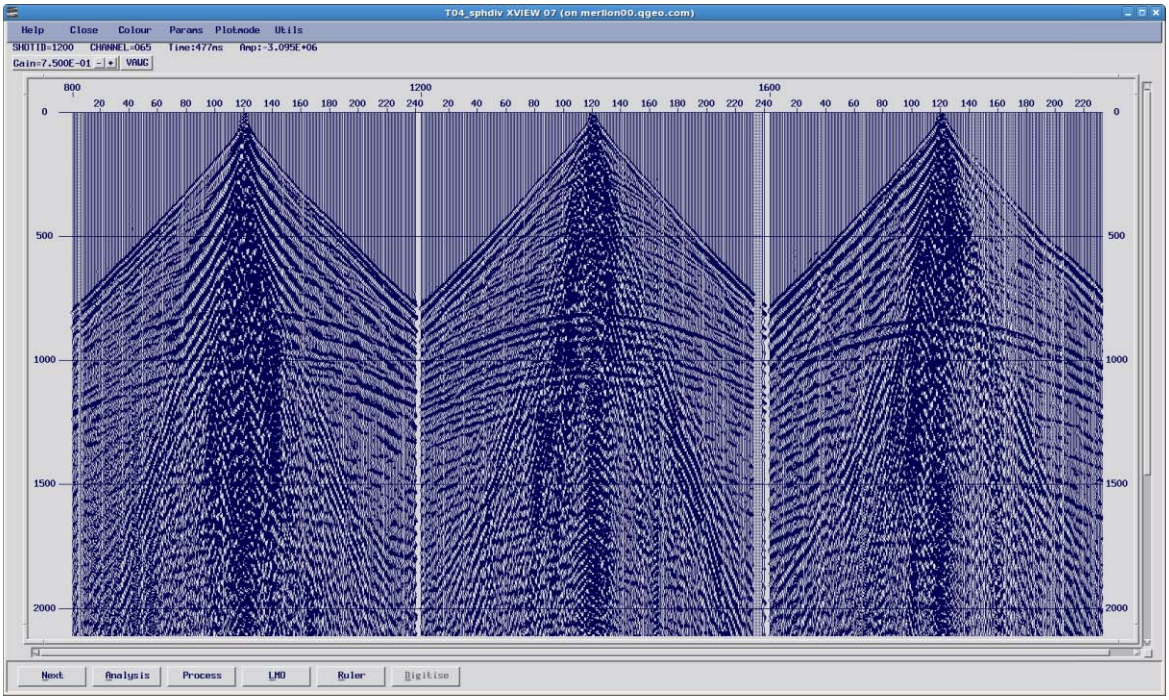
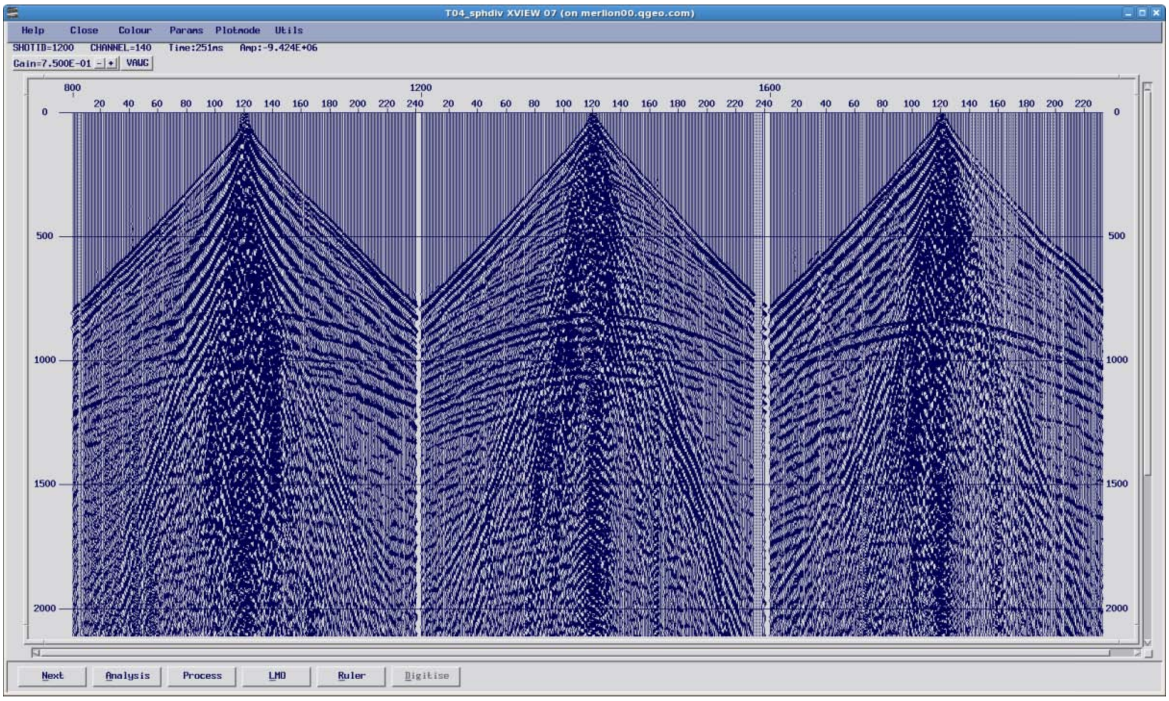
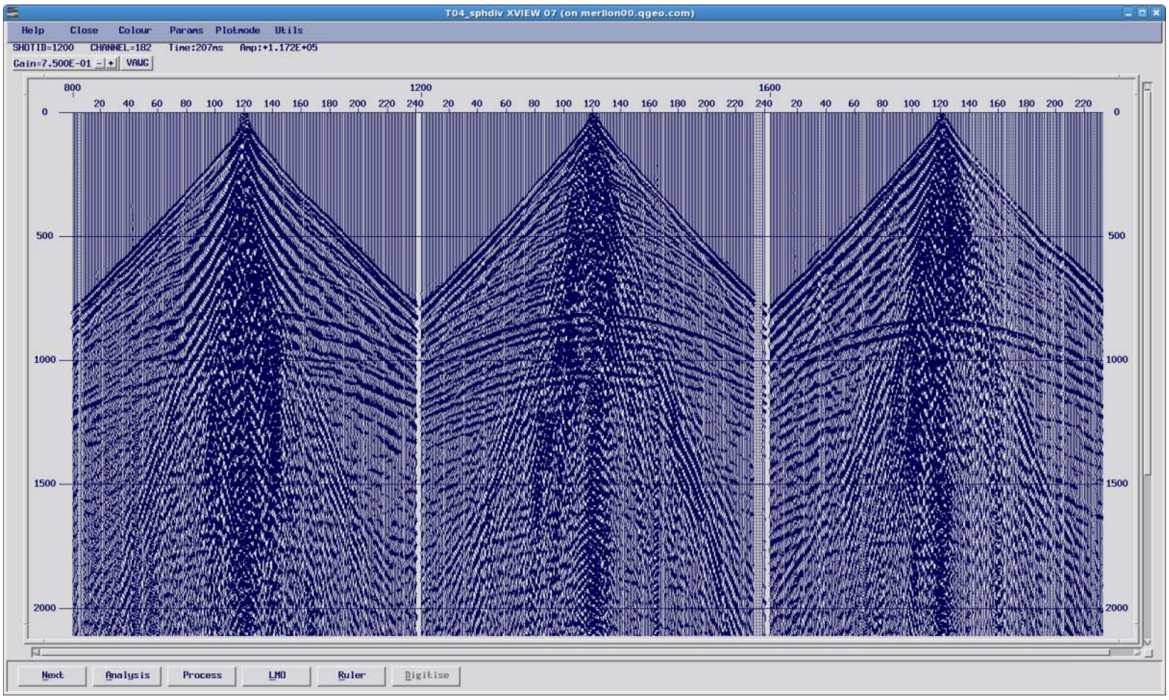


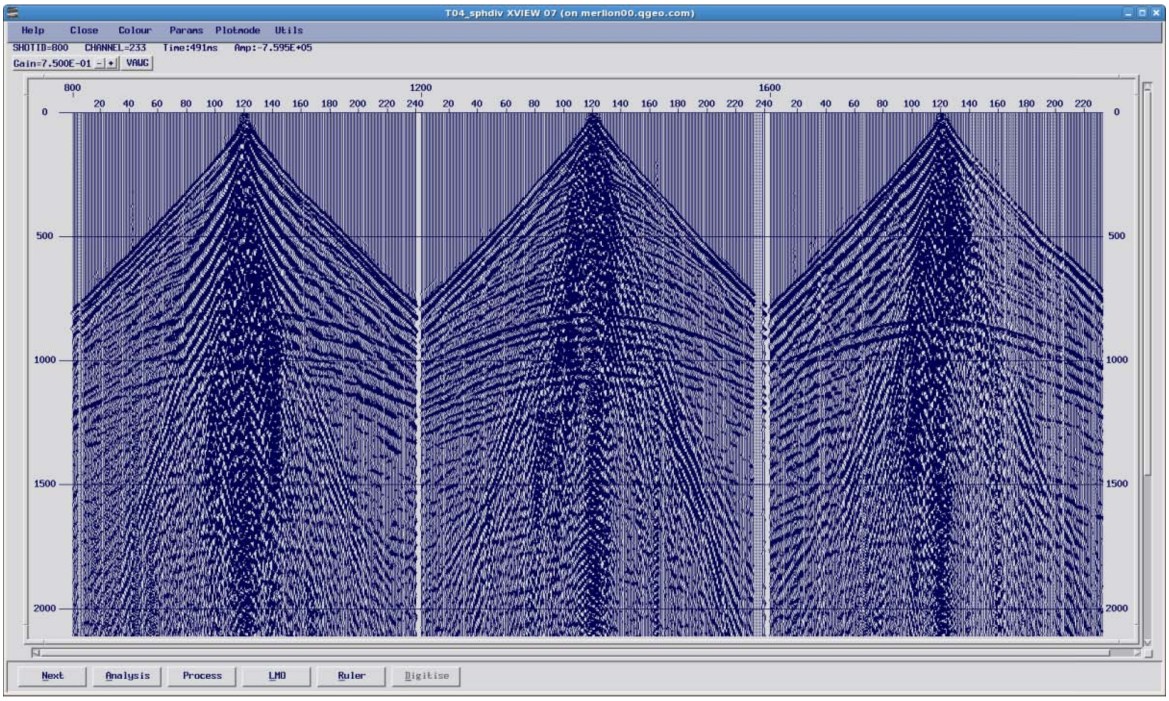
Source records, spherical divergence correction G(T) =$V^2T^{1.6}$



