Exploration Seismology II, GP-517
FINAL PROJECT

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Project Report

Problem Statement

• The purpose of the final project is to put together all the processing that we have done so far on the vikinggraben dataset and put together an optimum processing of the data. You need to process the entire dataset to produce a stacked section and a post-stack time migrated section (stolt migration: see Chapter 8, page 118 of John's notes).

• You should present the processing flow that you have adopted, write a line or two about it's utility. You should also present appropriate figures at each step. For example, discuss the acquisition geometry of the data, the raw data itself, deconvolution outputs, velocity analysis and demultiple processing sequence, stacked and migrated sections. Compare the stacked and post-stack migrated sections. Do you notice any difference? Can you interpret any structural features (like faults, unconfirmities or horsts/graben) in the migrated output?

1. Acquisition Parameters & Geometry:

obtained acquisition parameter by

```
$ surange < vg.su
```

The important data parameters for 2-D data are given in Table 1.1

No of Traces	120120
Sample Interval	4 ms
No of sample in each Trace	1500
Shots coordinates (sx)	3237- 28512
Receiver Coordinates (gx)	0- 28250
Range of CDPs (Total No.)	2142
CDP fold	1-60
Minimum offset	-3237
Maximum offset	-262
Time length of signal	3600 ms
Receiver group elevation from sea level (gelev)	-10
Surface elevation at source (selev)	-6

Shot coordinate limits:

North(3237,0) South(3237,0) East(28512,0) West(3237,0)

Receiver coordinate limits:

North(0,0) South(0,0) East(28250,0) West(0,0)

Midpoint coordinate limits:

North(1618.5,0) South(1618.5,0) East(28381,0) West(1618.5,0)

Stacking Chart :

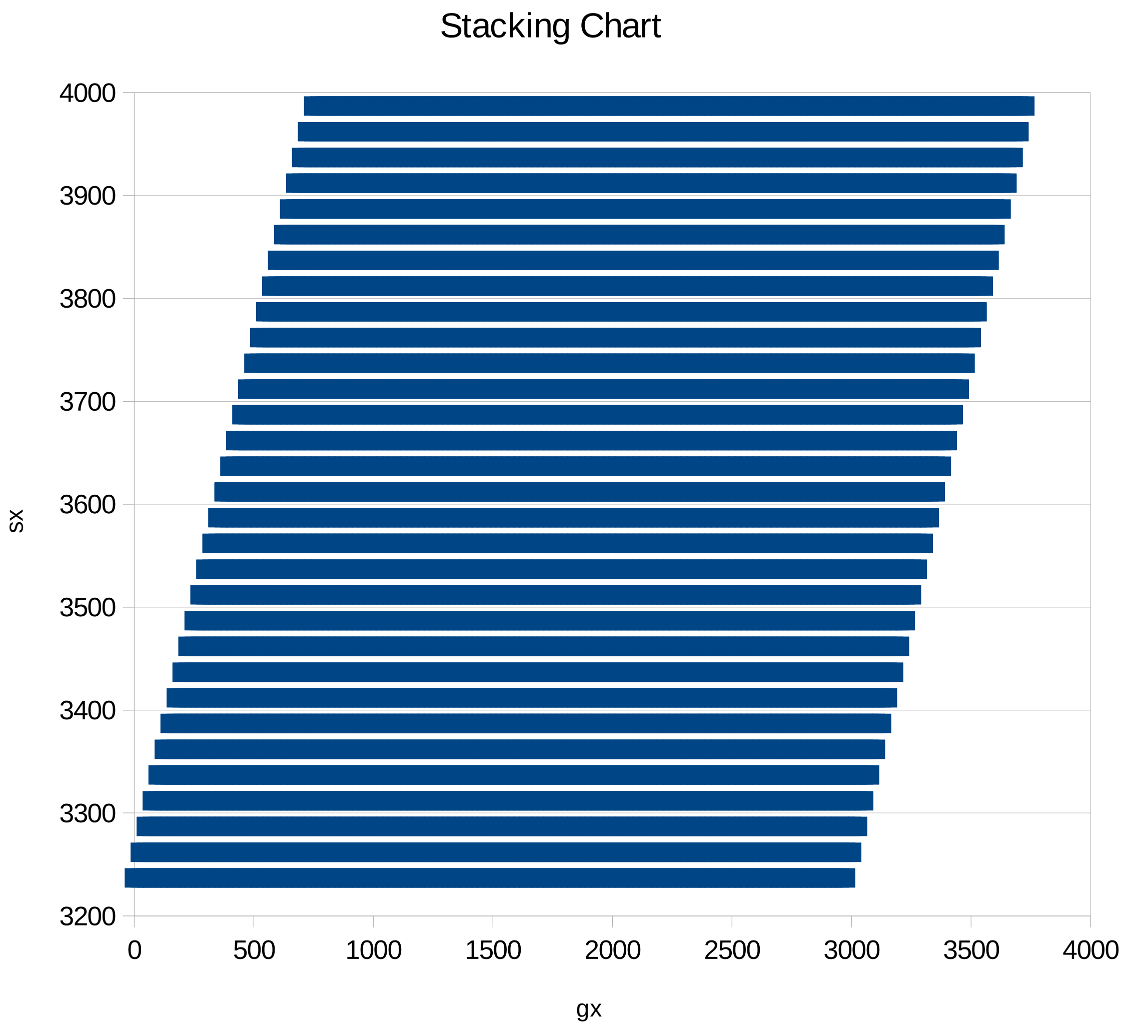


Fig-1: Stacking chart for vikinggraben data

Note: Here only ~4000 shot points coordinates plotted bcs of inability of software to plot whole data

Processing:

Here all processing operations are to be done in a proper sequence; where at each step, all possible parameters are tested in order to obtain the optimum result. However some steps were repeated iteratively such as Velocity Analysis, Deconvolution etc.

Processing Steps:

1.Converting the data to the internal format (.su format)
2.Amplitude Recovery (Gain and wavefront spreading correction)
3.Static correction.
4.Applying Mute
5.Minimum Phasing of data.
6.Deconvolution
7.Velocity Analysis CDP Sorting and Stacking
8 Post Stack Deconvolution ,Band-pass Filtering & Post Stack Migration

1.Converting the data to the SEISMIC UNIX compatible format(SU formate):

Vikinggraben data is in .segy format first we convert .su format, compatible with SEISMIC UNIX
$ segyread tape=vikinggraben.segy hfile=vikinggraben_ebcdic_hdr bfile=vikinggraben_bin_hdr > vikinggraben.su
reading .segy file vikinggraben.segy and converted to SU format and make a seperate header file vikinggraben_ebcdic_hdr and binary file vikinggraben_bin_hdr .From now onwards we will work on .su format.
Now convert ebcdic header to ascii:
$ dd if=vikinggraben_ebcdic_hdr of=vikinggraben_ebcdic conv=ascii

Raw data (Shot Gather) look like.

