vsp02 not necessary
______________________
Step #5 --> first plot
applies agc before plotting and plots eps file
Script: plot1_02.m for
__________________________________
Step #6 --> harmonic noise removal
wide bandpass and harmonic filter
Script: harmon_02.m
Save: vsp_02_filt.mat
__________________________________________________
Step #7 --> pick first breaks and set headerwords
picks first break with pick1comp and writes values to all records
Script: firstbreak_02.m
Save: fb_z_vsp_02.txt
_____________________
Step #8 --> rotation
rotates two horizontal components with rot3c
Script: rotaion_02.m
Save: vsp_02_rot3c.mat
_______________________________________
Step #9 --> removal of downgoing P-wave
removes downgoing p-wave with median filter
Script: remove_p_02.m
Save: vsp_02_wo_p.mat
______________________________________________
Step #10 --> removal of other downgoing energy
removes downgoing s-wave and tube wave with median filter
Script: remove_all_02.m
Save: vsp_02_wo_s.mat
vsp_02_wo_t.mat
______________________________________________
Step #11 --> bandpasstest, bandpass and gain
tests different bandpass filters and applies different agc's and energy balancy
Script: bandpass_02.m
Save: bandpass_test_vsp_02_z.mat
vsp_02_bp.mat
vsp_02_end_agc.mat
vsp_02_end_agc3c.mat
vsp_02_end_bal.mat
___________________________
Step #12 --> corridor stack
produces a corridor satck (composite trace)
Script: corridor_02.m
Save: vsp_02_corrst.mat
```

All plot scripts which were used for the report are numbered consecutively (i.e. plot1˙02.m, plot2˙02.m, etc.).

10 Appendix Two - Processing Scripts

```
=========================================================
```

All single processing scripts of vsp01 as example

```
=========================================================

_______________
-> convert_01.m
% READ SEG2 DATA and PUT it in DSI FORMAT
% FILE mc218_vsp_01_list.txt CONTENTS all FILE NAMES of DESIRED RECORDS
% Input files: the file*.dat in the ./raw directory

[mc218_vsp_01_raw] = myseg2mat('mc218_vsp_01_list.txt');

_____________
-> edit1_01.m
%SET BAD FLAG to kill EMPTY TRACES and KILL FLAGGED TRACES
bad = [13:50];
[mc218_vsp_01_raw] = kill(mc218_vsp_01_raw,1,bad);
[mc218_vsp_01_raw] = pack_good(mc218_vsp_01_raw,0);

clear bad

%SORT DATA into SHOTS with TRACE NUMBER
[mc218_vsp_01_raw] = sortrec(mc218_vsp_01_raw,2,1);

_________________
-> setheader_01.m
%Geometry
% -> recording component = headerword 4
% -> source northing = headerword 29
% -> source easting = headerword 31
% -> source elevation = headerword 33
% -> receiver northing = headerword 35
% -> receiver easting = headerword 37
% -> borehole elevation = headerword 38
% -> tool level (1-4) = headerword 36
% -> wireline depth = headerword 40
% -> receiver wireline depth = headerword 56
% -> receiver elevation = headerword 39
% -> shot receiver azimuth = headerword 9 %with DSISoft-program s2r_geom
% -> source to receiver offset = headerword 53 %with DSISoft-program s2r_geom

headerword=4; %recording component%
for shot=1:60
for trace=1:12
j=rem(trace,3);
if j==0
j=3;
end
mc218_vsp_01_raw.thshot(headerword,trace)=j;
end
end

headerword=29; %source northing%
for shot=1:60
for trace=1:12
mc218_vsp_01_raw.thshot(headerword,trace)=6402799.35;
end
end

headerword=31; %source easting%
for shot=1:60
for trace=1:12
mc218_vsp_01_raw.thshot(headerword,trace)=497540.1;
end
end

headerword=33; %source elevation%
for shot=1:60
for trace=1:12
mc218_vsp_01_raw.thshot(headerword,trace)=545.17;
end
end

headerword=35; %receiver northing%
for shot=1:60
for trace=1:12
mc218_vsp_01_raw.thshot(headerword,trace)=6402797;
end
end
```

```
headerword=37; %receiver easting%
for shot=1:60
for trace=1:12
mc218_vsp_01_raw.thshot(headerword,trace)=497567;
end
end

headerword=38; %borehole elevation%
for shot=1:60
for trace=1:12
mc218_vsp_01_raw.thshot(headerword,trace)=545.67;
end
end

headerword=36; %tool level%
for shot=1:60
for j=1:4
for i=0:2
trace=(j*3)-i;
mc218_vsp_01_raw.thshot(headerword,trace)=j;
end
end
end

load mc218_vsp_01_wireline.txt; %ascii file:wireline depth for the first level from observer notes%
wireline = mc218_vsp_01_wireline;
headerword=40; %wireline depth from the observer notes for the first level of borehole tool%
for shot=1:60
for trace=1:12
mc218_vsp_01_raw.thshot(headerword,trace)=wireline(shot,1);
end
end

receiver_wireline=[wireline,wireline+10,wireline+20,wireline+30];
headerword=56; %receiver(level) wireline depth%
for shot=1:60
for j=1:4
for i=0:2
trace=(j*3)-i;
mc218_vsp_01_raw.thshot(headerword,trace)=receiver_wireline(shot,j);
end
end
end

receiver_elevation=545.67-[receiver_wireline];
headerword=39; %receiver elevation%
for shot=1:60
for j=1:4
for i=0:2
trace=(j*3)-i;
mc218_vsp_01_raw.thshot(headerword,trace)=receiver_elevation(shot,j);
end
end
end

%SET SHOT_RECEIVER_AZIMUTH (headerwords 9) and SOURCE to RECEIVER OFFSET (headerword 53)
[mc218_vsp_01_raw]=s2r_geom(mc218_vsp_01_raw);

%SORT DATA to RECEIVER COMPONENT and RECEIVER ELEVATION
[vsp_01_raw]=sortrec(mc218_vsp_01_raw,4,39);

%SET a HEADERWORD for consecutive numbering of TRACES
headerword1=11; %successive trace number%
headerword2=30; %successive trace number%
i=240;
j=1;
for k=1:3;
for trace=1:240;
vsp_01_raw.th1(headerword1,trace)=i;
vsp_01_raw.th1(headerword2,trace)=j;
i=i-1;
j=j+1;
end
end

clear header* i j k receiver* shot trace wireline mc218_vsp_01_wireline
```

```
-> edit2_01.m
%CHOOSE TRACES by VIEW, who will NOT end in the SEISMOGRAM with DSISoft dispseis
%WRITE a VECTOR with BAD TRACENUMBERS
right1 = [6,8,10,12,14,16,18,20,22,24,26,28];
right2 = [37,39,41,43,45,47,49,51,53,55,57,59];
right3 = [69,71,73,75,77,79,81,83,85,87,89,91];
right4 = [102,104,106,108,110,112,114,116,118,120,122,124];
right5 = [133,135,137,139,142,144,146,147,149,151,153,155];
right6 = [165,167,169,172,173,176,178,180,181,184,185,187];
```

```
right7 = [198,200,202,203,205,208,210,212,214,215,217,219];
soright = [right1,right2,right3,right4,right5,right6,right7]

%SET BAD FLAG to kill UNNECESSARY/BAD/DOUBLE TRACES and KILL FLAGGED TRACES
[vsp_01_raw_kill] = kill(vsp_01_raw,13,soright);
[vsp_01_raw] = pack_good(vsp_01_raw_kill,0);

clear right* soright mc218* vsp_01_raw_kill;
save vsp_01_raw vsp_01_raw

_____________
-> plot1_01.m
%First PLOT

%APPLY AGC before plotting
[vsp_01_raw_agc]=agc3c(vsp_01_raw,0.05,1);