Source records, spherical divergence correction G(T) =$V^2T^{1.4}$



Source records, spherical divergence correction $G(T) = V^2T^{1.2}$



Source records, spherical divergence correction $G(T) = V^2T^1$

Test 5: F-K filter

Test Line 2009-GEL-01

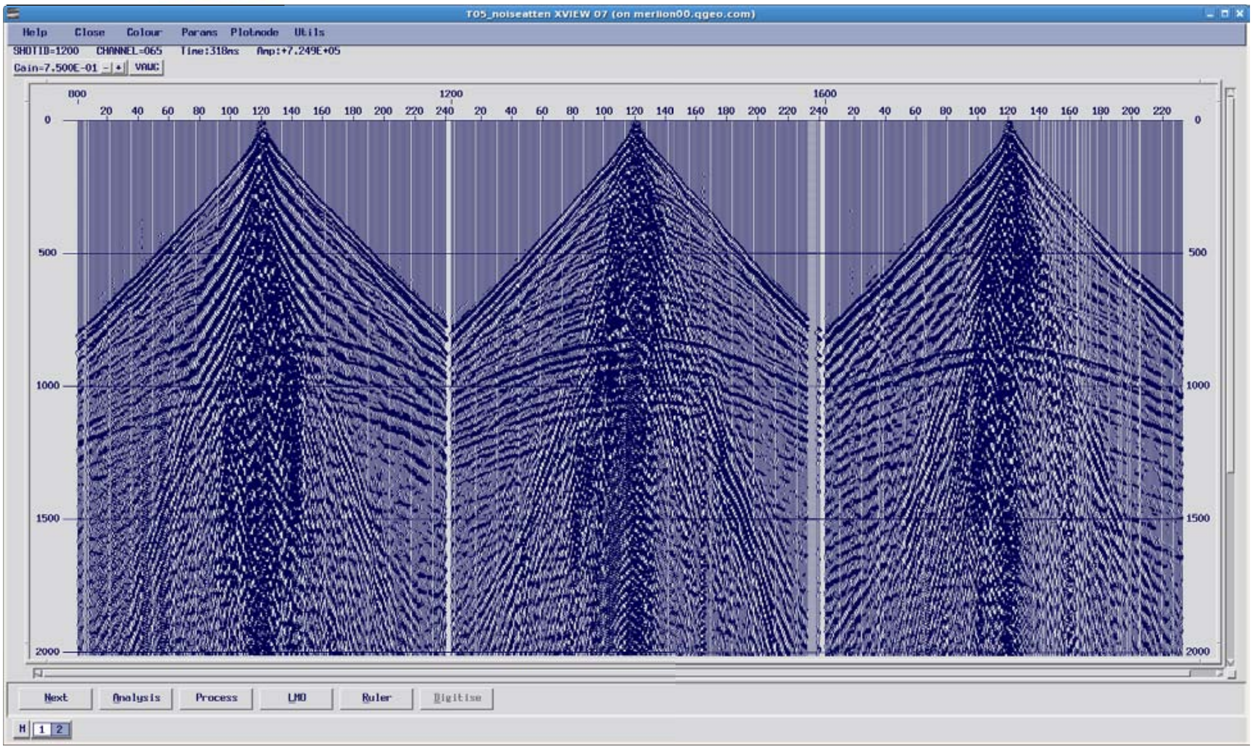
Objective:
To determine an optimum low-frequency noise attenuation routine to be applied after F-K filter, and to test air blast filtering.

Procedure:
A tailored amplitude-limiting noise attenuation algorithm ("Squelch") is applied to a set of records following F-K filtering, to attenuate the aliased low-velocity groundroll that F-K filtering has not completely removed.
The effect of air blast filtering on these records is also demonstrated.
The comparison was also made on the basis of brute stacks.

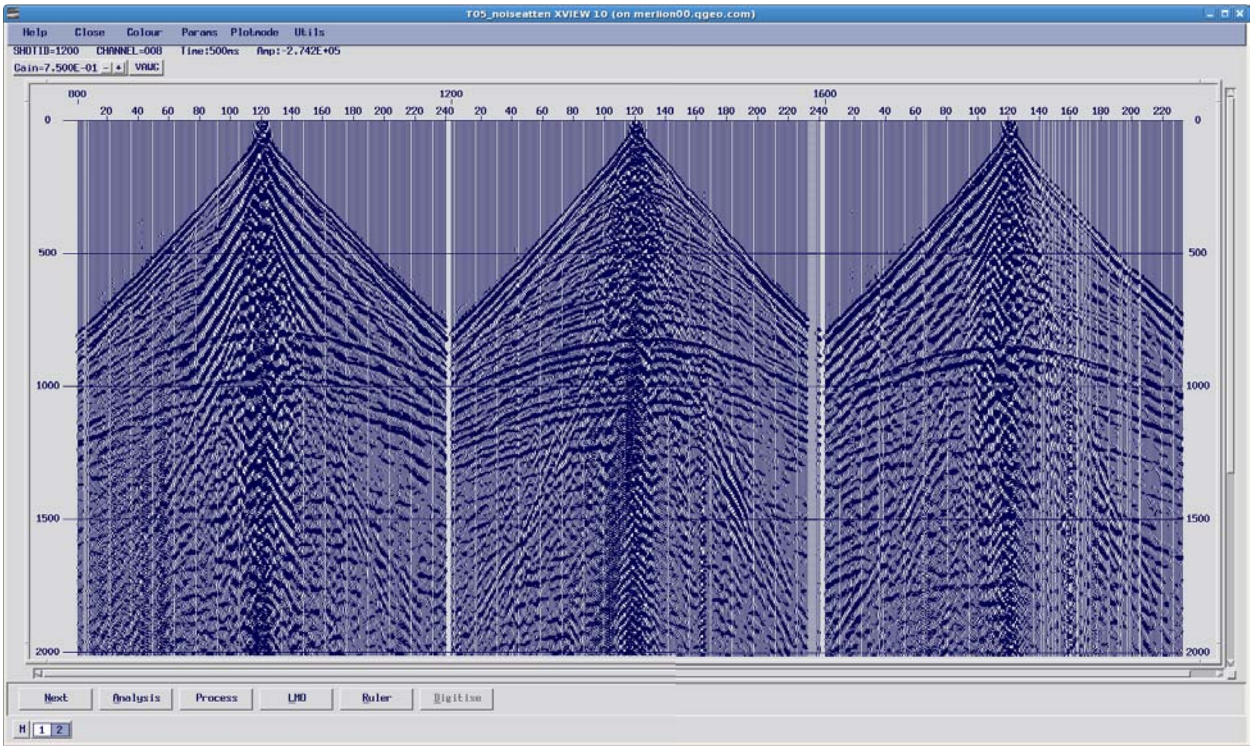
Comment:
Squelch and the air blast filter appear to be removing the unwanted noise without excessively impacting on reflection information.

Processing flow for source records in Test 5

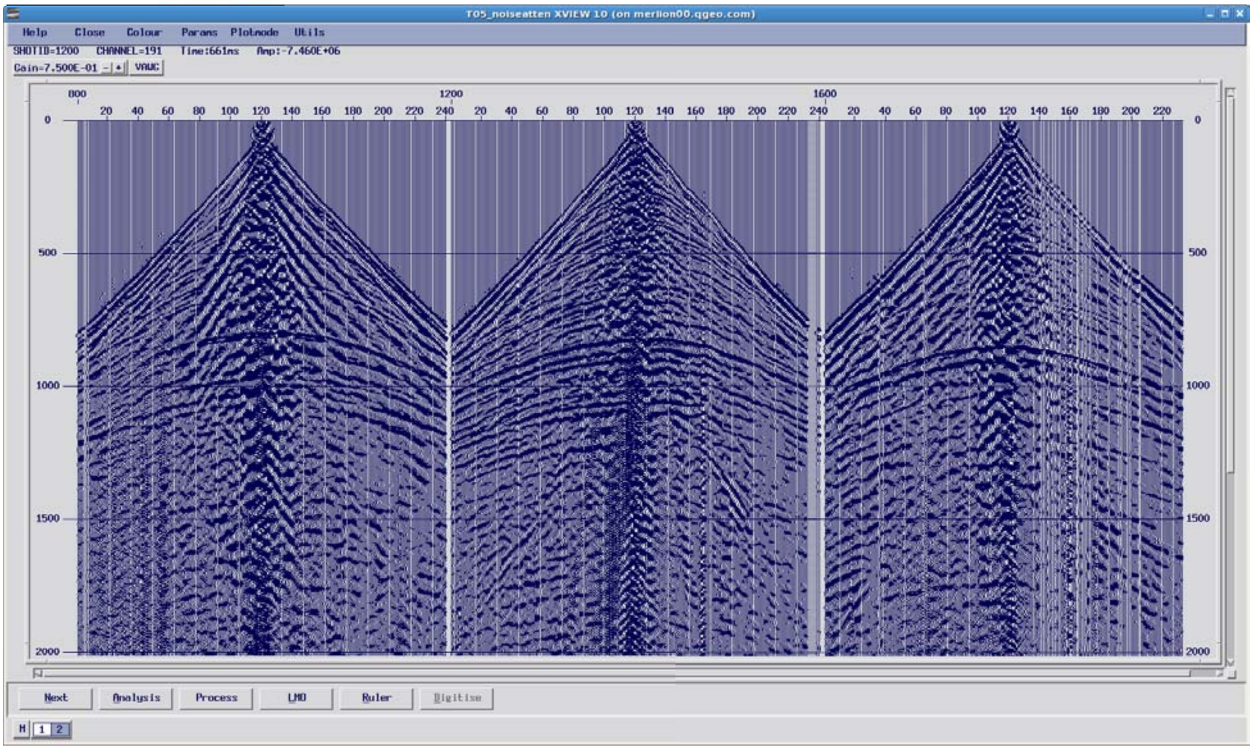
- Reformat SEG-Y data to Claritas internal format
- Resample to 2 ms
- Spherical divergence correction (rough velocities), $G(T)=V^2T^{1.4}$
- **AGC, 500 ms operator**
- **F-K filter, with cut-velocities as shown**
- **Remove AGC**
- Bandpass filter, 10 – 90 Hz