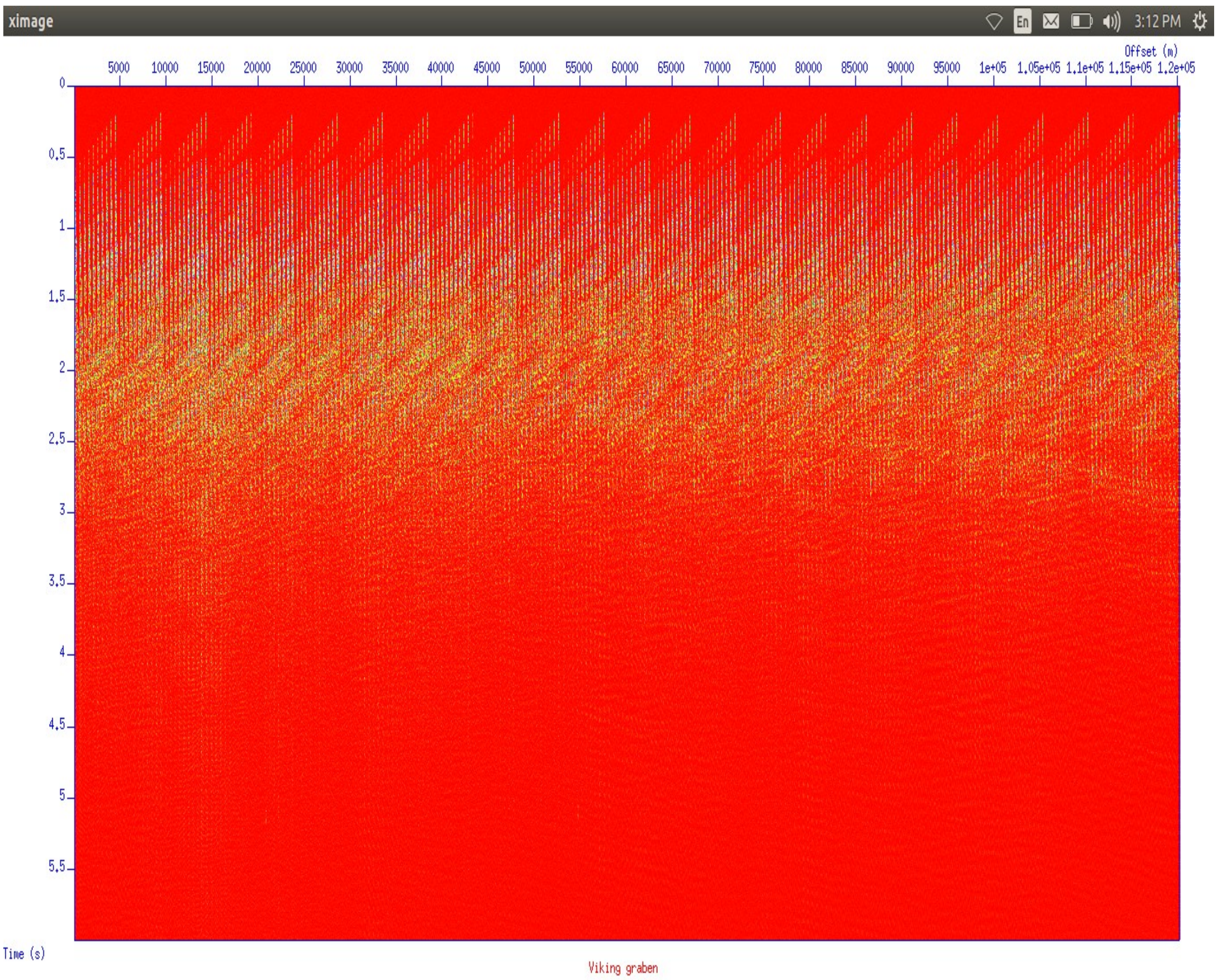


Fig-1: Raw (vikinggraben.su) data plot

2.Amplitude Recovery (Gain and wavefront spreading correction)

Theory:

A field record represents a wavefield that is generated by a single shot. The energy density decays inversely to the square of radius. Usually velocity increases with depth which causes further divergence of wavefront and a more rapid decay in amplitudes with distance.

Gain is time varying scaling in which the scaling function is based on a desired criterion.

Gain is usually applied to bring up the weak signals. Reflectors at depth receive less energy compared to those near the surface. These reflectors are not very clearly seen on a seismic section. So to enhance reflections due to reflectors at depth a gain function is applied on dataset.

Before Deconvolution, an exponential gain may be applied to compensate for attenuation losses.

Here we applied t^2 and g^.5 gain by using jon=1

$ sugain < vikinggraben.su jon=1 > vg.su

jon=1 means tpow=2, gpow=.5, qclip=.95 (clip by quantile on absolute values on trace)

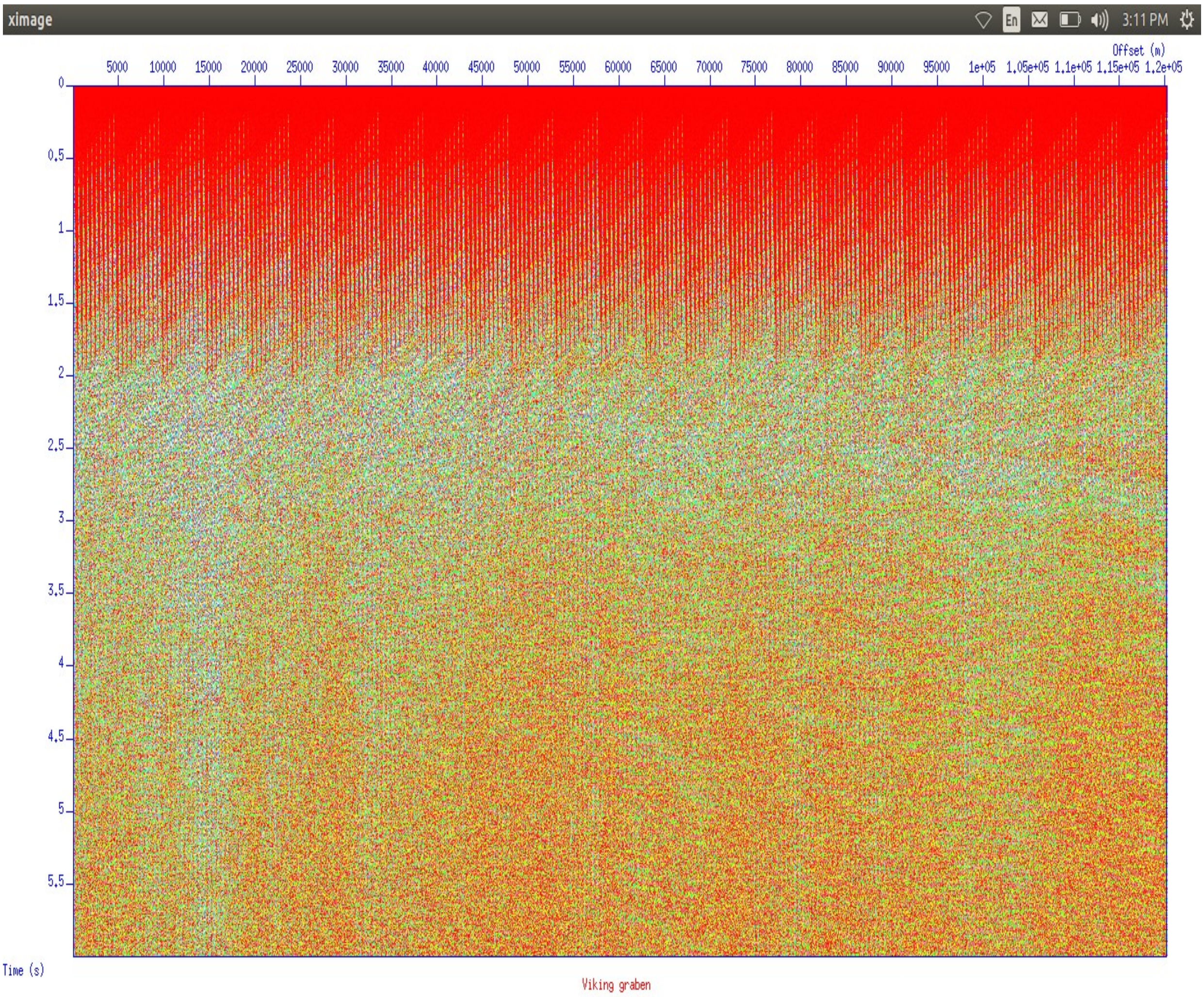
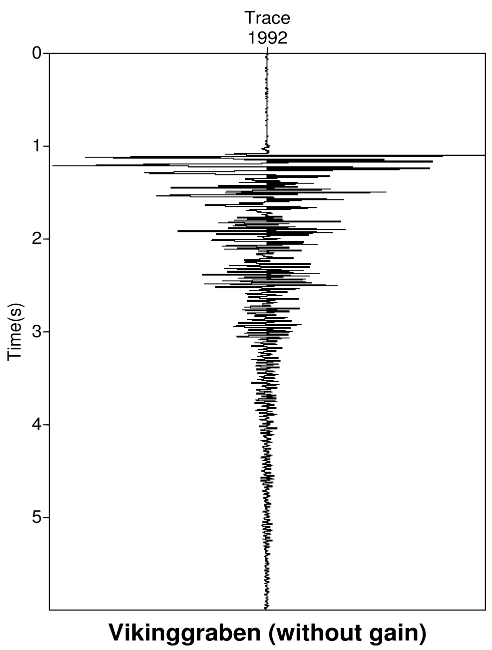