%PLOT single components
vaplot(vsp_01_raw_agc,0.0,0.8,1,156,1,0,2.0,'black',56,32,3,1,2,'vsp_01_raw_agc_h1.eps','McArthur MC218 vsp01 h1 raw')
vaplot(vsp_01_raw_agc,0.0,0.8,1,156,1,0,2.0,'black',56,32,3,2,2,'vsp_01_raw_agc_h2.eps','McArthur MC218 vsp01 h2 raw')
vaplot(vsp_01_raw_agc,0.0,0.8,1,156,1,0,2.0,'black',56,32,3,3,2,'vsp_01_raw_agc_z.eps','McArthur MC218 vsp01 z raw')

______________
-> harmon_01.m
%APPLY BANDPASS FILTER
[vsp_01_filt]=bandpass(vsp_01_raw,35,40,300,320);

%APPLY FILTER for HARMONICS
%frequencies to filter out are: 61.25, 126.5, 183.75, 306.25

f=[60.25 62.25; 125.5 129.5; 182.75 184.75; 305.25 307.25]; %f=matrix with frequencies in Hz
for i=1:4
[vsp_01_filt]=harmon(vsp_01_filt,f(i,1),f(i,2),0.01);
i=i+1;
end

clear f i
save vsp_01_filt vsp_01_filt

_____________
-> plot2_01.m
%APPLY AGC before plotting
[vsp_01_raw_agc]=agc3c(vsp_01_raw,0.05,1);
[vsp_01_filt_agc]=agc3c(vsp_01_filt,0.05,1);

%PLOT single components
vaplot(vsp_01_filt_agc,0.0,0.8,1,70,1,0,2.0,'black',56,32,3,3,2,'vsp_01_filt_agc_z_part.eps','McArthur MC218 vsp01 z after harmon')
vaplot(vsp_01_raw_agc,0.0,0.8,1,70,1,0,2.0,'black',56,32,3,3,2,'vsp_01_raw_agc_z_part.eps','McArthur MC218 vsp01 z before harmon')

__________________
-> firstbreak_01.m
%%NOW PICK THE FIRST BREAKS%%
%%OR USE TXT.FILE WITH ALREADY PICKED FIRST BREAKS%%

%SET FIRST BREAKS from picked z-COMPONENT to OTHER COMPONENTs
load fb_z_vsp_01.txt %file with first breaks picked from z component
headerword=15;  %first breaks for the two horizontal components%
for record=1:3 %for record one and two (h1 and h2) (and z)
for trace=1:156
vsp_01_filt.threcord(headerword,trace)=fb_z_vsp_01(1,trace);
end
end

clear headerword record trace fb_z_vsp_01

________________
-> rotation_01.m
%ENERGY BALANCING with all 3 COMPONENTS
%[vsp_01_filt_bal]=ener3c(vsp_01_filt,0.02,0.14); % not used!

%ROTATION of COMPONENT H1 and H2 with rot3c
[vsp_01_rot3c]=rot3c(vsp_01_filt,15,0.01,0.01,1,2);

%ROTATION of COMPONENT H1 and H2 with rot3c_eig
%[vsp_01_rot3c_eig]=rot3c_eig(vsp_01_filt,15,0.01,1,2); % result not satisfactory

save vsp_01_rot3c vsp_01_rot3c

_____________
-> plot3_01.m
%THIRD PLOT

%APPLY AGC before plotting
[vsp_01_filt_agc]=agc3c(vsp_01_filt,0.05,1);
[vsp_01_rot3c_agc]=agc3c(vsp_01_rot3c,0.05,1);

%or
```

```
%APPLY ENER3C before plotting
%[vsp_01_filt_bal]=ener3c(vsp_01_filt,0.02,0.14);
%[vsp_01_rot3c_bal]=ener3c(vsp_01_rot3c,0.02,0.14);

%PLOT single components with AGC
vaplot(vsp_01_filt_agc,0.0,0.3,1,156,1,0,2.0,’black’,56,32,6,1,2,’vsp_01_filt_agc_h1.eps’,’McArthur MC218 vsp01 h1 agc0.1
before rotation’)
vaplot(vsp_01_rot3c_agc,0.0,0.3,1,156,1,0,2.0,’black’,56,32,6,1,2,’vsp_01_rot_agc_h1.eps’,’McArthur MC218 vsp01 h1 agc0.1
after rotation’)
vaplot(vsp_01_filt_agc,0.0,0.3,1,156,1,0,2.0,’black’,56,32,6,2,2,’vsp_01_filt_agc_h2.eps’,’McArthur MC218 vsp01 h2 agc0.1
before rotation’)
vaplot(vsp_01_rot3c_agc,0.0,0.3,1,156,1,0,2.0,’black’,56,32,6,2,2,’vsp_01_rot_agc_h2.eps’,’McArthur MC218 vsp01 h2 agc0.1
after rotation’)

%PLOT single components with BALACING
%vaplot(vsp_01_filt_bal,0.0,0.8,1,156,1,0,2.0,’black’,56,32,3,1,2,’vsp_01_filt_bal_h1.eps’,’McArthur MC218 vsp01 h1 bal
before rotation’)
%vaplot(vsp_01_rot3c_bal,0.0,0.8,1,156,1,0,2.0,’black’,56,32,3,1,2,’vsp_01_rot_bal_h1.eps’,’McArthur MC218 vsp01 h1 bal
after rotation’)
%vaplot(vsp_01_filt_bal,0.0,0.8,1,156,1,0,2.0,’black’,56,32,3,2,2,’vsp_01_filt_bal_h2.eps’,’McArthur MC218 vsp01 h2 bal
before rotation’)
%vaplot(vsp_01_rot3c_bal,0.0,0.8,1,156,1,0,2.0,’black’,56,32,3,2,2,’vsp_01_rot_bal_h2.eps’,’McArthur MC218 vsp01 h2 bal
after rotation’)

________________
-> remove_p_01.m
%REMOVE DOWNGOING P-WAVE
[vel]=velocity(vsp_01_rot3c,1); %calculates the p-velocity
% interpolated-p-vel=4591.11 m/s and average-p-vel=4620.15 m/s %

[flatout1_01]=flat2(vsp_01_rot3c,0.0245,15);
[med1_01]=medi_filt(flatout1_01,11);
[sub1_01]=subr(med1_01,flatout1_01); %subtracts the median from the data
[vsp_01_wo_p]=unflat2(sub1_01,0.0245,15); %unflat the data using the same velocity as for

clear vel flat* med1* sub1*
save vsp_01_wo_p vsp_01_wo_p

_____________
-> plot4_01.m
%APPLY AGC before plotting
[vsp_01_rot3c_agc]=agc3c(vsp_01_rot3c,0.05,1);
[flatout1_01_agc]=agc3c(flatout1_01,0.05,1);
[med1_01_agc]=agc3c(med1_01,0.05,1);
[sub1_01_agc]=agc3c(sub1_01,0.05,1);
[vsp_01_wo_p_agc]=agc3c(vsp_01_wo_p,0.05,1);