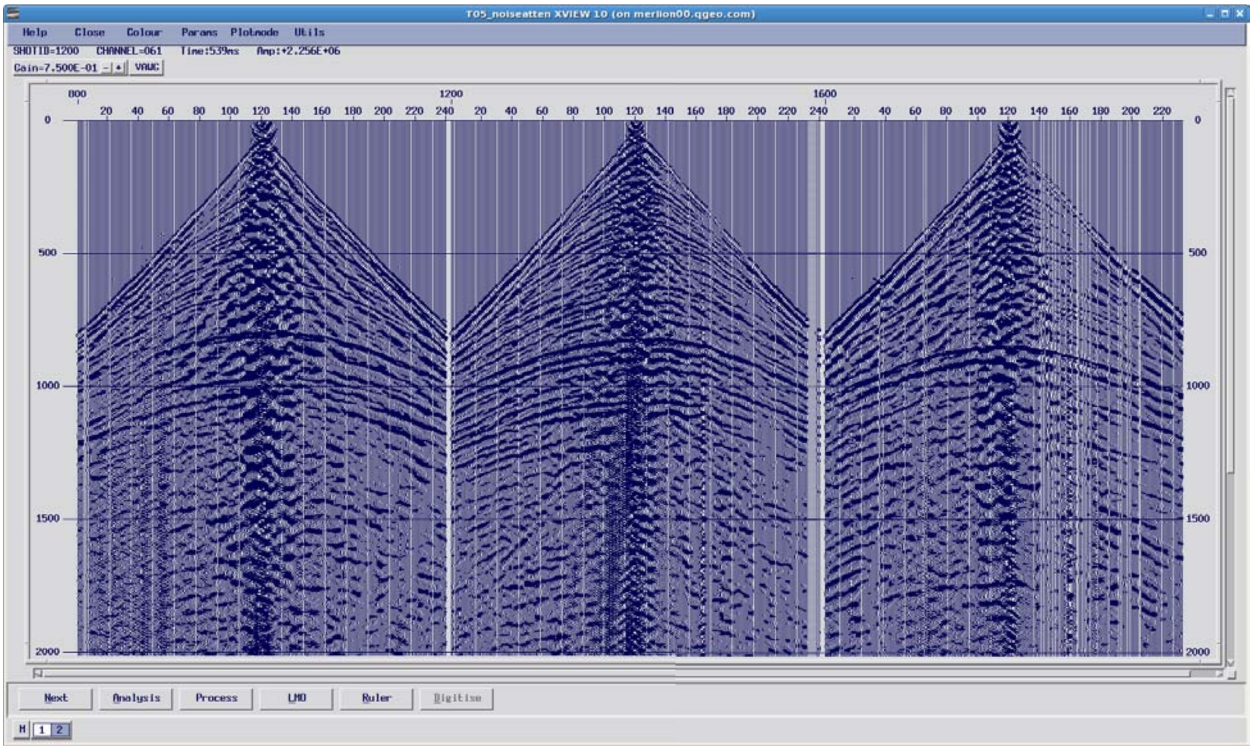
Source records, no F-K filter



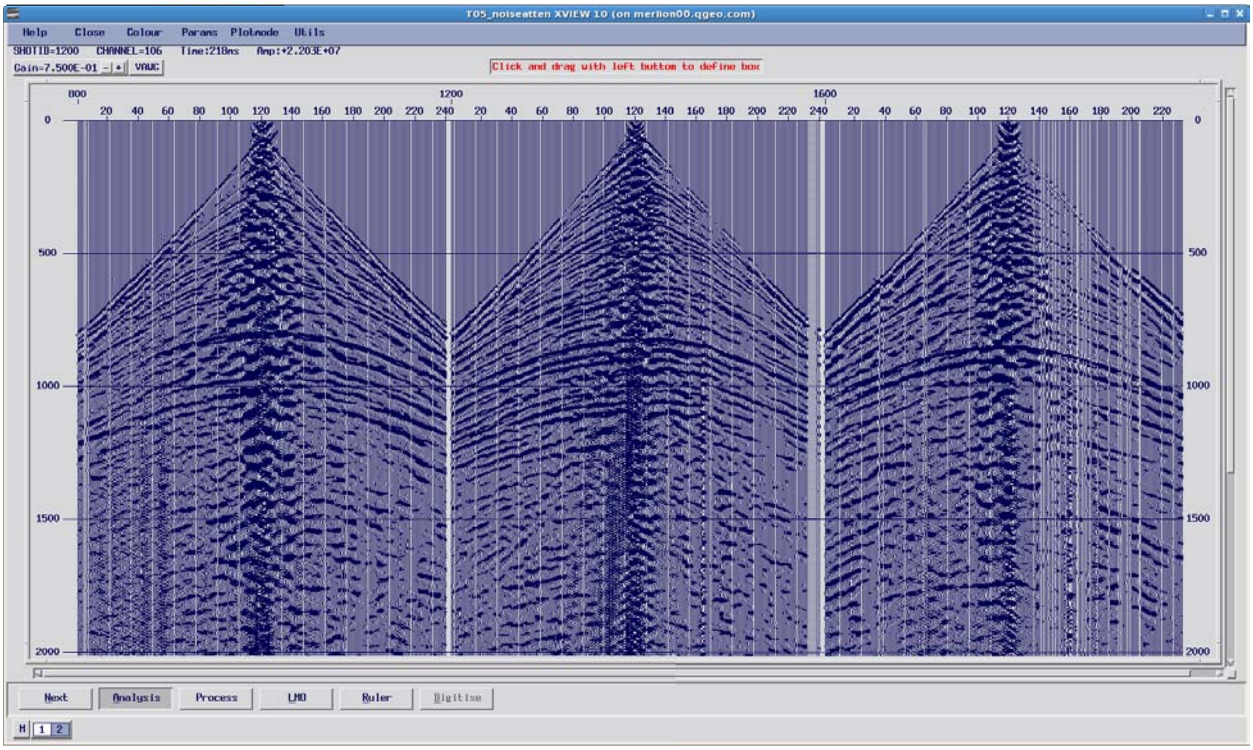
Source records, F-K filter (800 m/s cut)



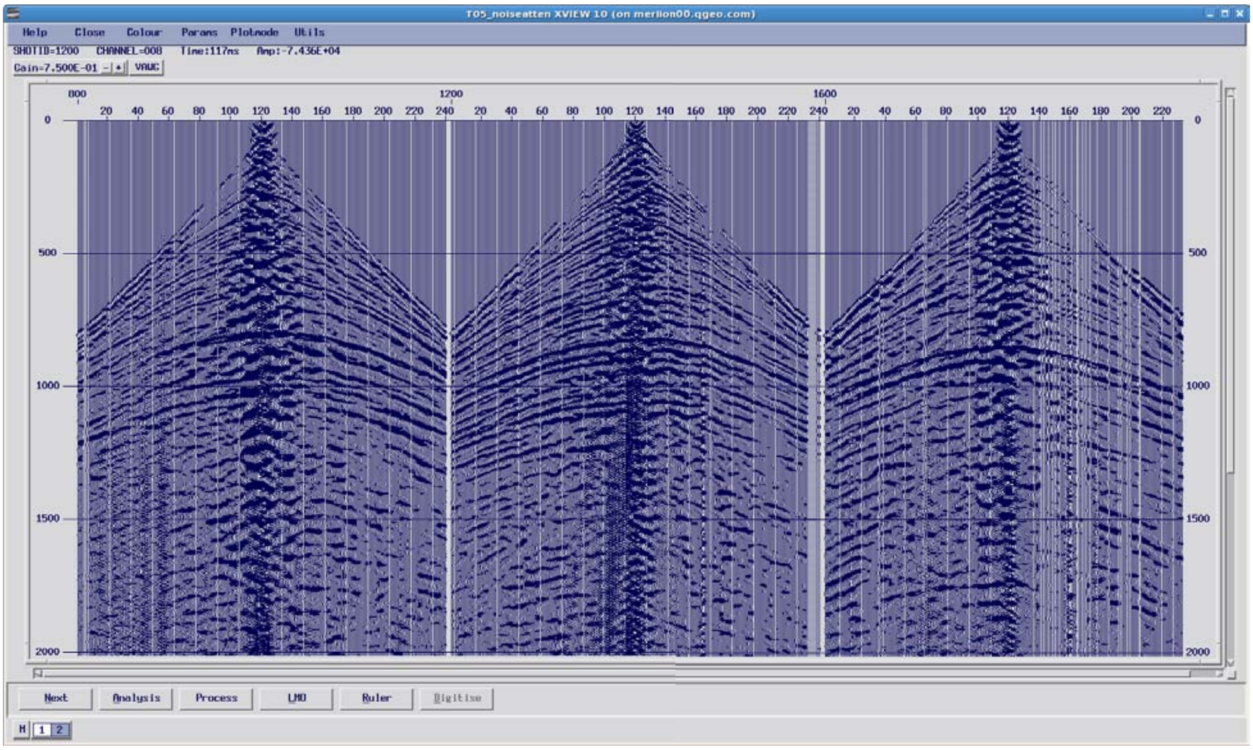
Source records, F-K filter (1200 m/s cut)



Source records, F-K filter (1600 m/s cut)



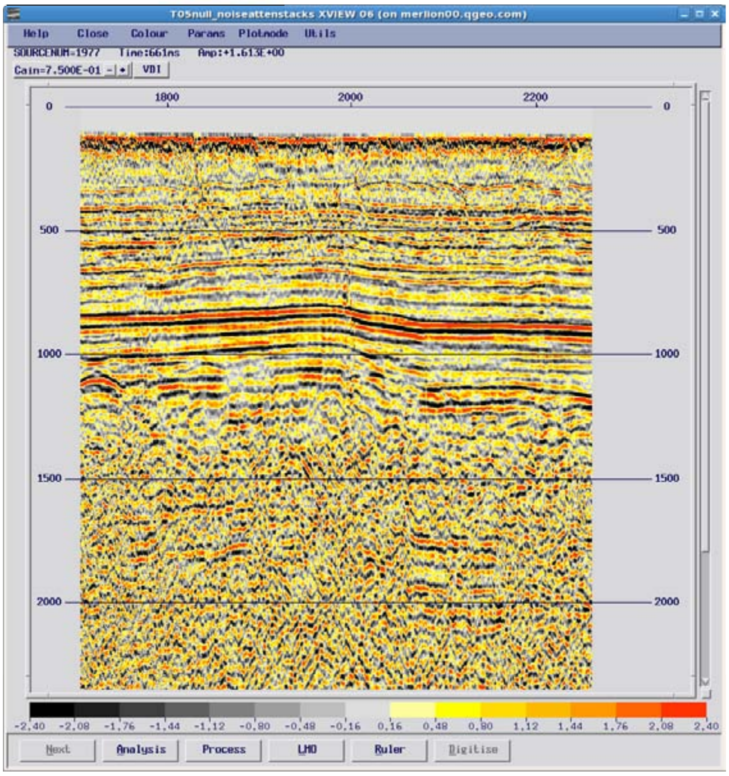
Source records, F-K filter (1800 m/s cut)



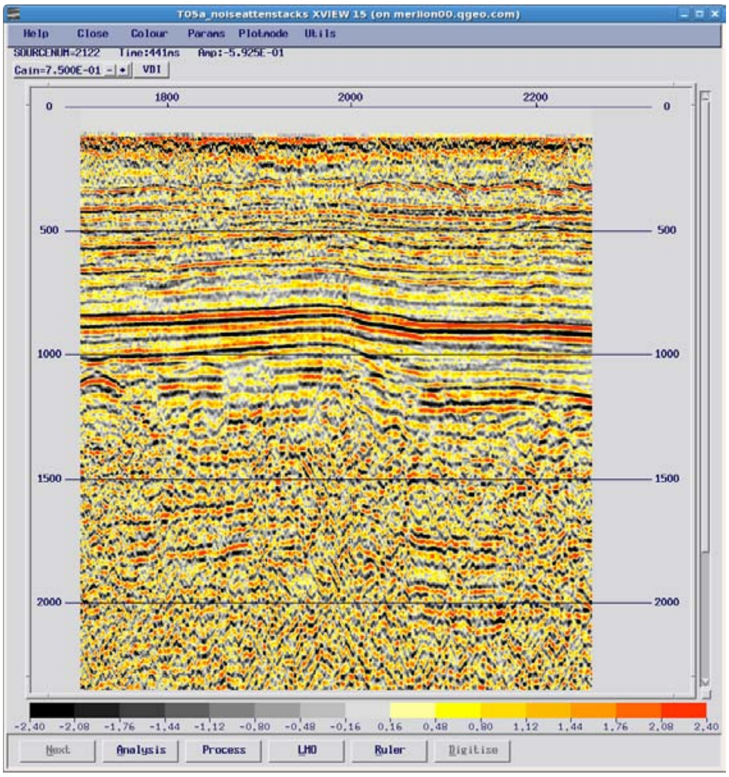
Source records, F-K filter (2000 m/s cut)