Fig-2: Vikinggraben data after applying gain



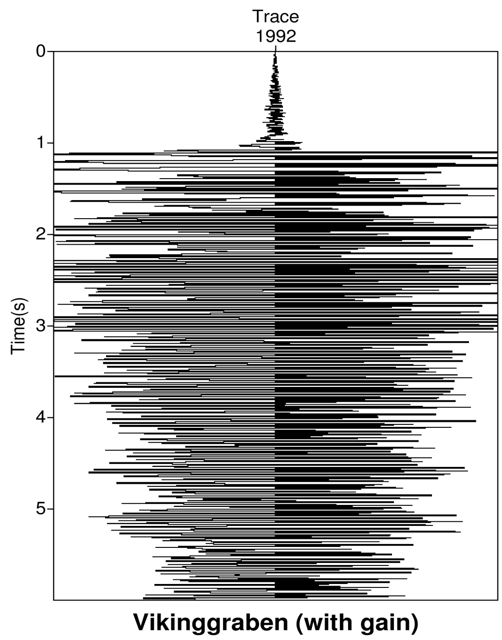


Fig-3: Trace comparision (trace no 1992) before and after gain.

3.Static correction:

Applied static correction based on source and receiver elevation.
For this we update header by changing following value
header update for the static correction:
putting values of sdepth=-6
swevel=10(random value)
wevel=1450 (caluculated from autocorrelation)

```
$ sushw < vg.su key=wevel a=1450 b=0|sushw key=swevel a=10 b=0|sushw key=sdepth a=-6 b=0
> hdrs_vg.su
```

For hdrs=1, statics calculation is not performed, statics correction
is applied to the data by reading statics (in ms) from the header.

For hdrs=0, field statics are calculated, and
input field sut is assumed measured in ms.
output field sstat = 10^scalel*(sdel - selev + sdepth)/swevel-------->(10*1*(0+6-6)/10)=10
output field gstat = sstat - sut/1000.   --->(0-0/1000)=0
output field tstat = sstat + gstat + 10^scalel*(selev - gelev)/wevel =0+0+10*(-6+10)/1450=2.7ms

After updating header we applied static correction using updated header:

```
$ sustatic< hdrs_vg.su > static_vg.su hdrs=0
```

static corrected section:

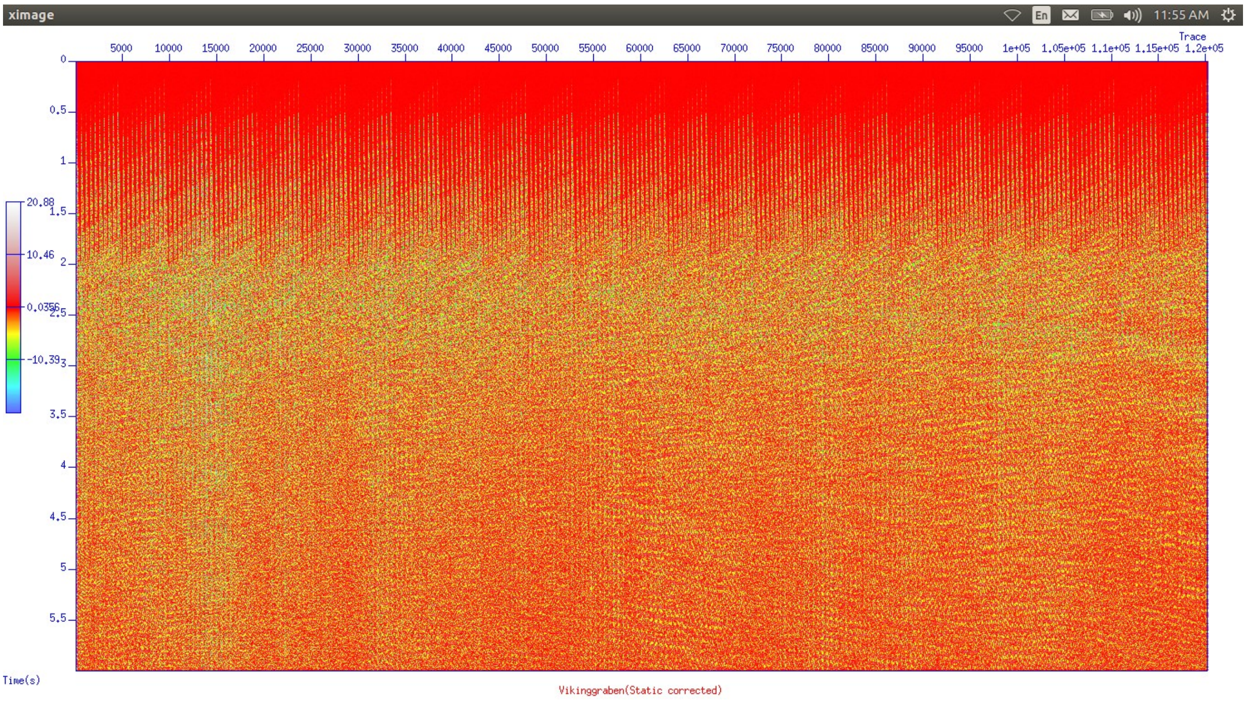


Fig-4: Static corrected Vikinggraben data

4. Applying Mute:

To remove direct waves from source to receiver or refracted waves mute is applied for this first supergather is formed . These are usually so strong that these have to be excluded from the data to prevent degradation of the quality of shallow reflections. As we are dealing only with reflection events, everything else will be considered as noise in data.

Forming Supergather:

$susort offset < static_vg.su | sustack key=offset | sugain jon=1 > superCMP.su

selecting t & x value by presseing 's' on superCMP.su plot .Putting all t & x value in smute command to remove direct arrivals.

$sumute < static_vg.su   tmute=0.483052,0.617341,0.712749,0.944392,1.22058,1.36313,1.44332,1.67496,1.79969,1.96006,2.11152 xmute=-262,-593,-842,-1268,-1746,-2021,-2121,-2414,-2672,-2994,-3247 > muted_vg.su.