%PLOT single components with AGC
vaplot(vsp_01_rot3c_agc,0.0,0.5,1,156,1,0,2.0,’black’,56,39,8,3,2,’vsp_01_rot3c_agc_z.eps’,’McArthur MC218 vsp01 z agc0.05
before median’)
vaplot(flatout1_01_agc,0.0,0.5,1,156,1,0,2.0,’black’,56,39,8,3,2,’flatout1_01_agc_z.eps’,’McArthur MC218 vsp01 z agc0.05
after aligning first break’)
vaplot(med1_01_agc,0.0,0.5,1,156,1,0,2.0,’black’,56,39,8,3,2,’med1_01_agc_z.eps’,’McArthur MC218 vsp01 z agc0.05
resulting median filter’)
vaplot(sub1_01_agc,0.0,0.5,1,156,1,0,2.0,’black’,56,39,8,3,2,’sub1_01_agc_z.eps’,’McArthur MC218 vsp01 z agc0.05
subtracted median filter’)
vaplot(vsp_01_wo_p_agc,0.0,0.5,1,156,1,0,2.0,’black’,56,39,8,3,2,’vsp_01_wo_p_agc_z.eps’,’McArthur MC218 vsp01 z agc0.05
p-wave energy removed’)

__________________
-> remove_all_01.m
%% REMOVE DOWNGOINGS AND TUBEWAVES WITH FK-FILTERING
%% CREATE POLYGONS WITH FKPOLY

%% INPUT FOR THIS SEQUENCE WAS vsp_01_wo_p!!!!
%poly1.txt --> for all positive wavenumbers to be filtered
%poly2.txt --> for harmonics between 112 and 113 Hz to be filtered
%poly3.txt --> for harmonics between 82 and 83 Hz to be filtered
%poly4.txt --> for tubewaves with 1000-1500 m/s to be filtered
%poly5.txt --> for tubewaves with 900-1400 m/s to be filtered

%% INPUT FOR THE FOLLOWING SEQUENCE WAS vsp_01_wo_p
load poly1.txt
[vsp_01_fk1]=fkfilt(vsp_01_wo_p,poly1,500,10,1,2.5,1);
[vsp_01_fk1]=fkfilt(vsp_01_fk1,poly1,500,10,1,2.5,2);
[vsp_01_fk1]=fkfilt(vsp_01_fk1,poly1,500,10,1,2.5,3);

%% INPUT FOR THE FOLLOWING SEQUENCE WAS vsp_01_fk1
load poly2.txt
[vsp_01_fk2]=fkfilt(vsp_01_fk1,poly2,500,10,1,2.5,1);
[vsp_01_fk2]=fkfilt(vsp_01_fk2,poly2,500,10,1,2.5,2);
[vsp_01_fk2]=fkfilt(vsp_01_fk2,poly2,500,10,1,2.5,3);

%% INPUT FOR THE FOLLOWING SEQUENCE WAS vsp_01_fk2
load poly3.txt
[vsp_01_fk3]=fkfilt(vsp_01_fk2,poly3,500,10,1,2.5,1);
```

```
[vsp_01_fk3]=fkfilt(vsp_01_fk3,poly3,500,10,1,2.5,2);
[vsp_01_fk3]=fkfilt(vsp_01_fk3,poly3,500,10,1,2.5,3);

%% INPUT FOR THE FOLLOWING SEQUENCE WAS vsp_01_fk3 % not used
%load poly4.txt
%[vsp_01_fk4]=fkfilt(vsp_01_fk3,poly4,500,10,1,2.5,1);
%[vsp_01_fk4]=fkfilt(vsp_01_fk4,poly4,500,10,1,2.5,2);
%[vsp_01_fk4]=fkfilt(vsp_01_fk4,poly4,500,10,1,2.5,3);

%% INPUT FOR THE FOLLOWING SEQUENCE WAS vsp_01_fk3
load poly5.txt
[vsp_01_fk5]=fkfilt(vsp_01_fk3,poly5,500,10,1,2.5,1);
[vsp_01_fk5]=fkfilt(vsp_01_fk5,poly5,500,10,1,2.5,2);
[vsp_01_fk5]=fkfilt(vsp_01_fk5,poly5,500,10,1,2.5,3);

vsp_01_fk=vsp_01_fk5

clear vsp_01_fk1 vsp_01_fk2 vsp_01_fk3 vsp_01_fk4 vsp_01_fk5
save vsp_01_fk vsp_01_fk

_____________
-> plot5_01.m
%FIFTH PLOT

%APPLY AGC before plotting
%[vsp_01_fk_agc]=agc(vsp_01_fk,0.1,1);
[vsp_01_fk_bal]=ener(vsp_01_fk,0.0,0.2);

%PLOT vertical component with AGC
%vaplot(vsp_01_fk_agc,0.0,0.5,1,156,1,0,2.0,'black',56,32,5,3,2,'vsp_01_fk_agc01_z.eps','McArthur MC218 vsp01 z agc0.1 fk')

%PLOT vertical component with BALANCING
vaplot(vsp_01_fk_bal,0.0,0.5,1,156,1,0,2.0,'black',56,39,8,3,2,'vsp_01_fk_bal_z.eps','McArthur MC218 vsp01 z balanc fk')

________________
-> bandpass_01.m
% LOOKING AFTER NOISE!!!!
% looked after noise in low frequencies and in single parts or traces
% tried different bandpass filter (lower edge) to improve the data but doesn't work very well

%BANDPASS FILTER TEST with VERTICAL COMPONENT
[vsp_01_fk_z]=subset(vsp_01_fk,1,156,0.0,2.0,3,3);
[bp0]=bandpass(vsp_01_fk_z,10,20,50,60);
[bp1]=bandpass(vsp_01_fk_z,40,50,80,90);
[bp2]=bandpass(vsp_01_fk_z,70,80,110,120);
[bp3]=bandpass(vsp_01_fk_z,100,110,140,150);
[bp4]=bandpass(vsp_01_fk_z,130,140,170,180);
[bp5]=bandpass(vsp_01_fk_z,160,170,200,210);
[bp6]=bandpass(vsp_01_fk_z,190,200,230,240);
[bp7]=bandpass(vsp_01_fk_z,220,230,300,310);

%MERGE FILES TOGETHER for BETTER HANDLING
[hugo]=merge_files(bp0,bp1);
[hugo]=merge_files(hugo,bp2);
[hugo]=merge_files(hugo,bp3);
[hugo]=merge_files(hugo,bp4);
[hugo]=merge_files(hugo,bp5);
[hugo]=merge_files(hugo,bp6);
[bandpass_test_vsp_z]=merge_files(hugo,bp7);

clear bp* vsp_01_fk_z hugo
save bandpass_test_vsp_z bandpass_test_vsp_z

%APPLY CHOSEN BANDPASS FILTER
[vsp_01_bp]=bandpass(vsp_01_fk,40,70,160,190);

save vsp_01_bp vsp_01_bp

%APPLY DIFFERENT GAINS and BALANCING
[vsp_01_end_agc3c]=agc3(vsp_01_bp,0.15,1);
[vsp_01_end_bal]=ener3c(vsp_01_bp,0.0,0.2);

save vsp_01_end_agc vsp_01_end_agc
save vsp_01_end_agc3c vsp_01_end_agc3c
save vsp_01_end_bal vsp_01_end_bal

_____________
-> plot6_01.m
%SIXTH PLOT

%APPLY AGC before plotting
[bp_agc]=agc(bandpass_test_vsp_z,0.2,1);

%PLOT BANDPASS TEST with AGC
vaplot(bp_agc,0.0,0.5,1,156,1,0,1.0,'black',56,39,8,1,2,'bp0_vsp01_z.eps','McArthur MC218 vsp01 z  20-50 Hz');
vaplot(bp_agc,0.0,0.5,1,156,1,0,1.0,'black',56,39,8,2,2,'bp1_vsp01_z.eps','McArthur MC218 vsp01 z  50-80 Hz');
vaplot(bp_agc,0.0,0.5,1,156,1,0,1.0,'black',56,39,8,3,2,'bp2_vsp01_z.eps','McArthur MC218 vsp01 z  80-110 Hz');
```