Processing flow for stacks in Test 5

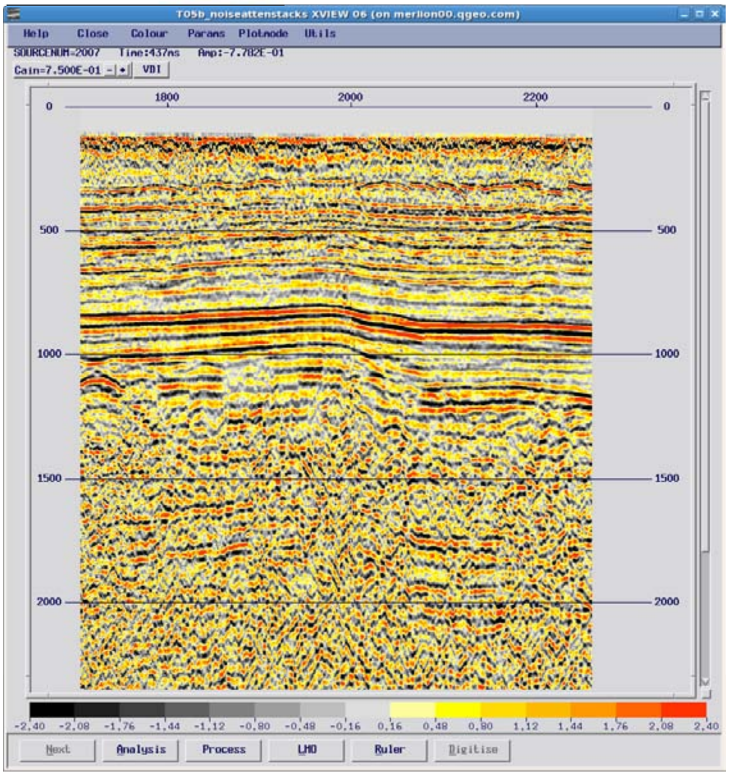
- Reformat SEG-Y data to Claritas internal format
- Resample to 2 ms
- Minimum-phasing filter
- Spherical divergence correction
- **AGC, 500 ms operator**
- **F-K filter, with cut-velocities as shown**
- **Remove AGC**
- Refraction statics correction
- NMO (rough velocities), 40% stretch mute
- AGC, 500 ms operator
- Stack, shift to final datum (400 m)
- Bandpass filter, as shown
- AGC, 500 ms operator



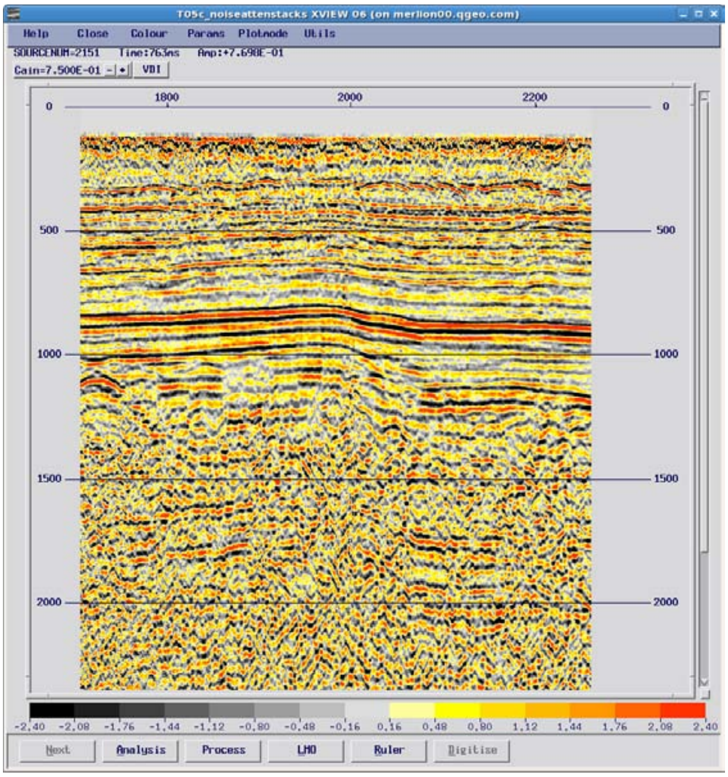
Brute stack (No F-K filter in flow) (**<u>2009-GEL-01 part)</u>**



Brute stack (1400 m/s F-K filter in flow) (**<u>2009-GEL-01-part)</u>**



Brute stack (1600 m/s F-K filter in flow) (**2009-GEL-01-part)**



Brute stack (1800 m/s F-K filter in flow) (**2009-GEL-01-part)**

Test 6: Noise attenuation

Test Line 2009-GEL-01

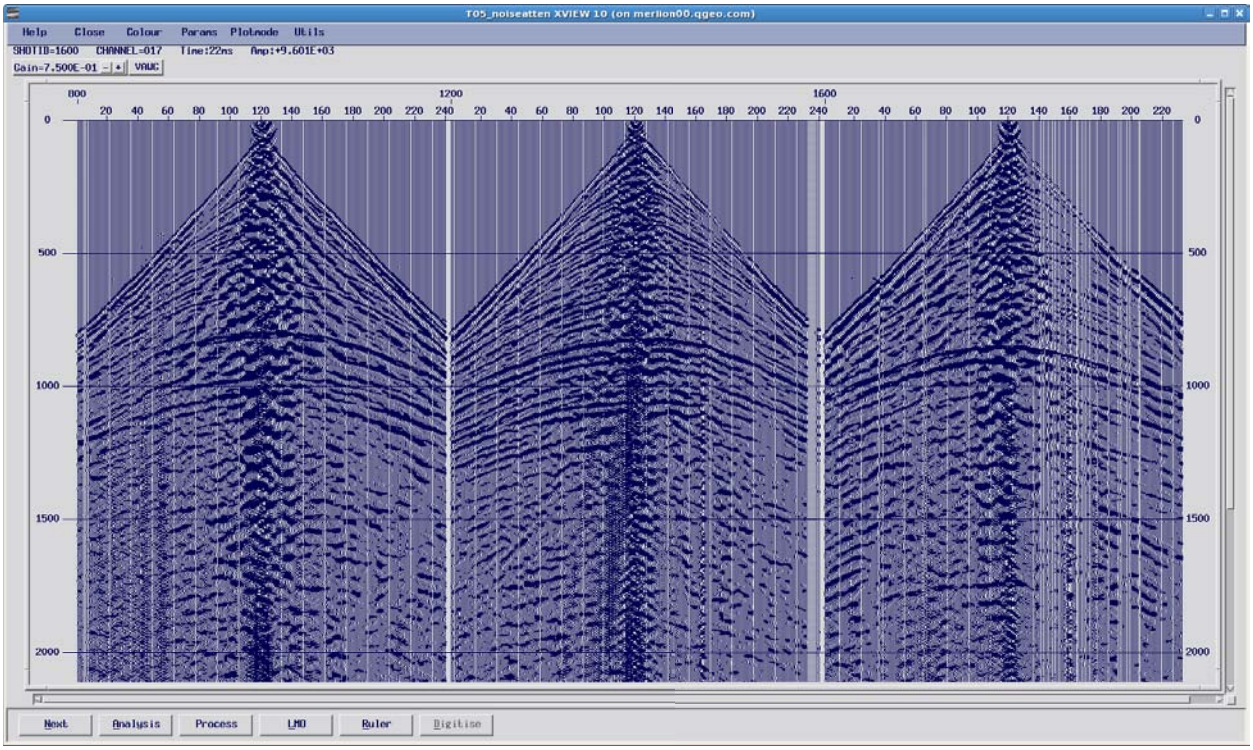
Objective:
To determine an optimum low-frequency noise attenuation routine to be applied after F-K filter, and to test air blast filtering.

Procedure:
A tailored amplitude-limiting noise attenuation algorithm ("Squelch") is applied to a set of records following F-K filtering, to attenuate the aliased low-velocity groundroll that F-K filtering has not completely removed.
The effect of air blast filtering on these records is also demonstrated.
The comparison was also made on the basis of brute stacks.

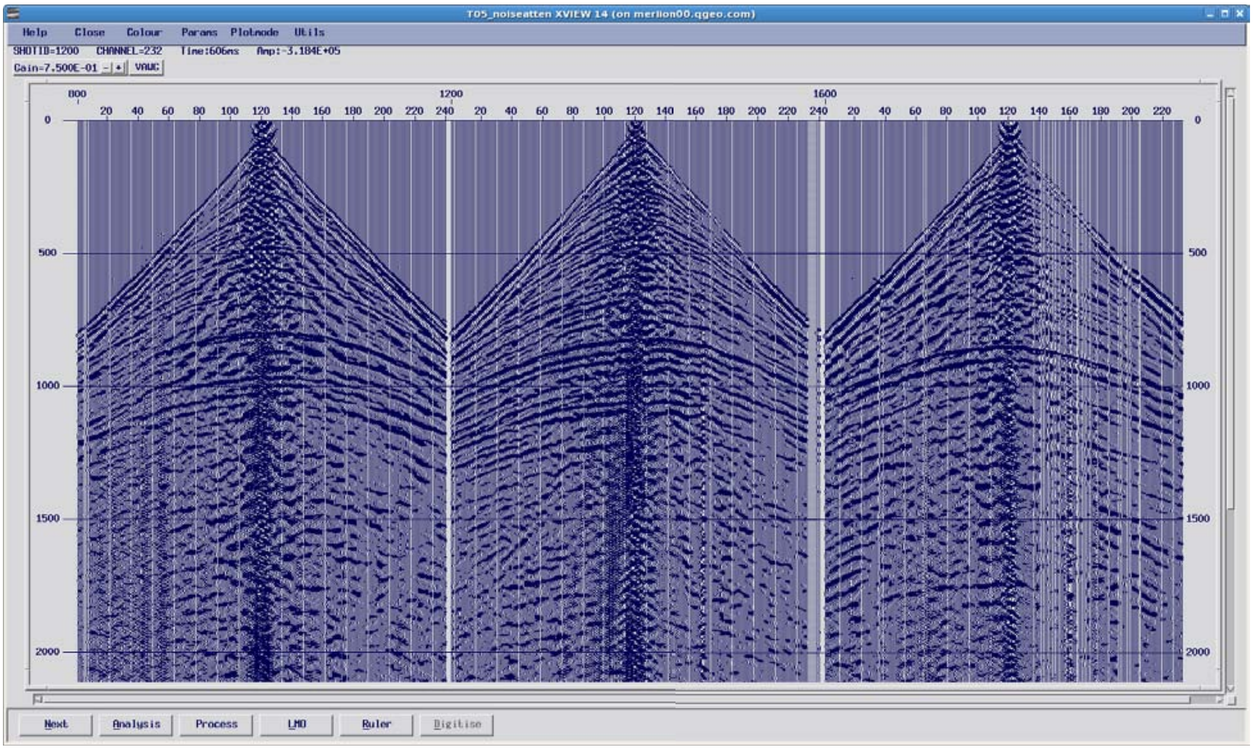
Comment:
Squelch and the air blast filter appear to be removing the unwanted noise without excessively impacting on reflection information.