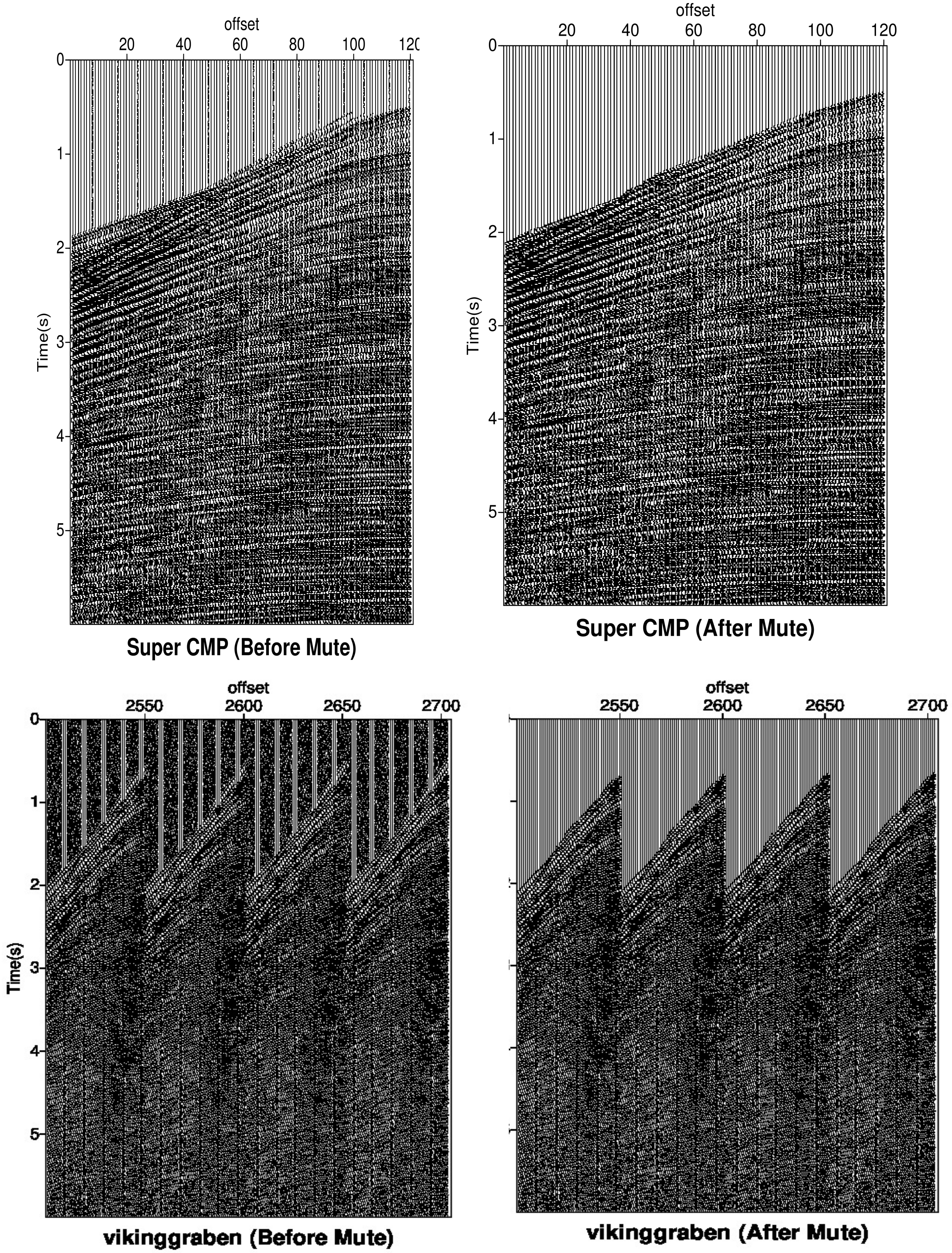


Fig-5: Cdp 100-103 plot before and after mute

5.Minimum Phasing of the data

Farfeild wavelet proceessing:

The far-field signature is provided as a segy file “farfield.sgy”. First we read this file and convert into .su format. The sampling interval for the wavelet is 1 ms. The farfield wavelet is sampled at 1 ms and the seismic data is sampled at 4 ms. We should resample the farfield wavelet. But before we resample, we need to apply a low-pass filter. now convert the wavelet into minimum phase:
The same filter should be applied to the data to convert it to minimum phase.

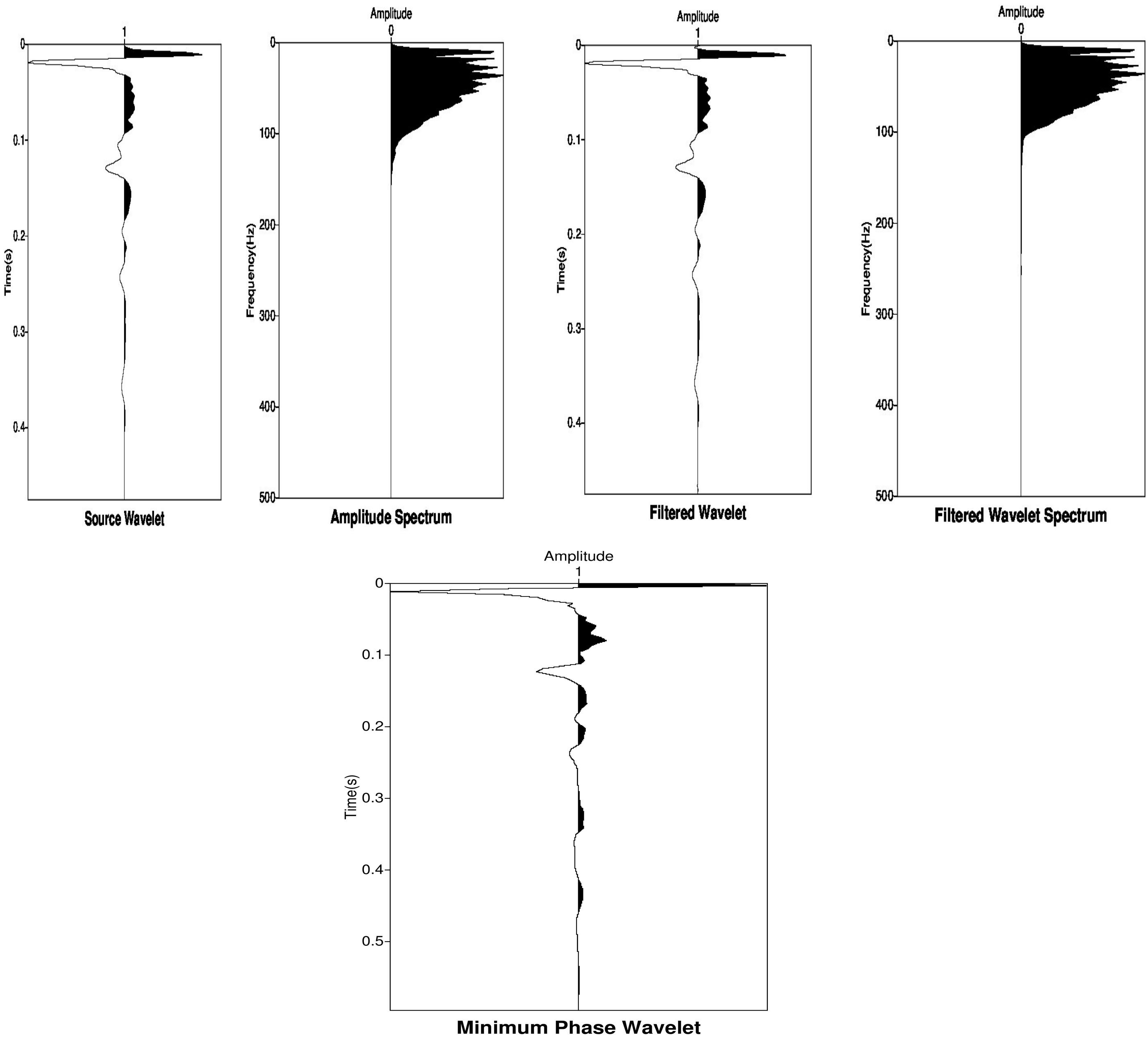


Fig-6: source wavelet after minimum phasing

$sushape < muted_vg.su wfile=resamp_farfield.su dfile=minphs_farfield.su nshape=3000 > minphs_VG.su
here
nshape=trace length of shaping filter