```
vaplot(bp_agc,0.0,0.5,1,156,1,0,1.0,'black',56,39,8,4,2,'bp3_vsp01_z.eps','McArthur MC218 vsp01 z  110-140 Hz');
vaplot(bp_agc,0.0,0.5,1,156,1,0,1.0,'black',56,39,8,5,2,'bp4_vsp01_z.eps','McArthur MC218 vsp01 z  140-170 Hz');
vaplot(bp_agc,0.0,0.5,1,156,1,0,1.0,'black',56,39,8,6,2,'bp5_vsp01_z.eps','McArthur MC218 vsp01 z  170-200 Hz');
vaplot(bp_agc,0.0,0.5,1,156,1,0,1.0,'black',56,39,8,7,2,'bp6_vsp01_z.eps','McArthur MC218 vsp01 z  200-230 Hz');
vaplot(bp_agc,0.0,0.5,1,156,1,0,1.0,'black',56,39,8,8,2,'bp7_vsp01_z.eps','McArthur MC218 vsp01 z  230-300 Hz');
```

-> plot7_01.m

```
%SEVENTH PLOT

%PLOT all records with AGC
vaplot(vsp_01_end_agc,0.0,0.8,1,156,1,0,2.0,'black',56,32,3,1,2,'vsp_01_end_agc_h1.eps','McArthur MC218 vsp01 h1 result agc');
vaplot(vsp_01_end_agc,0.0,0.8,1,156,1,0,2.0,'black',56,32,3,2,2,'vsp_01_end_agc_h2.eps','McArthur MC218 vsp01 h2 result agc');
vaplot(vsp_01_end_agc,0.0,0.8,1,156,1,0,2.0,'black',56,32,3,3,2,'vsp_01_end_agc_z.eps','McArthur MC218 vsp01 z result agc');

%PLOT all records with AGC3C
%vaplot(vsp_01_end_agc3c,0.0,0.8,1,156,1,0,2.0,'black',56,32,3,1,2,'vsp_01_end_agc3c_h1.eps','McArthur MC218 vsp01 h1 result agc3c');
%vaplot(vsp_01_end_agc3c,0.0,0.8,1,156,1,0,2.0,'black',56,32,3,2,2,'vsp_01_end_agc3c_h2.eps','McArthur MC218 vsp01 h2 result agc3c');
%vaplot(vsp_01_end_agc3c,0.0,0.8,1,156,1,0,2.0,'black',56,32,3,3,2,'vsp_01_end_agc3c_z.eps','McArthur MC218 vsp01 z result agc3c');

%PLOT all records with Balancing
%vaplot(vsp_01_end_bal,0.0,0.8,1,156,1,0,2.0,'black',56,32,3,1,2,'vsp_01_end_bal_h1.eps','McArthur MC218 vsp01 h1 result bal');
%vaplot(vsp_01_end_bal,0.0,0.8,1,156,1,0,2.0,'black',56,32,3,2,2,'vsp_01_end_bal_h2.eps','McArthur MC218 vsp01 h2 result bal');
%vaplot(vsp_01_end_bal,0.0,0.8,1,156,1,0,2.0,'black',56,32,3,3,2,'vsp_01_end_bal_z.eps','McArthur MC218 vsp01 z result bal');
```

-> corridor_01.m

```
%Corridor Stack

% (1.) shift the data to TWT with first breaks
[vsp_01_shift]=unflat(vsp_01_bp,0.0245,15);

% (2.) write a topmute and a bottommute vector and put these into headerword 16 and 17
%topmute=[0.14:-0.000903225:0.01];
%botmute=[0.4:-0.001612903:0.15];
%for mute with  double first break time
%fbmute2=[0.218:-0.001090322:0.049];

load topmute_vsp01.txt
load botmute_vsp01.txt
%load fbmute2_vsp01.txt

for rec=1:3
vsp_01_shift.threc(19,:)=topmute_vsp01;
vsp_01_shift.threc(20,:)=botmute_vsp01;
% vsp_01_shift.threc(21,:)=fbmute2_vsp01;
end

% (3.) mute the data on top and on bottom
[muted]=mute(vsp_01_shift,3,19,20);

% (4.) make corridor stack with function corrstack.m
[vsp_01_corrst]=corrstack(muted,10,4605);

clear botmute_vsp01 muted rec topmute_vsp01 vsp_01_shift
save vsp_01_corrst vsp_01_corrst
```

-> plot8_01.m

```
%EIGTH PLOT

%PLOT corridor stack
%vaplot(vsp_01_corrst,0.0,700,1,10,1,0,1.0,'black',13,5,0.01,1,2,'vsp_01_corr_h1.eps','McArthur MC218 vsp01 h1 corridor stack');
%vaplot(vsp_01_corrst,0.0,700,1,10,1,0,1.0,'black',13,5,0.01,2,2,'vsp_01_corr_h2.eps','McArthur MC218 vsp01 h2 corridor stack');
vaplot(vsp_01_corrst,0.0,700,1,10,1,0,1.0,'black',13,5,0.01,3,2,'vsp_01_corr_z.eps','McArthur MC218 vsp01 z corridor stack');
vaplot(vsp_01_corrst,0.0,500,1,10,1,0,1.0,'black',13,5,0.01,3,2,'vsp_01_corr_z_small.eps','McArthur MC218 vsp01 z corridor stack');
```

All scripts and data files (raw and results) can be found on the enclosed compact disk.

11 Appendix Three - New Functions for DSISoft

```
===========================================

   Two new written functions for DSISoft

===========================================

______________________
%FUNCTION plotspecmatr
%plots spectrum of all traces

function [X,Y,w]=plotspecmatr(tata);

toto=tata.dat1;

[d,e]=size(toto)

f=zeros(e,(d-1)/2);
w=zeros(e,(d-1)/2);

for k=1:e
 [f(k,:) w(k,:)]=plotspectrum(toto(:,k),0.0005);
end

[X,Y]=meshgrid(f(1,:),[1:e]);

pcolor(X,Y,log(w)), shading interp;
colorbar;

___________________
%FUNCTION corrstack
%creates a corridor stack (aka composite trace)

function [dataout]=corrstack(datain,ntrpr,vel)

%ntrpr = number of traces per record to put in corridor stack output
%vel = estimated or known average p-wave velocity in m/s to calculate depth

dt=datain.fh8;
dt_neu=(dt*vel)/2;

dataout=datain;

for COUNT=1:datain.fh12 %loop over records

%make some changes to file header
dataout.fh=datain.fh; %copy file header
n=datain.fh7;
dataout.fh1=3*ntrpr;  %number of trace in dataset
dataout.thCOUNT=datain.thCOUNT(:,1);
dataout.datCOUNT=zeros(n,ntrpr);

for j=1:ntrpr
dataout.thCOUNT(12,j)=ntrpr; %number of traces in record
%put sum into dataout
dataout.datCOUNT(:,j)=sum(datain.datCOUNT(:,:)')';
end