Processing flow for source records in Test 6

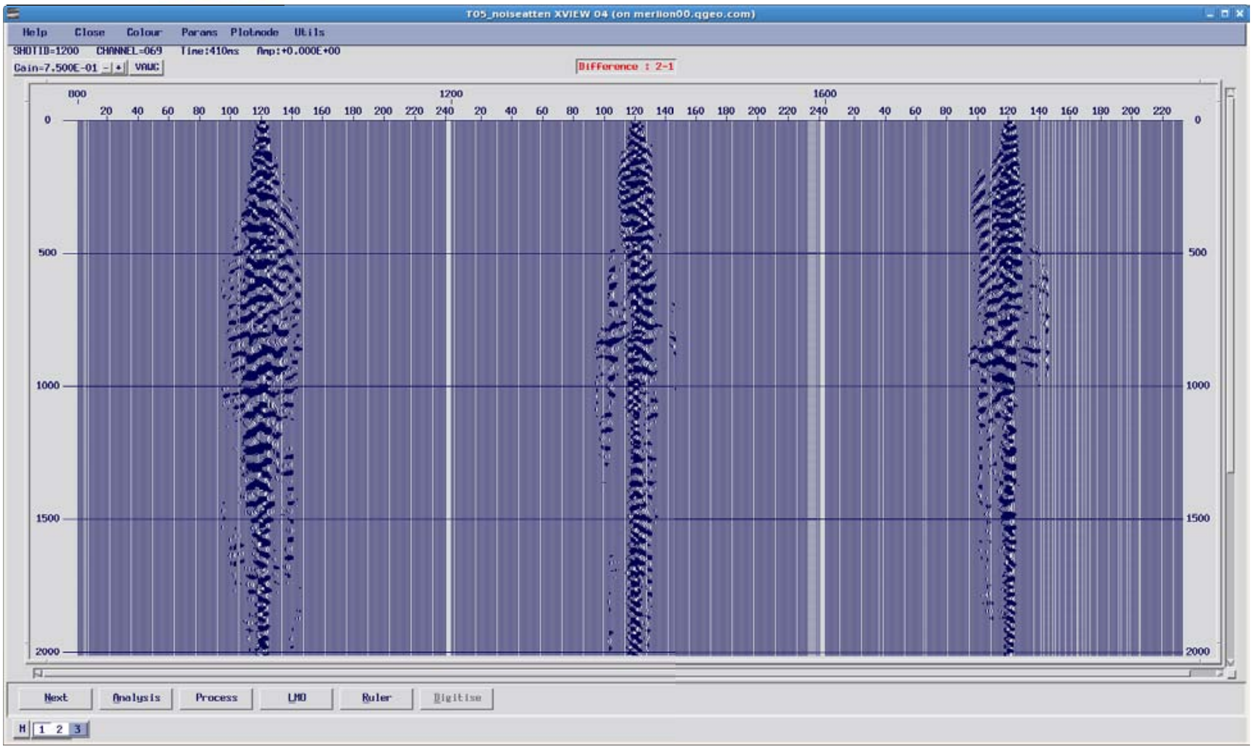
- Reformat SEG-Y data to Claritas internal format
- Resample to 2 ms
- Spherical divergence correction (rough velocities), $G(T)=V^2T^{1.4}$
- AGC, 500 ms operator
- F-K filter, with cut-velocities as shown
- Remove AGC
- **Squelch (tailored amplitude limiting noise attenuation algorithm)**
- Air blast attenuation
- Bandpass filter, 10 – 90 Hz



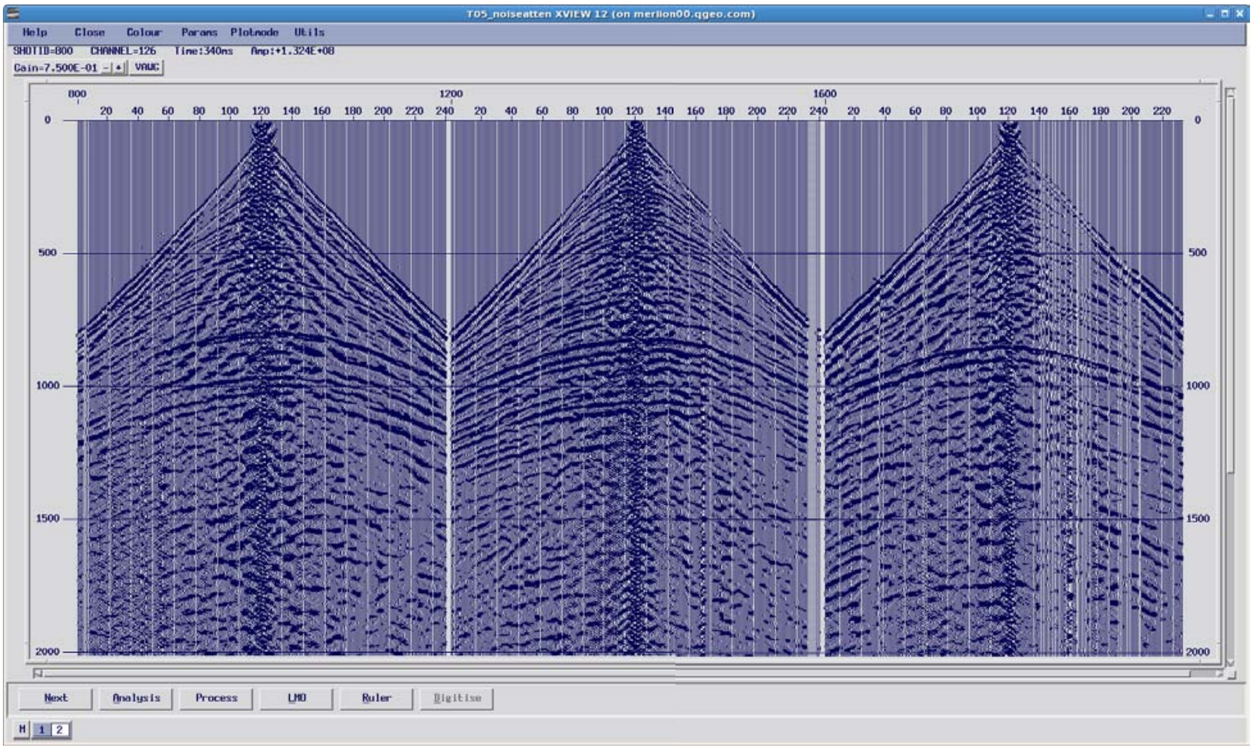
Source records, F-K filter (1600 m/s cut)



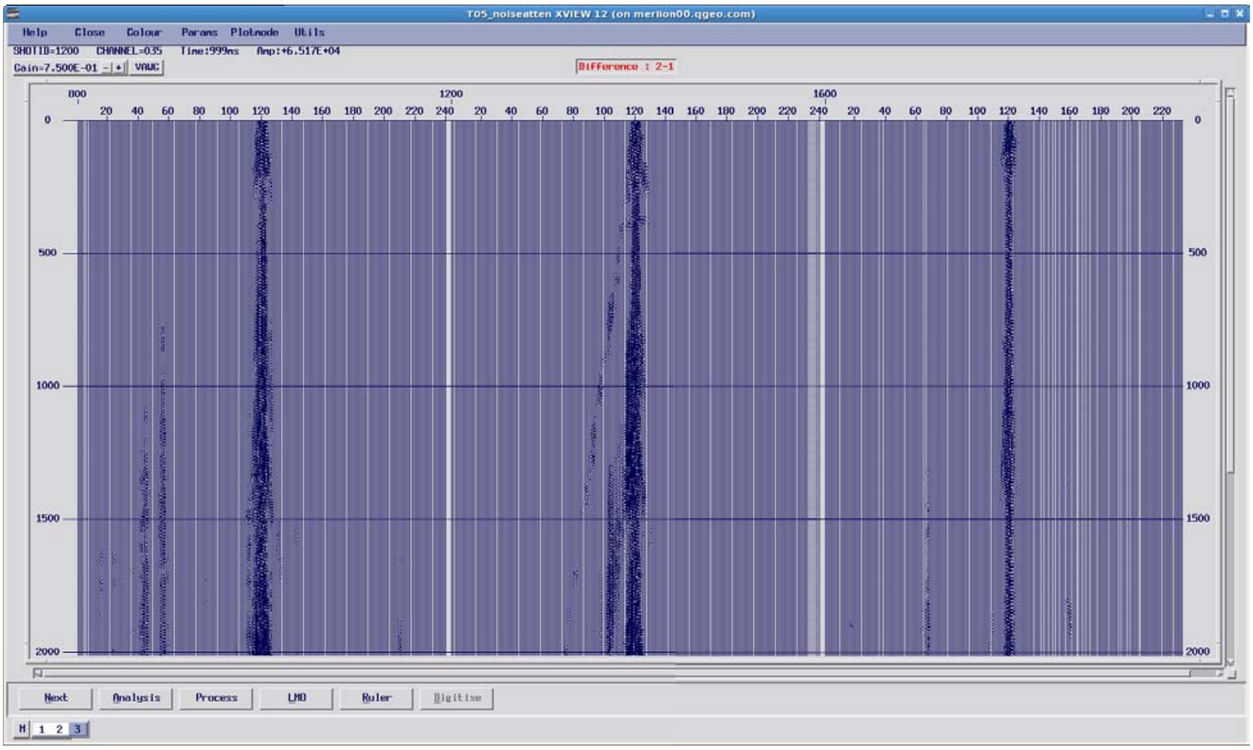
Source records, F-K filter (1600 m/s cut) followed by Squelch



Difference plot for Squelch
(Pre-squelch records minus post-squelch records)



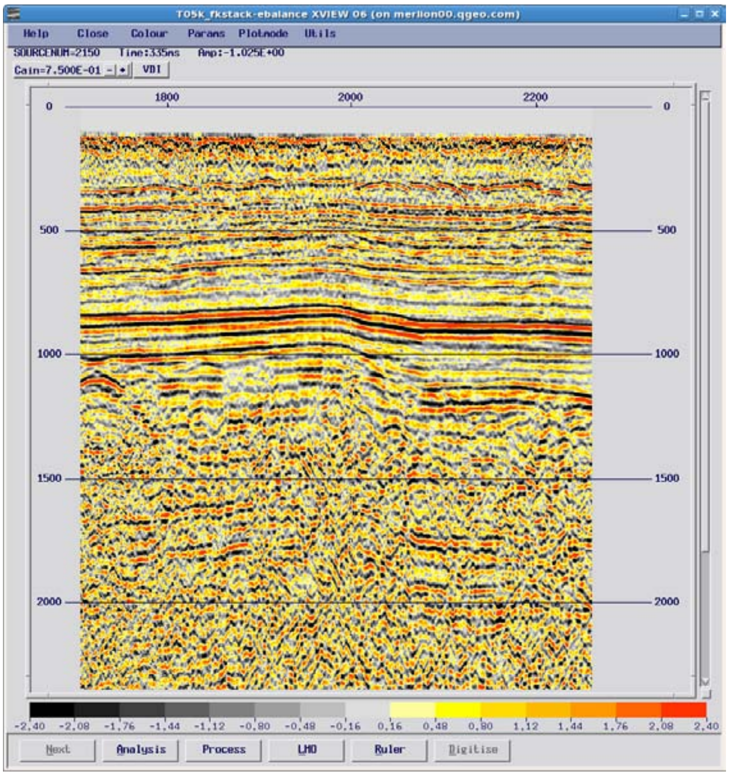
Source records, F-K filter (1600 m/s cut), Squelch, then air blast filter