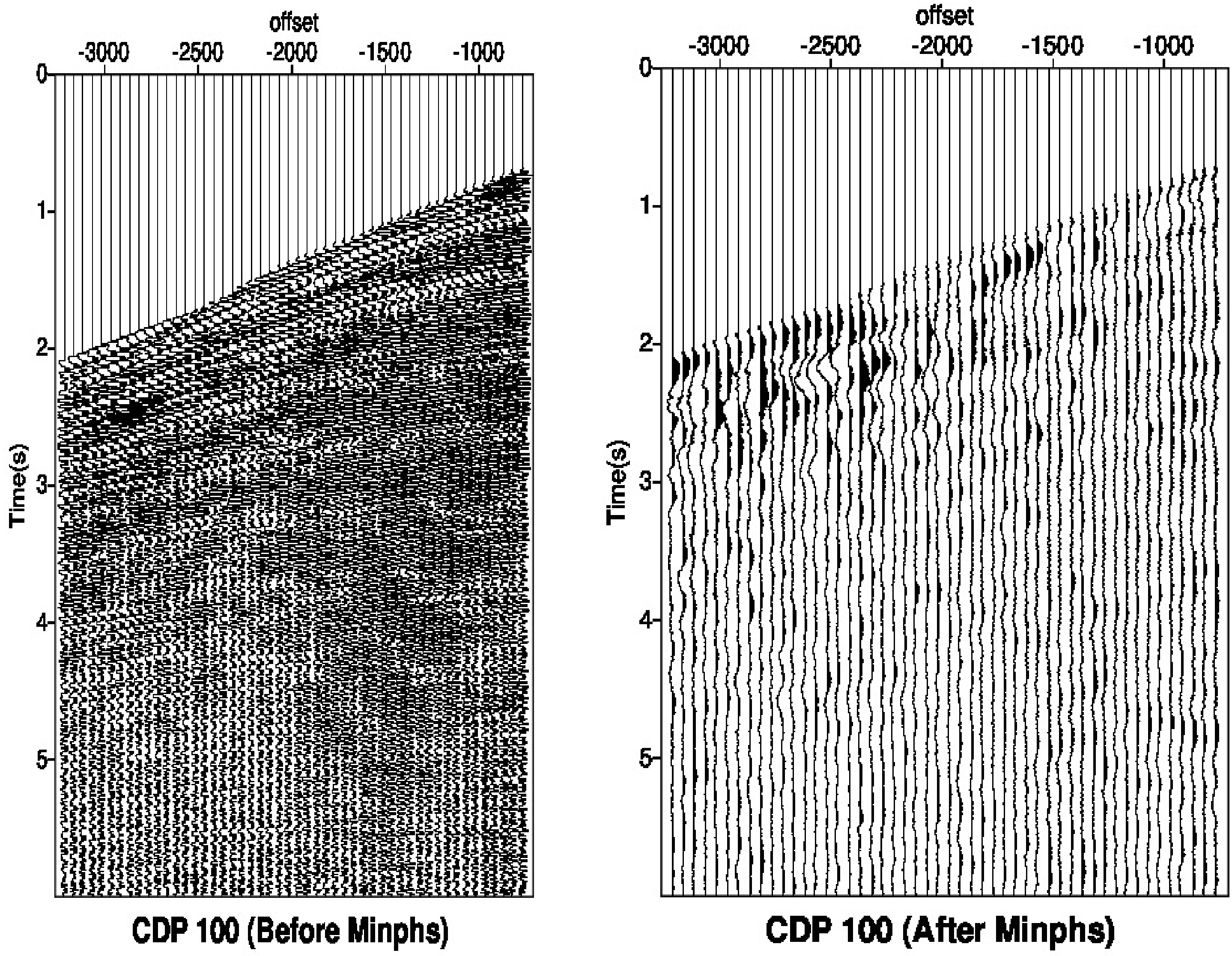


Fig-7: cdp 100 plot before and after minimum phasing

6.Deconvolution:

Deconvolution inhances temporal resolution we applied here pef , with band pass filtering.

$ sunmo < minphs_vg.su vnmo=1450 smute=5.0 | supef minlag=0.02 maxlag=0.6 |sufilter f=0,2,70,90 amp=0,1,1,0 | sunmo vnmo=1450 invert=1 smute=5.0 | sugain jon=1 > decon_vg.su

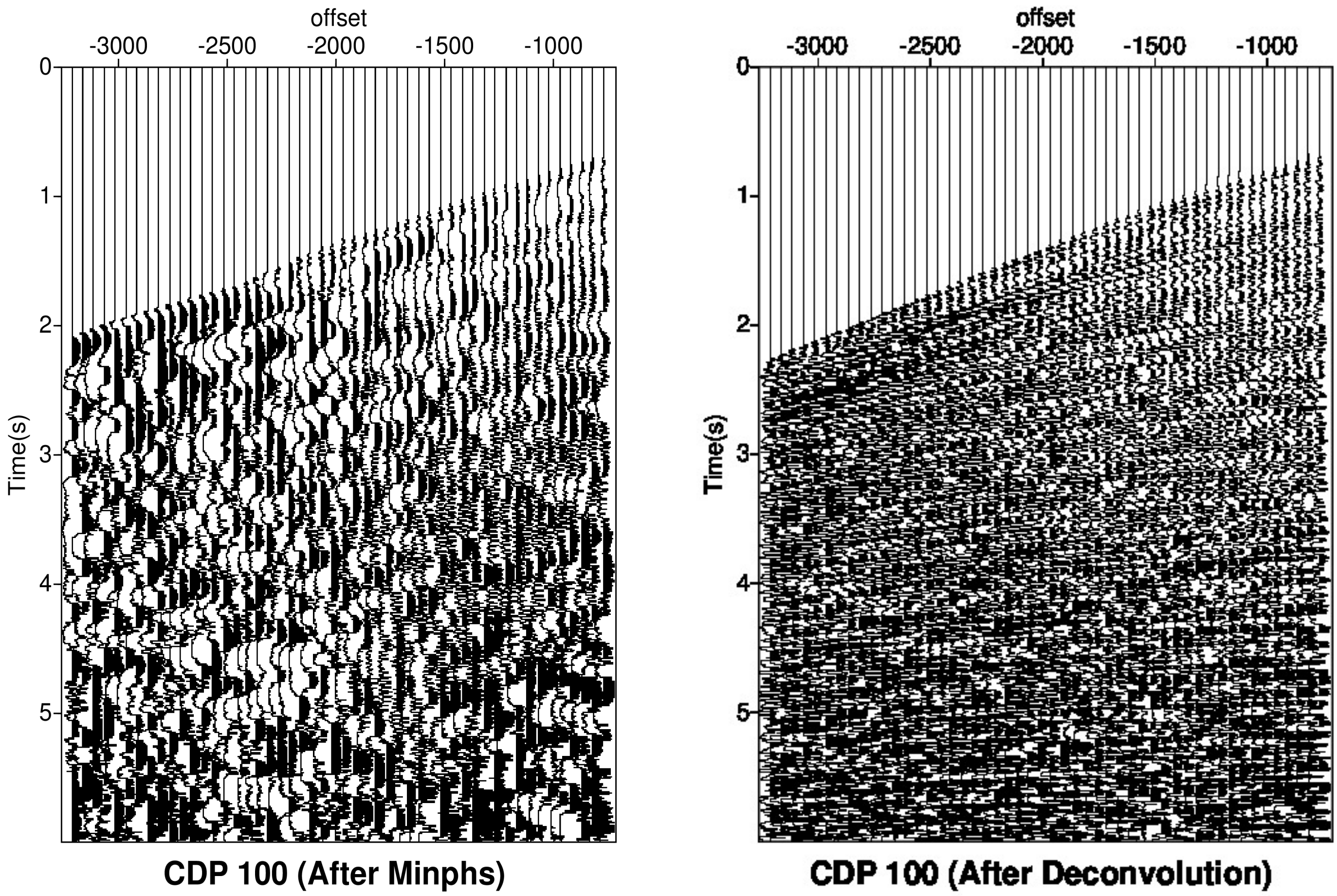


Fig-8: cdp 100 plot before and after deconvolution

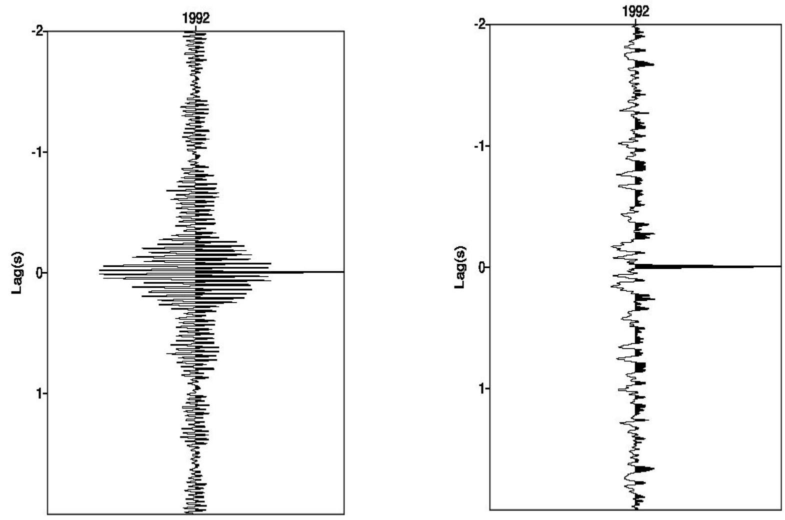


Fig-9: Autocorrelation of 1992 trace before(left) and after deconvolution (right).