end %loop over records

dataout.fh8=dt_neu;
```

12 Appendix Four - Figures of vsp02 Dataset

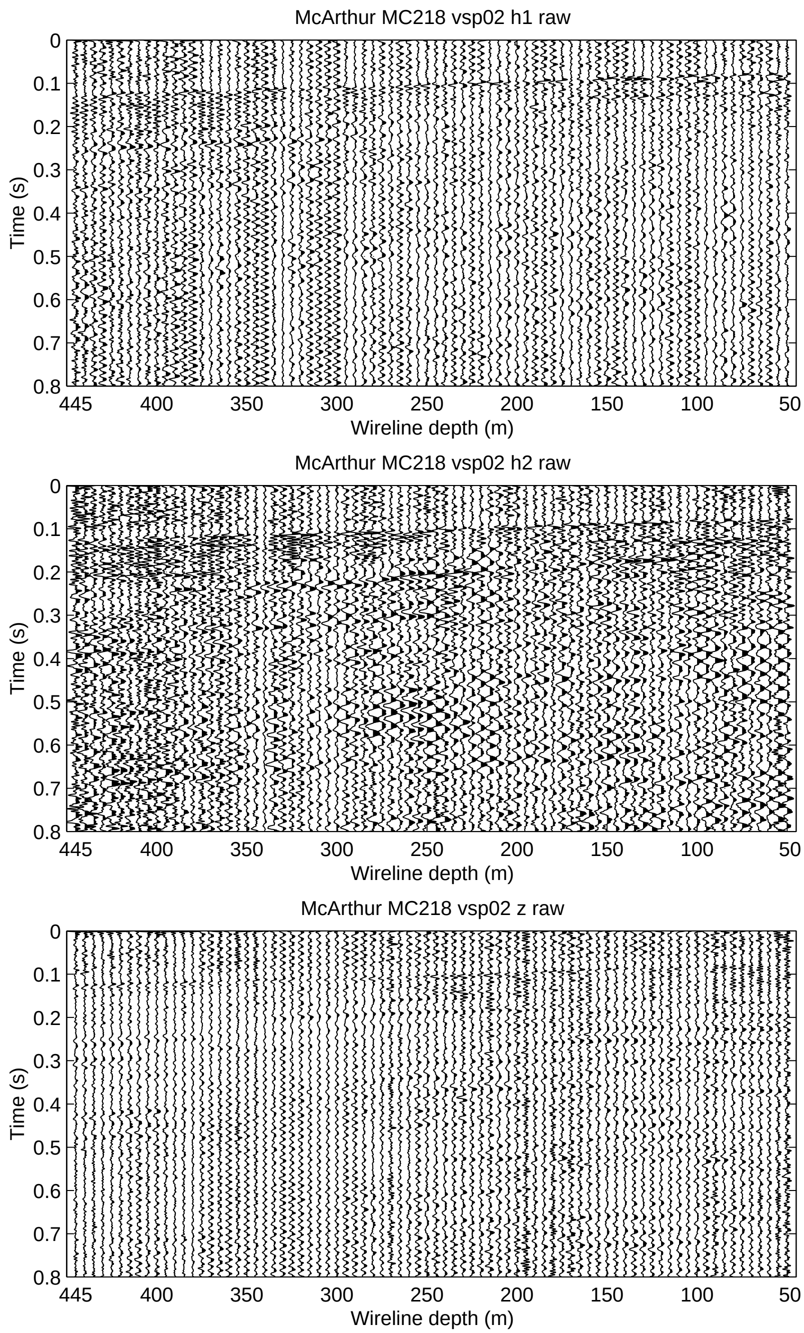

Figure 15: *All three components of raw data of vsp02 after trace editing, geometry assignment and sorting. A three component AGC with a window length of 0.1s has been applied, which preserves the amplitude ratio between the components.*

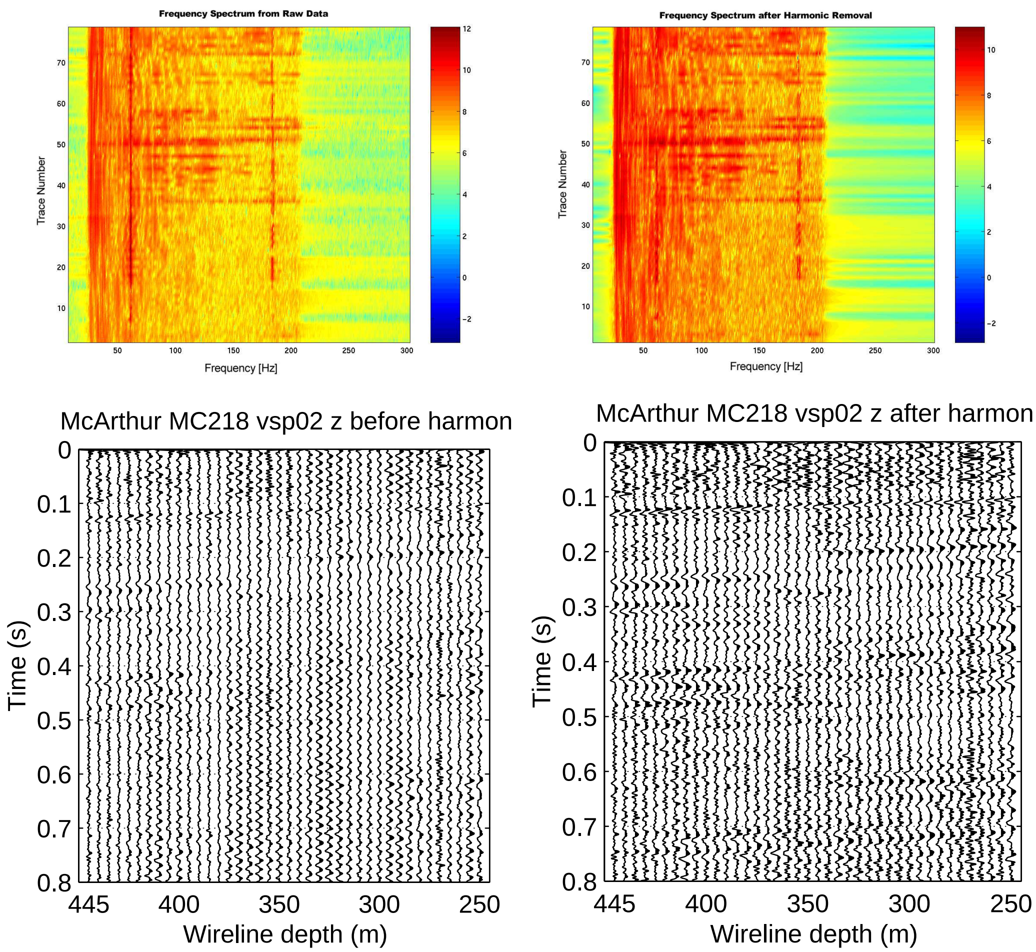

Figure 16: *Frequency spectra from the vsp02 raw dataset (upper left) and after removal of the monofrequency noise (upper right). Both lower figures show a portion of the z component of the data sets, again on the left hand side before and on the right hand side after filtering. Notice that the energy about 61 Hz is much lower after filtering than the energy about 180 Hz.*

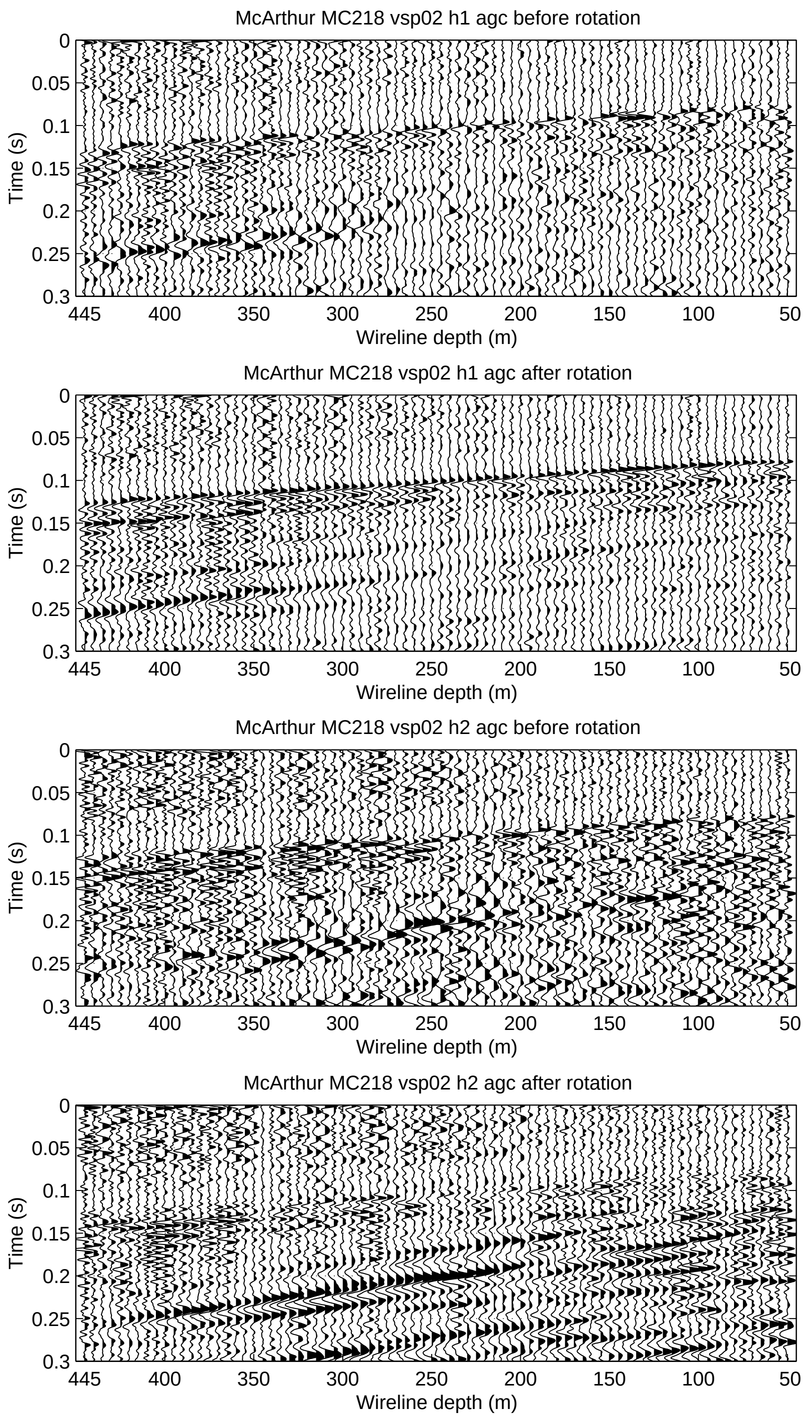

Figure 17: *Horizontal component 1 and 2 before and after rotation to maximize the horizontal energy in H1 (vsp02). Gain functions are different for each subfigure. Direct p-wave arrivals are successfully maximized on the first component