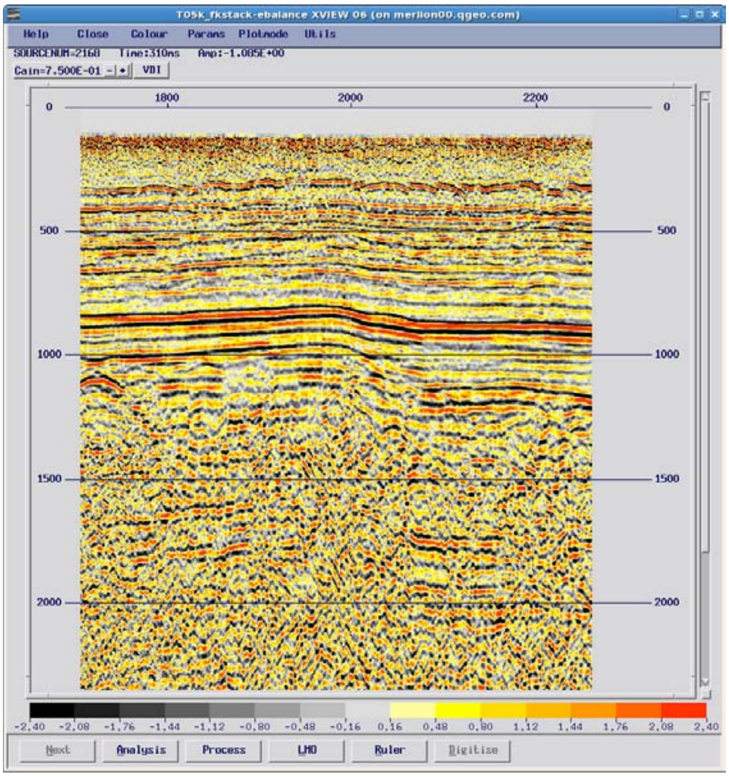
Difference plot for air blast filter
(Pre-air blast filter records minus post-air blast filter records)

Processing flow for stacks in Test 6

- Reformat SEG-Y data to Claritas internal format
- Resample to 2 ms
- Minimum-phasing filter
- Spherical divergence correction
- AGC, 500 ms operator
- F-K filter, with 1600 m/s cut velocity
- Remove AGC
- **Squelch**
- **Air blast attenuation**
- Refraction statics correction
- NMO (rough velocities), 40% stretch mute
- AGC, 500 ms operator
- Stack, shift to final datum (400 m)
- Bandpass filter, 15-90 Hz
- AGC, 500 ms operator



Stack (No Squelch or air blast attenuation) (**<u>2009-GEL-01-part)</u>**



Stack (Squelch and air blast attenuation in flow) (**<u>2009-GEL-01-part)</u>**

Test 7: Deconvolution gap length tests (source record displays)

Test Line 2009-GEL-01

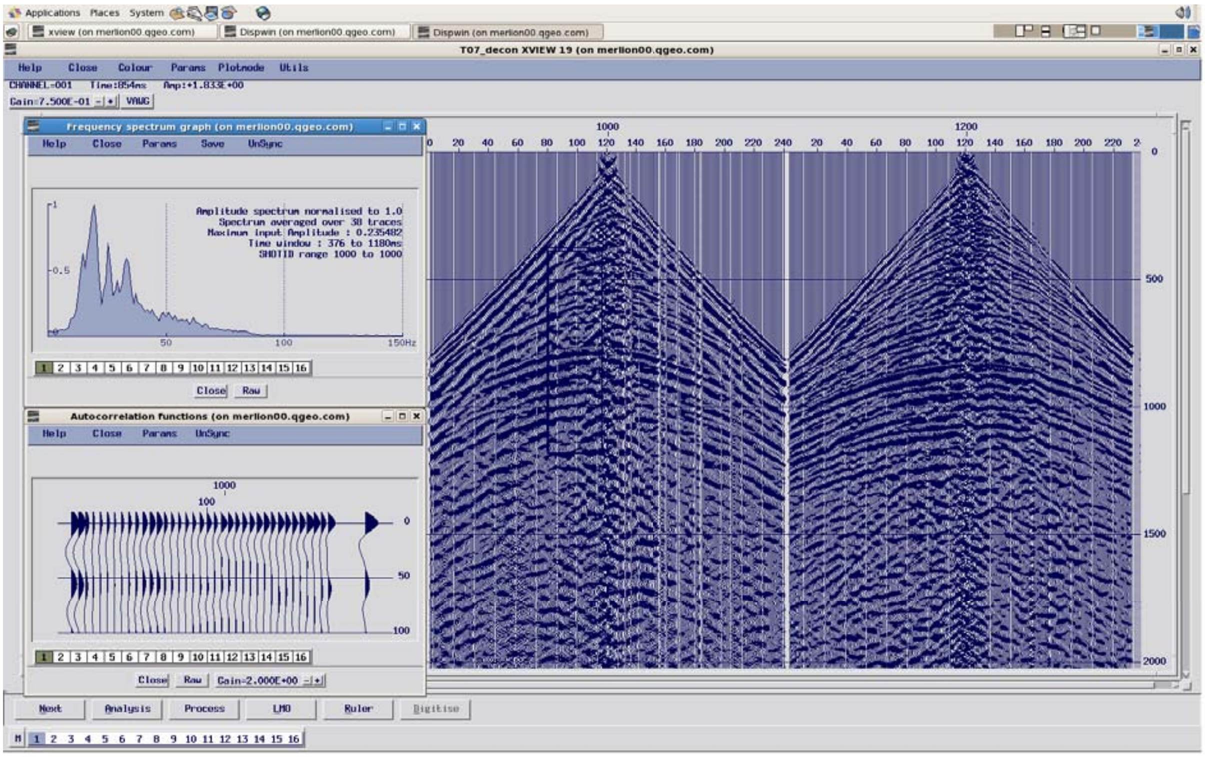
Objective:
To determine an optimum deconvolution gap length.

Procedure:
Surface consistent deconvolution was applied to a set of records from the test line following noise attenuation.
Spiking deconvolution was tested, as was gap deconvolution with various gap lengths. Operator length was held constant at 100 ms.
Additionally, the effect of post-deconvolution spectral whitening was tested.
For each case, the autocorrelations and spectra are shown.

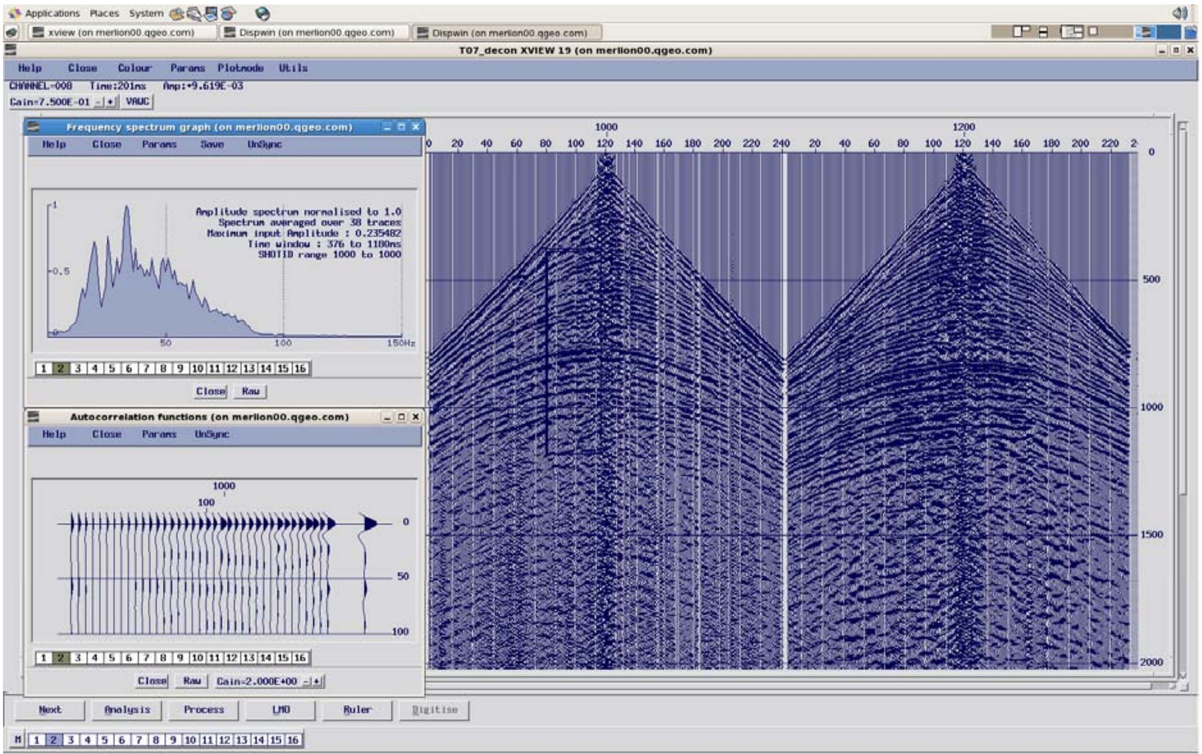
Comment:
Spiking deconvolution with post-deconvolution spectral whitening seems appropriate on the basis of this test.

Processing flow for source records in Test 7

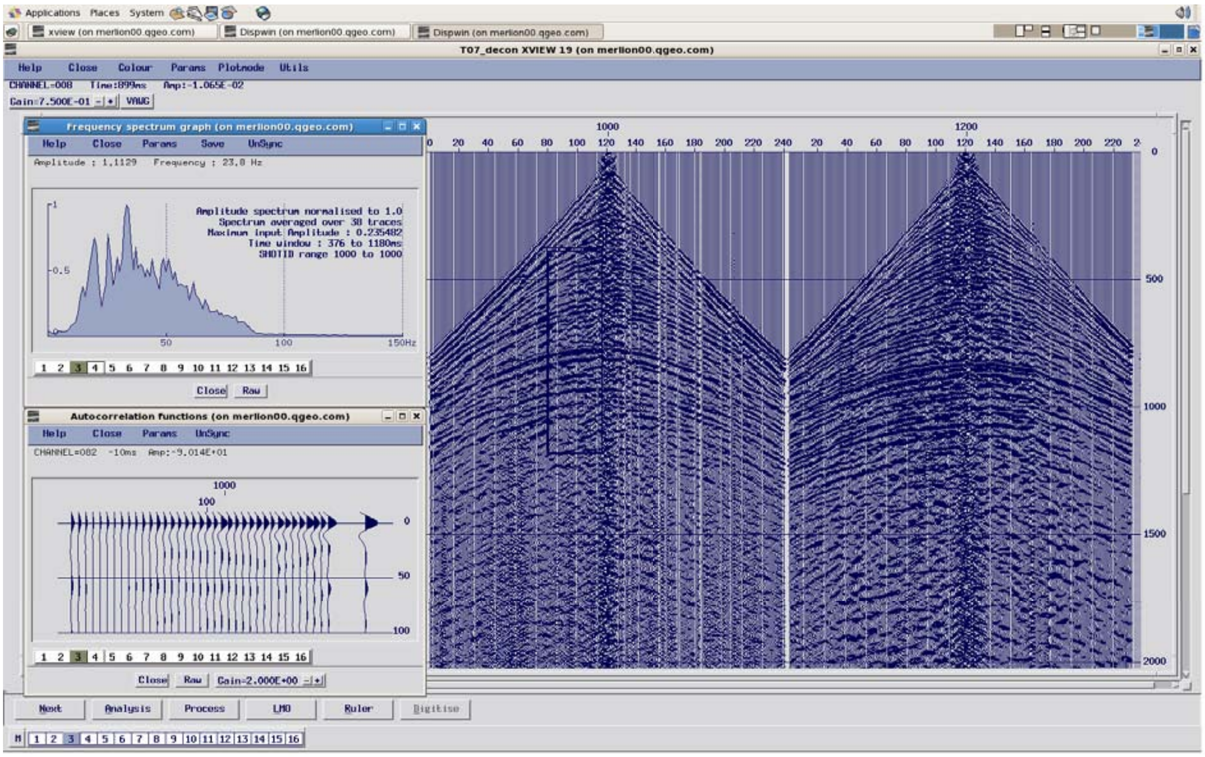
- Reformat SEG-Y data to Claritas internal format
- Resample to 2 ms
- Minimum phasing filter
- Spherical divergence correction (rough velocities), $G(T)=V^2T^{1.4}$
- AGC, 500 ms operator
- F-K filter, with cut-velocities as shown
- Remove AGC
- Coherent noise attenuation and air blast attenuation
- **Surface consistent deconvolution, operator length 100 ms, other details as shown**
- **Spectral whitening (or null)**
- Bandpass filter, 10 – 90 Hz