7.Radon transform of the data:

Linear radon is applied for radon transform for this first perform nmo with water velocity 1450 then radon transform is applied after that inverse nmo is done.

$ sunmo < decon_cdp_vg.su vnmo=1450 |suradon offref=-3237 interoff=-262 pmin=-2000 pmax=2000 dp=8 choose=1 igopt=3 pmula=-400 pmulb=100 | sunmo vnmo=1450 invert=1 > radon_cdp_vg.su

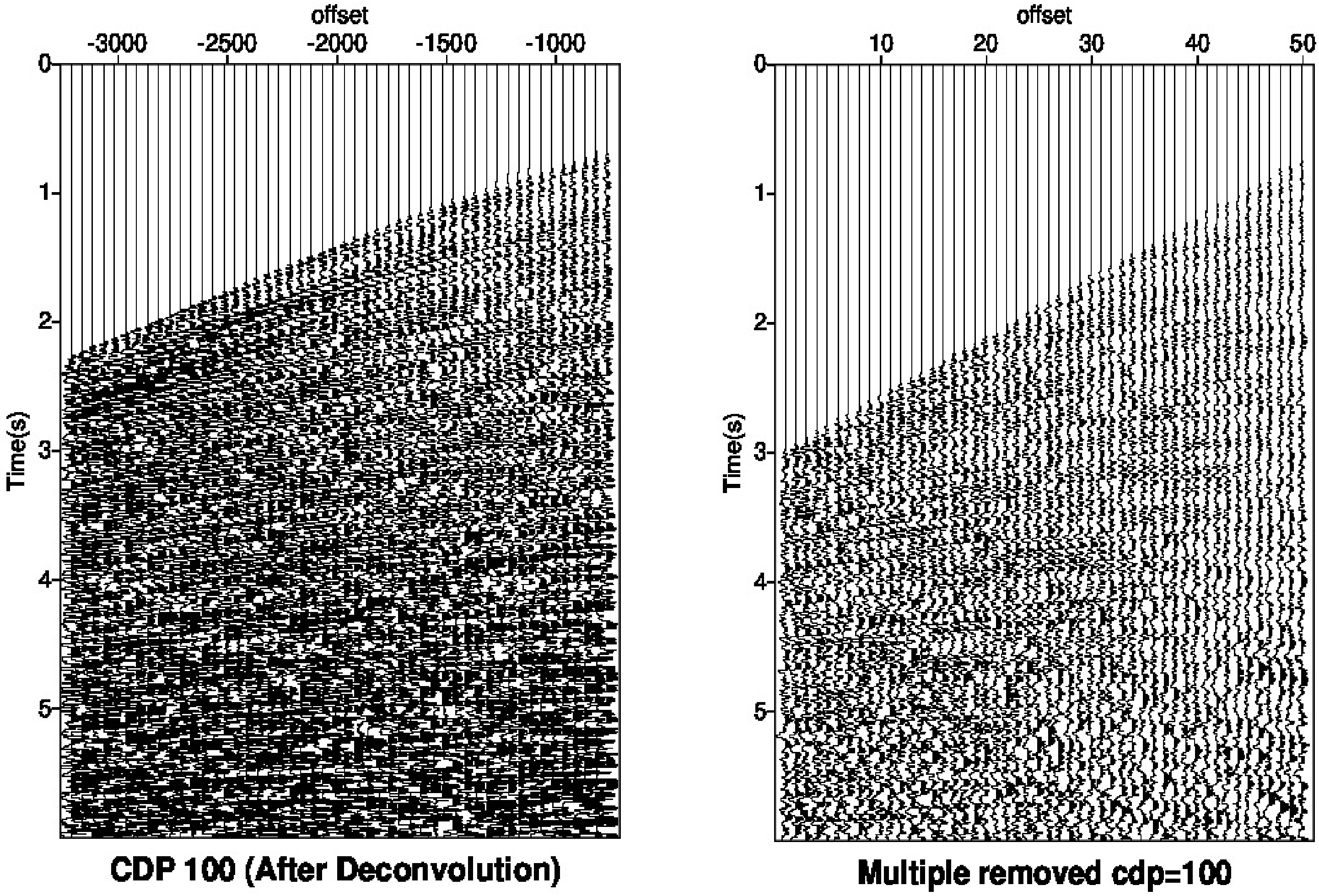


Fig-10: cdp 100 plot before and after radon.