after rotation. Also shearwave energy appears after rotation on the second component (lowest panel).*

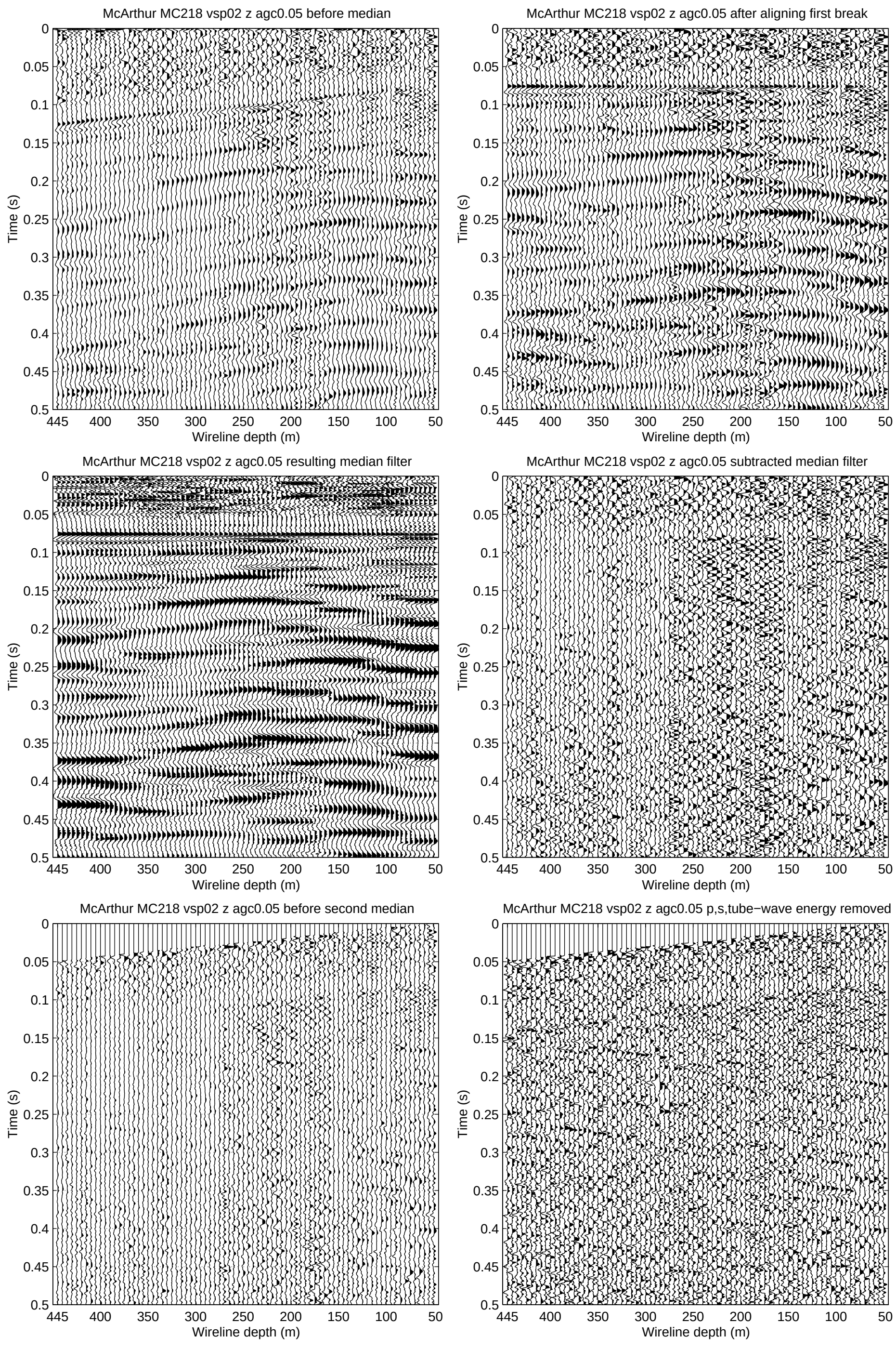

Figure 18: *Figures from upper left to lower right: z-component before removal of p-wave energy, data aligned at first break, resulting median filtered data, median subtracted from aligned data, result of median filtered data and data after s and tube wave median filter (vsp02).*

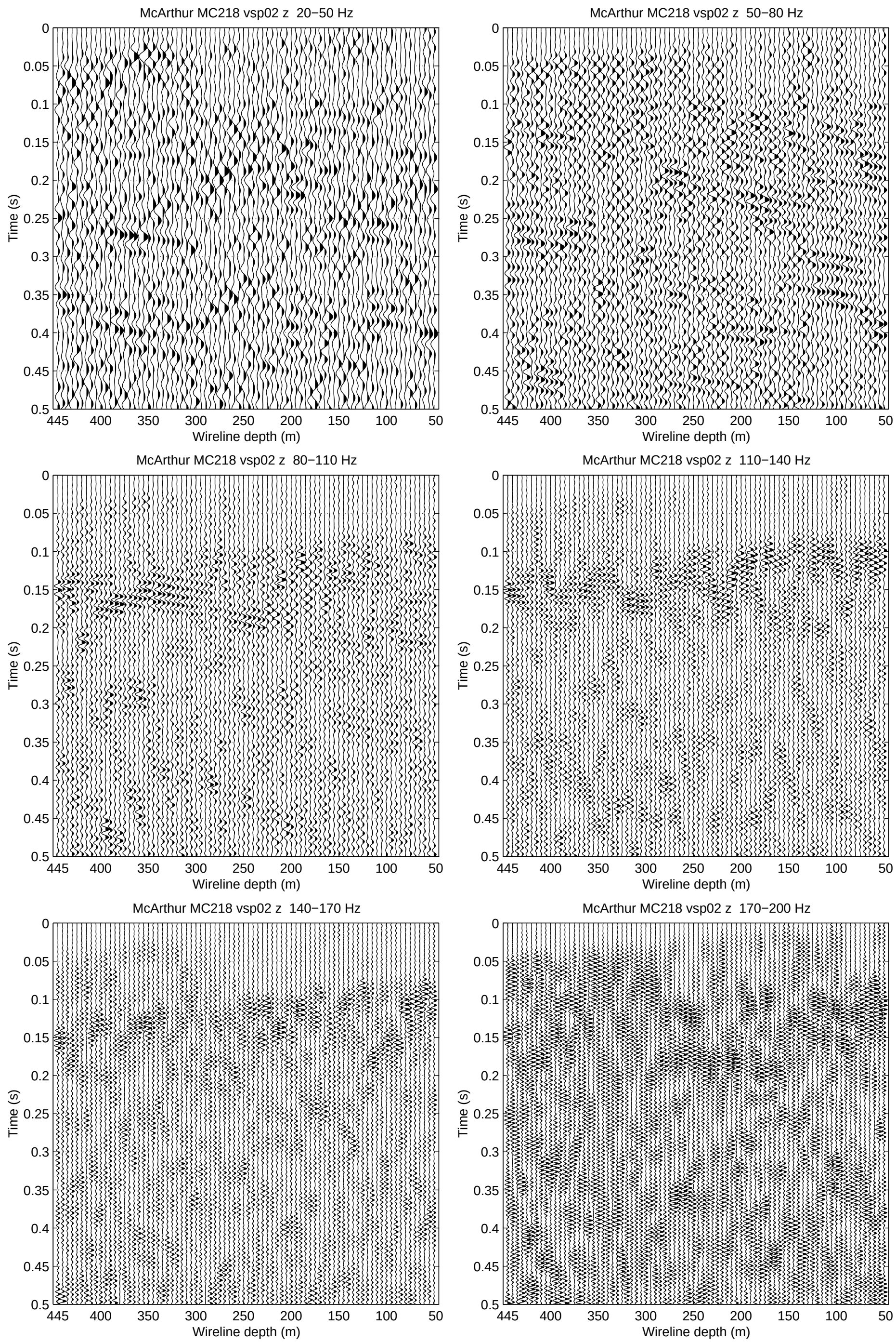