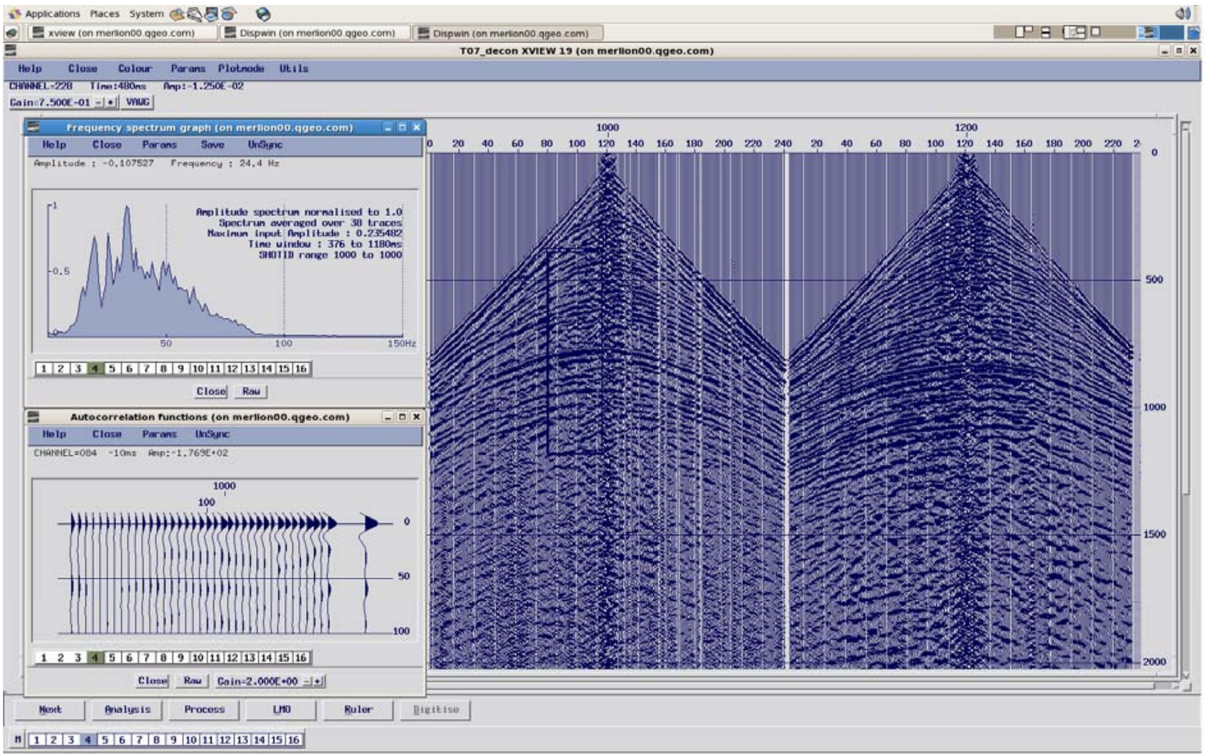
No deconvolution



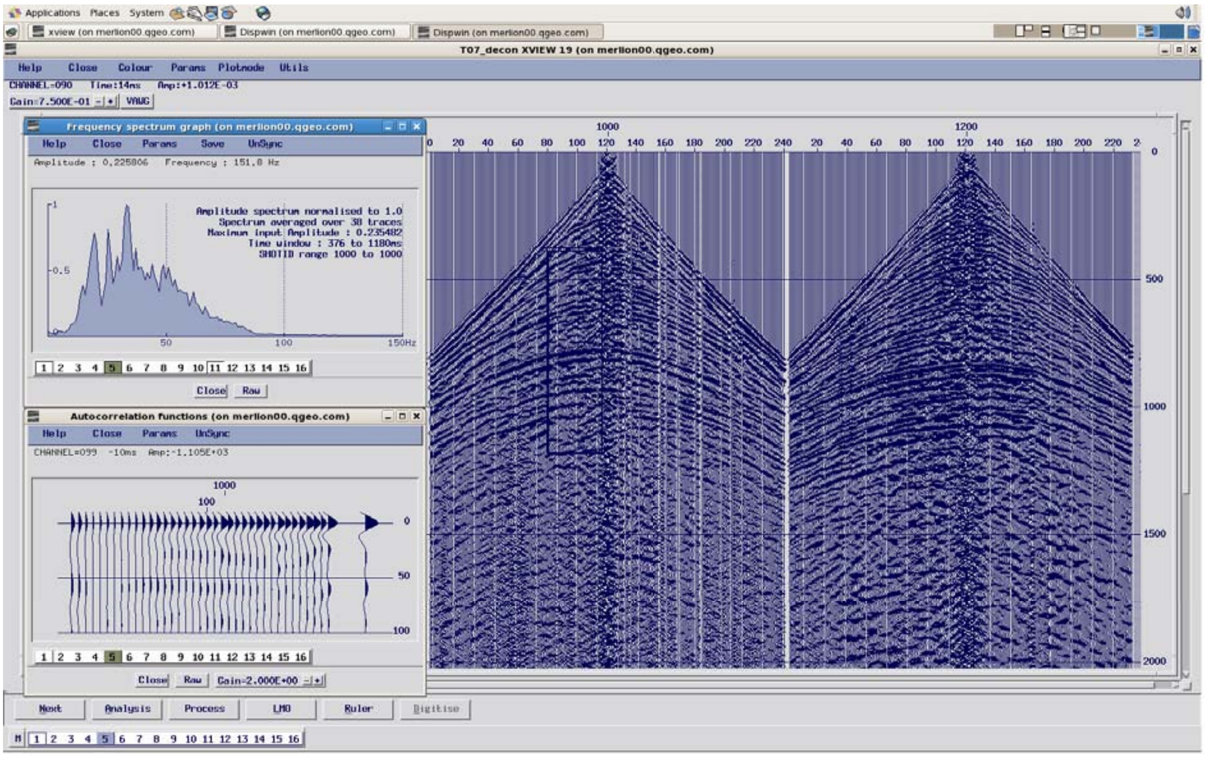
Surface consistent spiking deconvolution, 100 ms operator



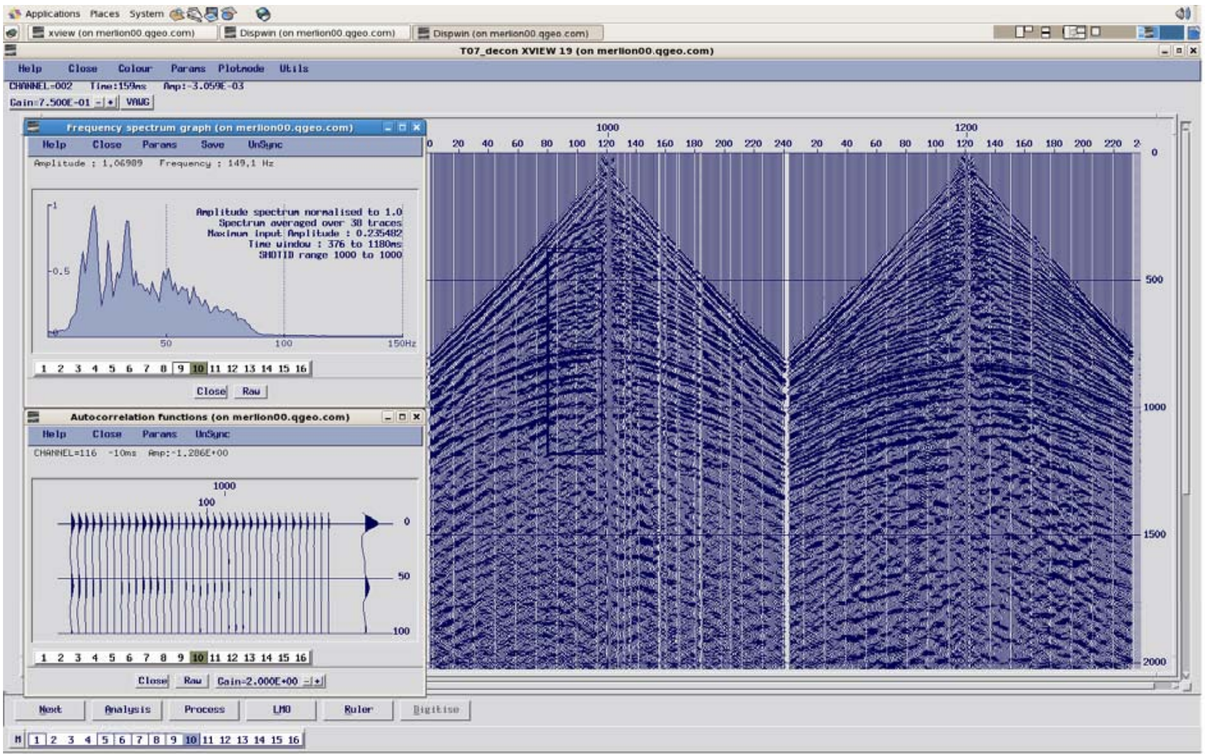
Surface consistent spiking deconvolution, 100 ms operator