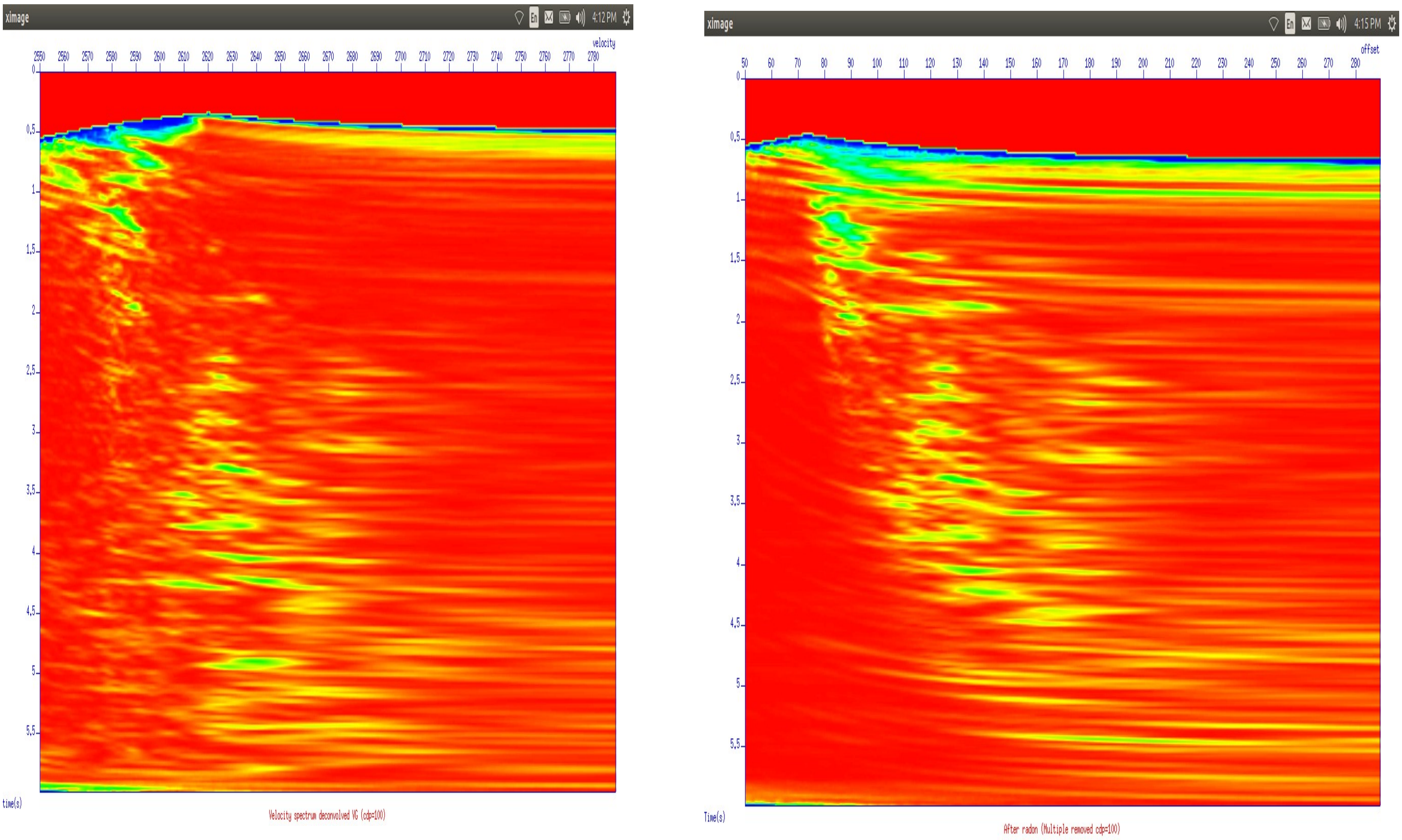


Fig-11: sembelence plot after and before radon

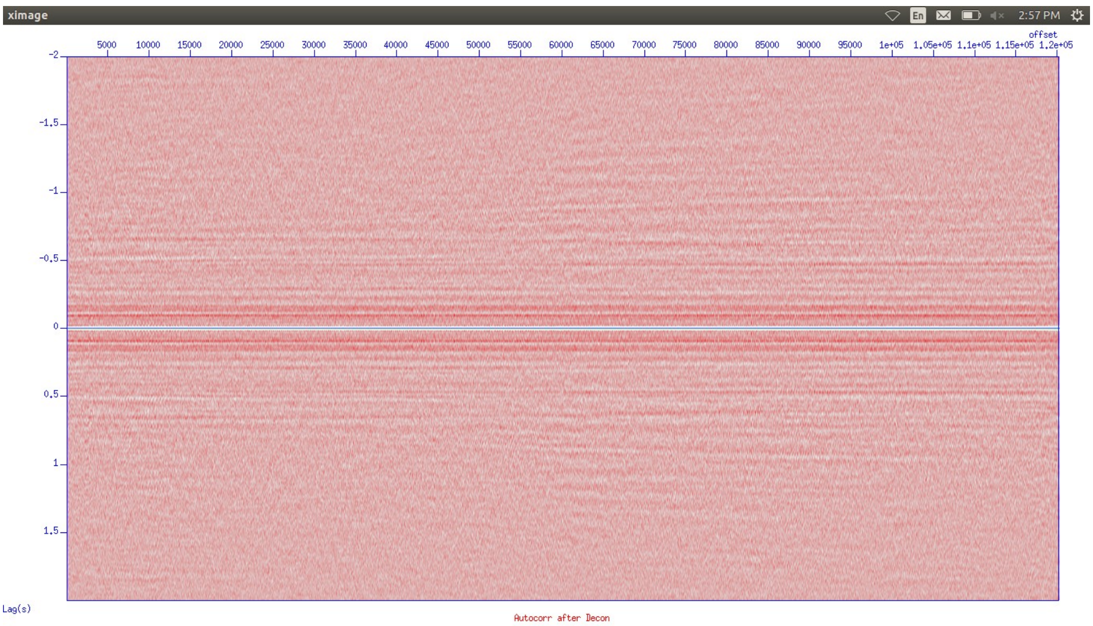


Fig-12: Autocrr plot before decon

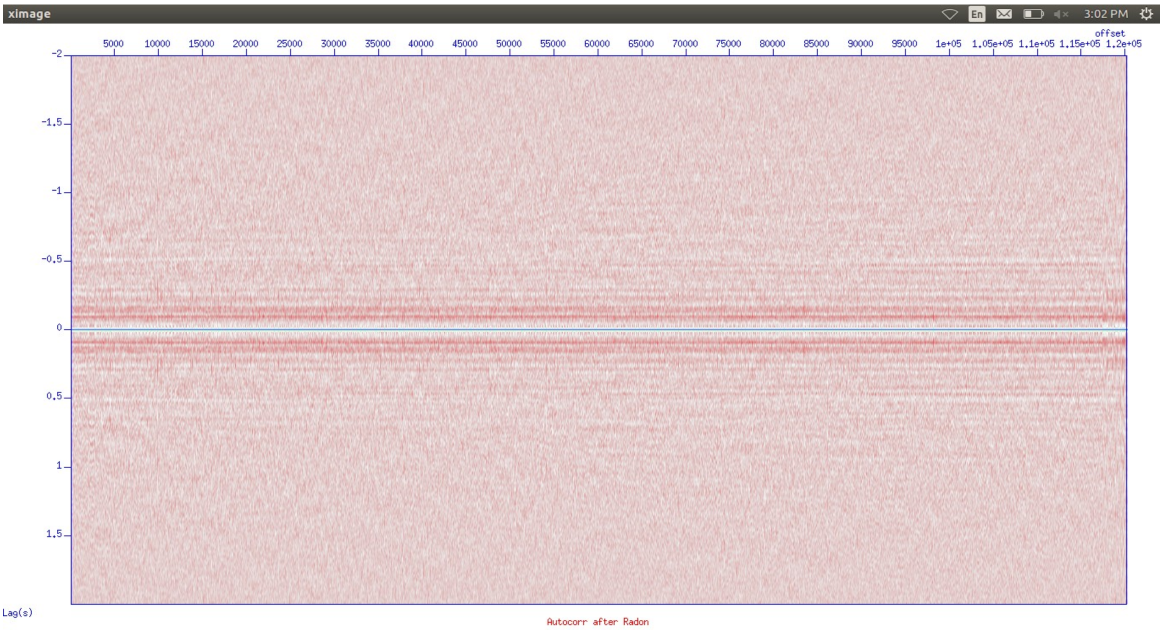


Fig-13: Autocorr after radon transform

8.Velocity Analysis CDP Sorting and Stacking :

Velocity analysis is being done after radon and correct velocity is being picked, stkvel.p1 file is generated which is used in NMO correction.

Nmo correction:

$ sunmo <radon.decon_vg_cdp.su par=stkvel.p1 >nmocorrected_vg.su

CDP Sorting and Stacking:

$ susort <nmocorrected_vg.su cdp offset |sustack key=cdp >stacked_vg.su

First applied NMO to each cdp (i.e. nmocorrected_VG.su) . Then traces are summed to reduce noise and improve overall data quality. The number of traces that have been added together during stacking is called the fold. So finally for 1 cdp we got 1 trace.

Interpretation:

1.we can see that bow ties are visible in the stacked section b/w 1.5 to 2.5 sec (near at uncoformity at 2.5).

2. As marked in stacked section there are diffraction hyperbolas in the stacked section.

3. Dipping Layer which is marked in migrated section as unconformity is less steep, and downward extended. After Migration this layer moved updip and became more steeper.