Figure 19: *Different bandpass filters were applied to the z-component of the dataset vsp02 in order to find optimum bandpass filter parameters.*

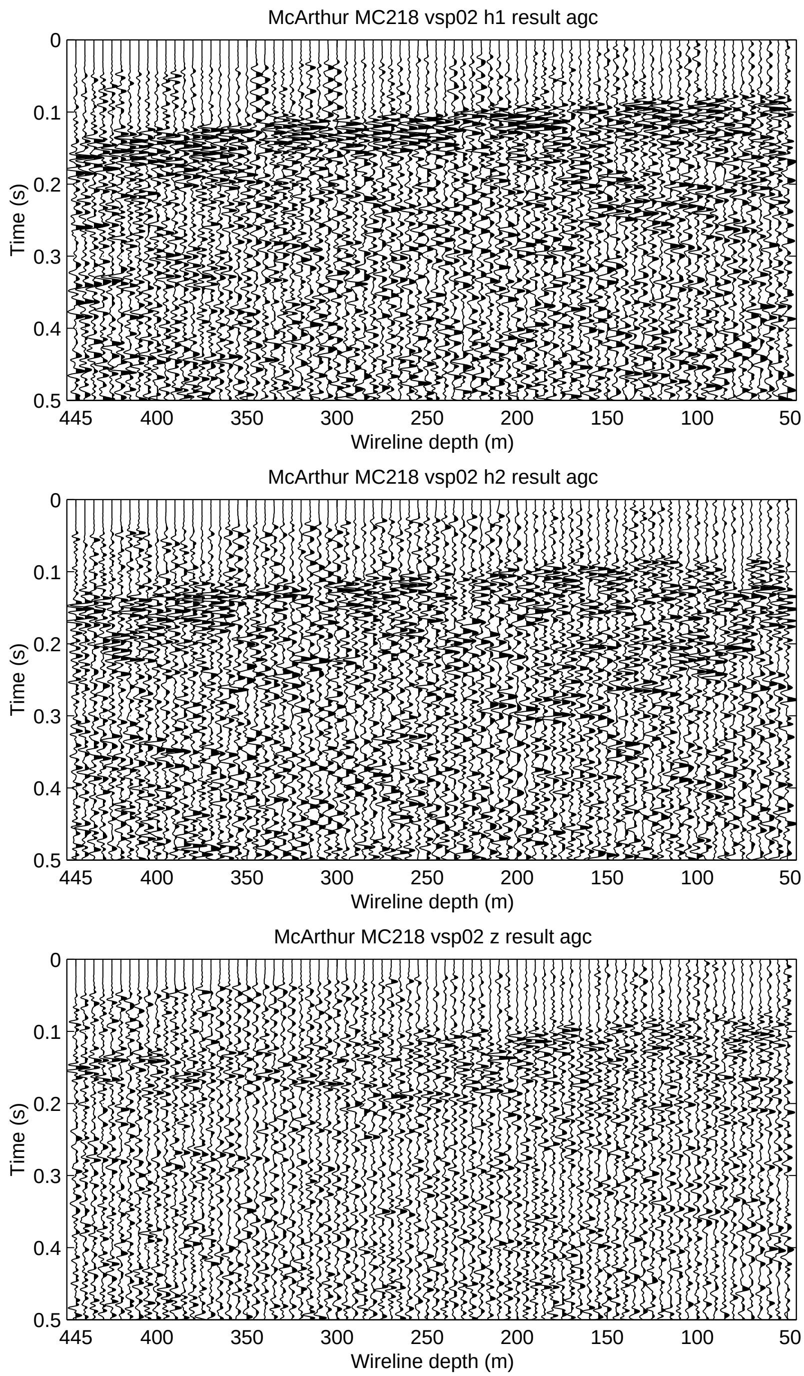

Figure 20: *All components of vsp02 after bandpass filtering (20/40-150/170 Hz) and three component AGC (windowlength=0.15s).*

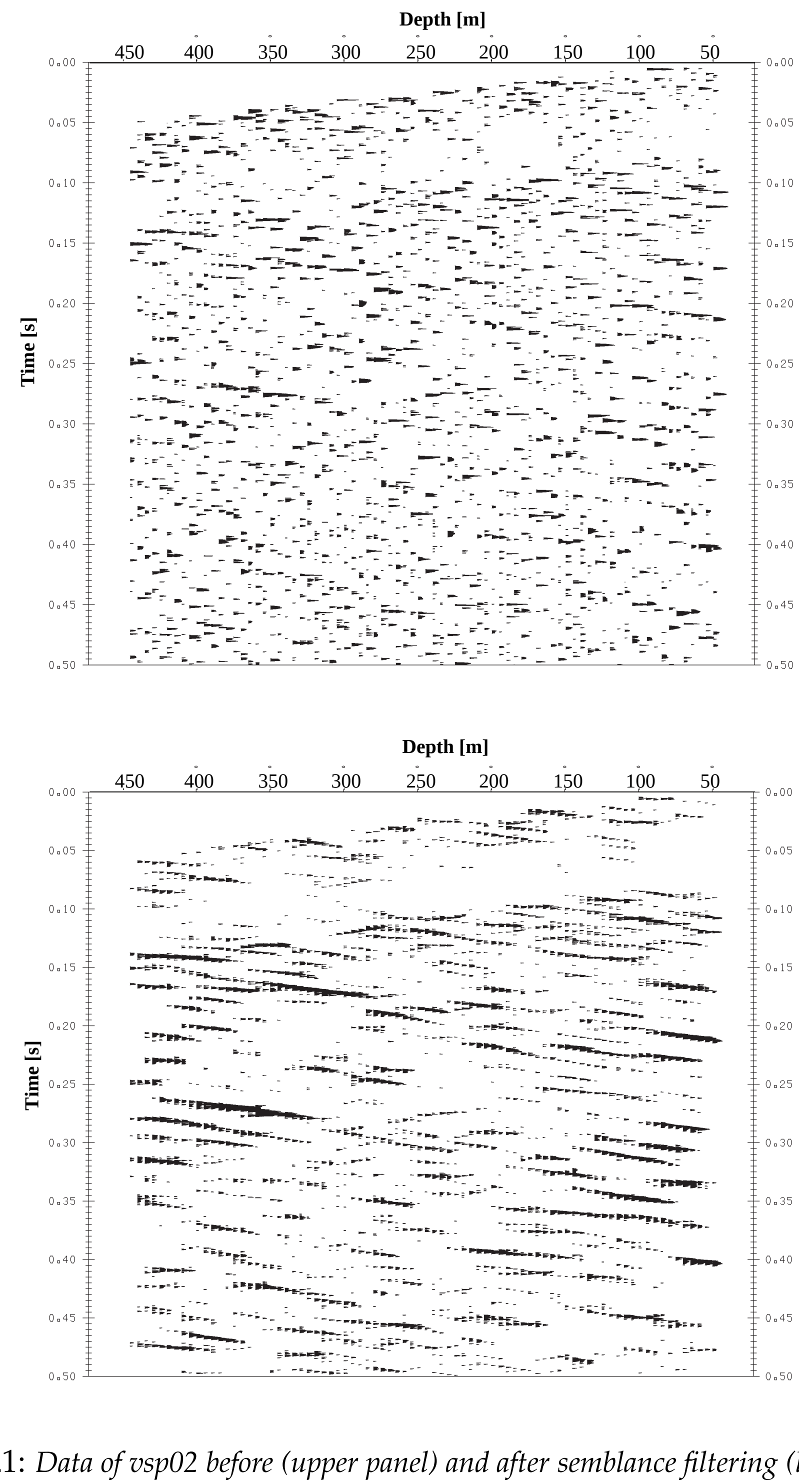

Figure 21: *Data of vsp02 before (upper panel) and after semblance filtering (lower panel).*

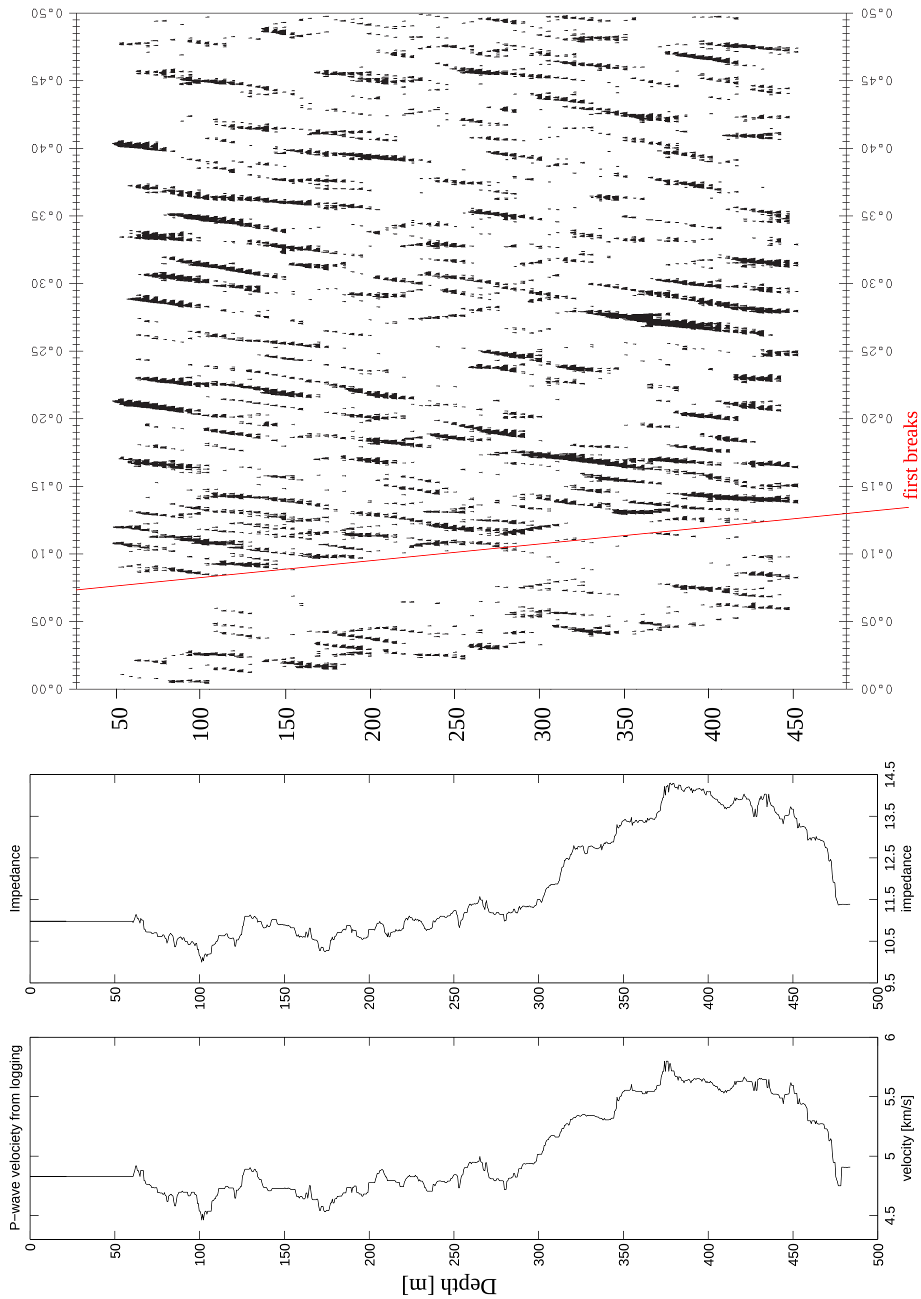

Figure 22: *Semblance filtered data from vsp02 compared to p-wave velocity and impedance from logging.*