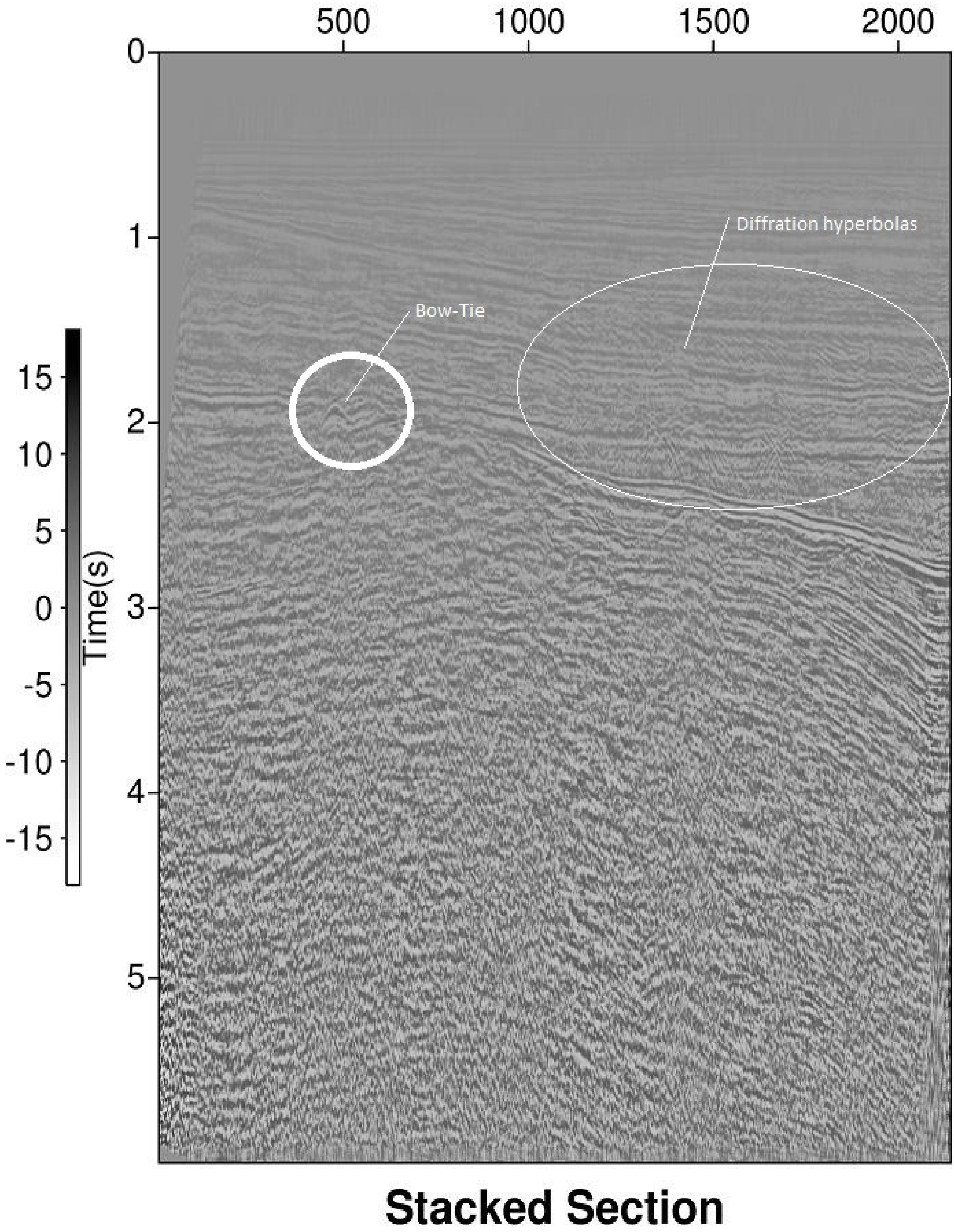


Fig-12: Stacked section plot.

8.Post Stack Deconvolution ,Band-pass Filtering & Post Stack Migration :

Post Stack Deconvolution and Band Pass Filtering:

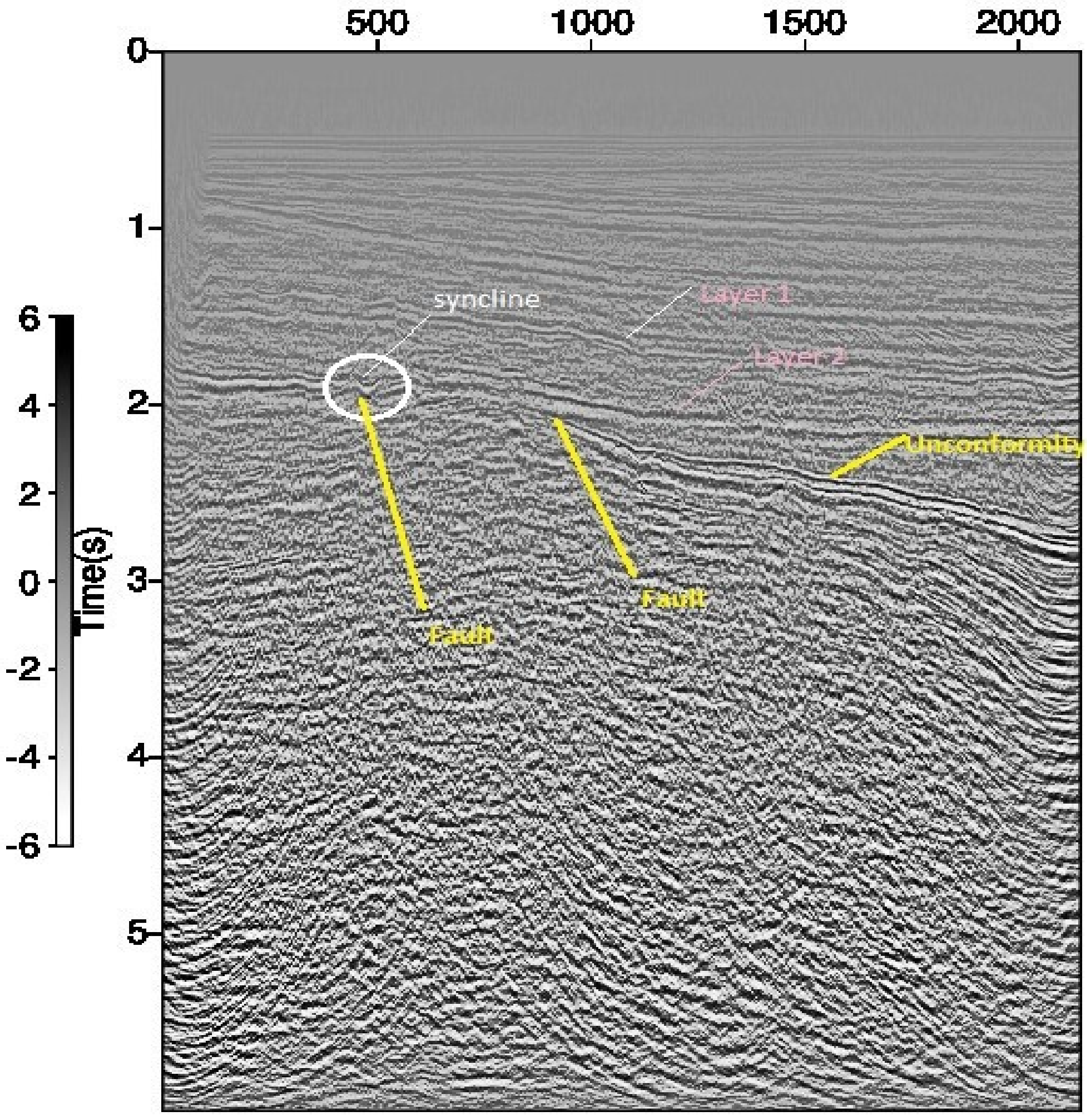
$supef < stacked_vg.su maxlag=0.6 | sufilter f=0,10,70,90 amp=0,1,1,0 > decon.stacked.su

Post Stack Stolt Migration:

assuming layers are flat,for migration used same velocity file which is used for NMO correction.

$ sustolt < decon.stacked.su par=stkvel.p1 cdpmin=1 cdpmax=2142 dxcdp=12.5 | maxlag=0.6 > migrate.su

cdpmin=	minimum cdp (integer number) in dataset
cdpmax=	maximum cdp (integer number) in dataset
dxcdp=	distance between adjacent cdp bins (m)
distance	



Migrated Section

Fig-13: Migrated Section

Interpretation:

1. Bow ties untied after migration and appeared as syncline.
2. Diffraction Hyperbola collapsed as marked in stacked section
3. In Migrated section there is a **Graben** b/w **2 faults** marked, 2 major layer boundaries are visible marked as L**ayer 1 , Layer 2** and **1 unconformity**(can say layer boundary also) visible which is passing through graben (at portion of graben this unconformity not clearly visible).
4. Since migraton is a **spatial deconvolution .** After Migration stacked section became more interpretable.
5. There will be more faults but due to unclear image we are unable to mark.