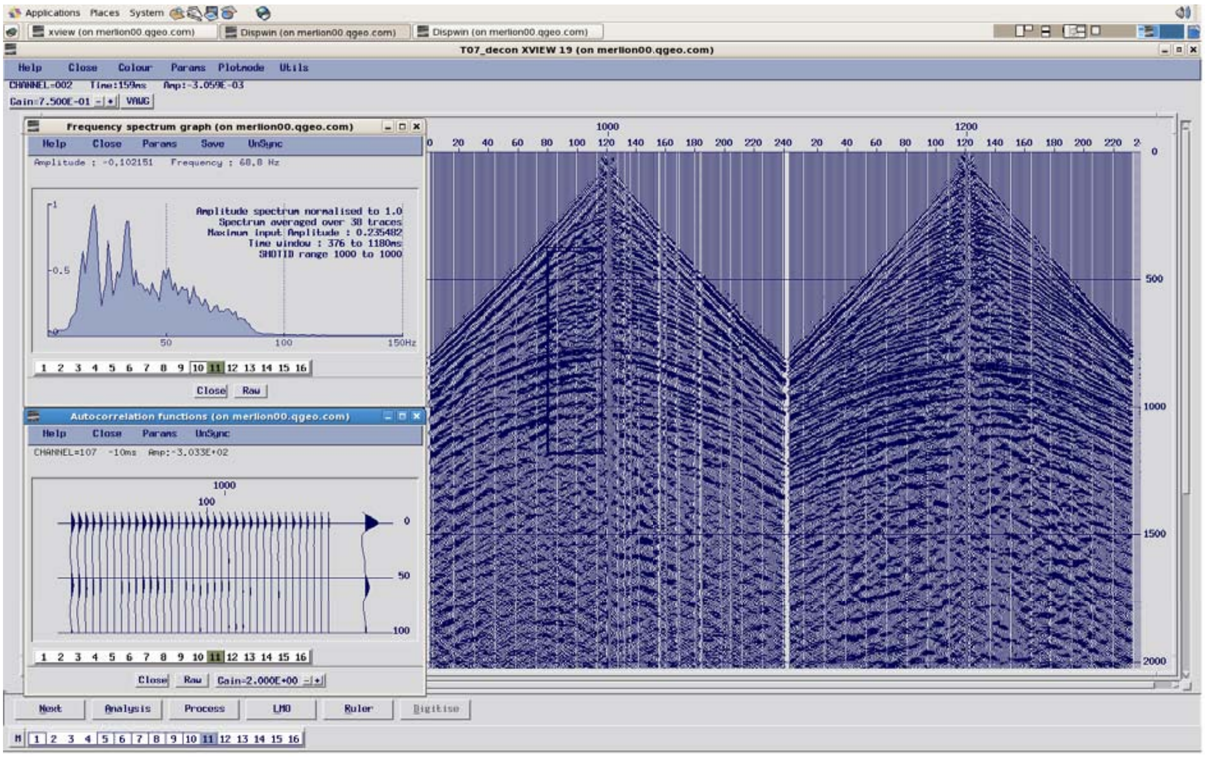
Surface consistent gap deconvolution, 6 ms gap, 100 ms operator



Surface consistent gap deconvolution, 8 ms gap, 100 ms operator



Surface consistent spiking deconvolution, 100 ms operator, followed by spectral whitening



Surface consistent gap deconvolution, 4 ms gap, 100 ms operator, followed by spectral whitening

Test 7a: Deconvolution gap length tests (stack displays)

Test Line 2009-GEL-01

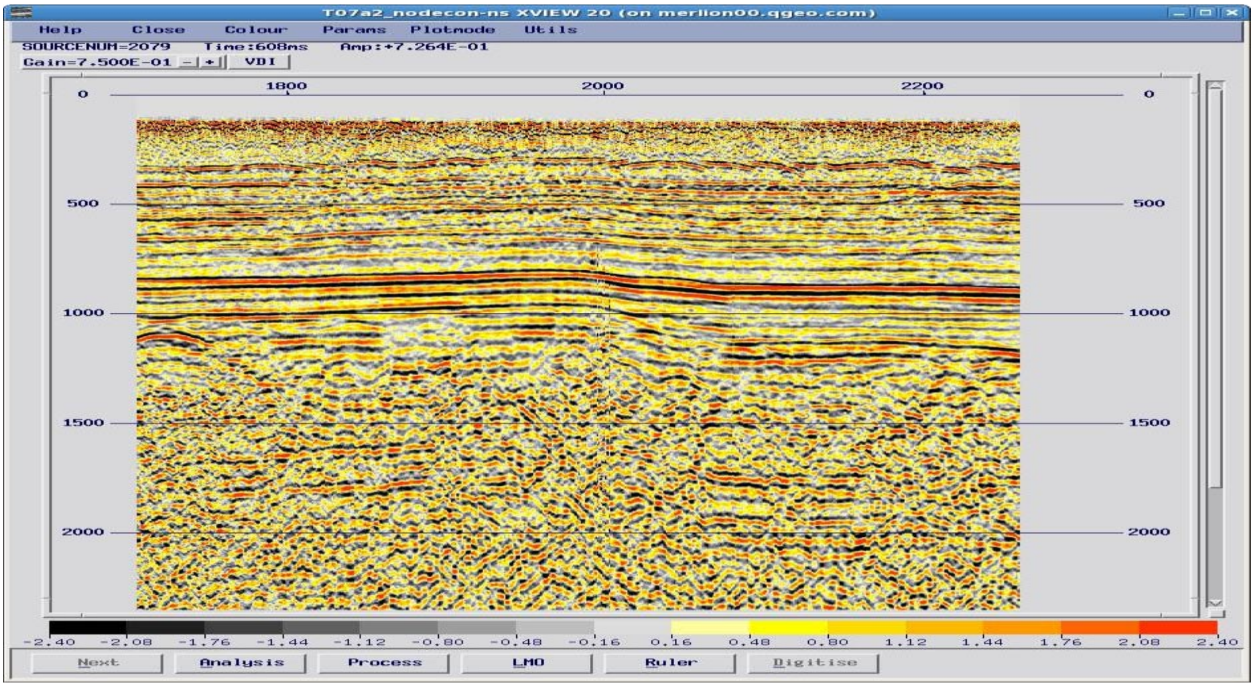
Objective:
To determine an optimum deconvolution gap length.

Procedure:
Surface consistent deconvolution, with various properties, was applied in the creation of stacks.
Spiking deconvolution was tested, as was gap deconvolution with various gap lengths. Operator length was held constant at 100 ms.
Additionally, the effect of post-deconvolution spectral whitening was tested.

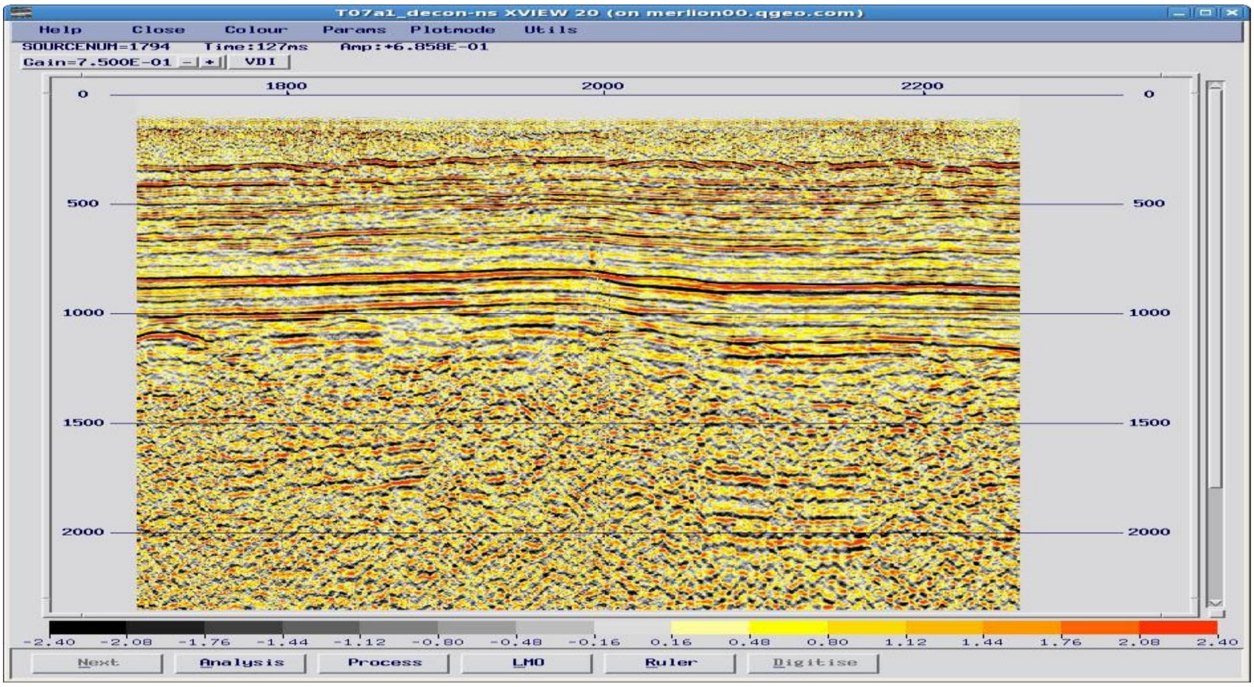
Comment:
Spiking deconvolution with post-deconvolution spectral whitening seems appropriate on the basis of this test.

Processing flow for stacks in Test 7a

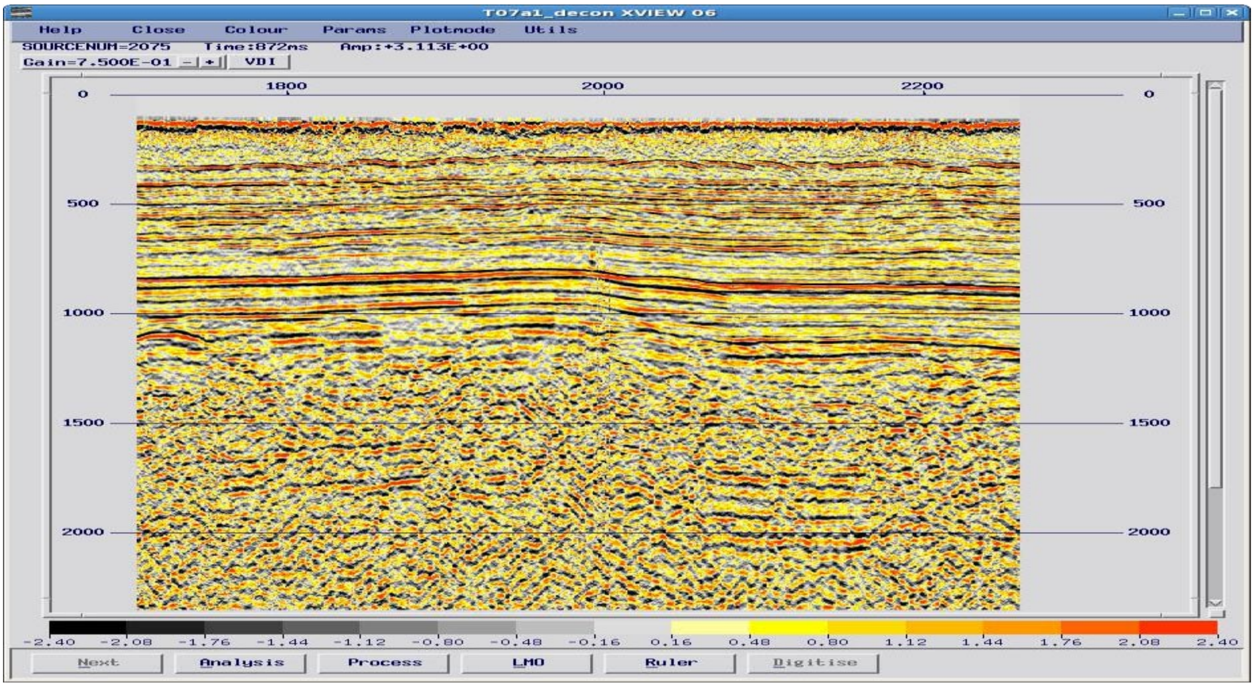
- Reformat SEG-Y data to Claritas internal format
- Resample to 2 ms
- Minimum phasing filter
- Spherical divergence correction (rough velocities), $G(T)=V^2T^{1.4}$
- AGC, 500 ms operator
- F-K filter, with cut-velocities as shown
- Remove AGC
- Coherent noise attenuation and air blast attenuation
- **Surface consistent deconvolution, operator length 100 ms, other details as shown**
- **Spectral whitening (or null)**
- Refraction statics application
- NMO, 40% stretch mute, (rough velocities)
- AGC, 500 ms operator
- Stack, shift to final datum
- Mild coherency filter
- Bandpass filter, 10 – 90 Hz



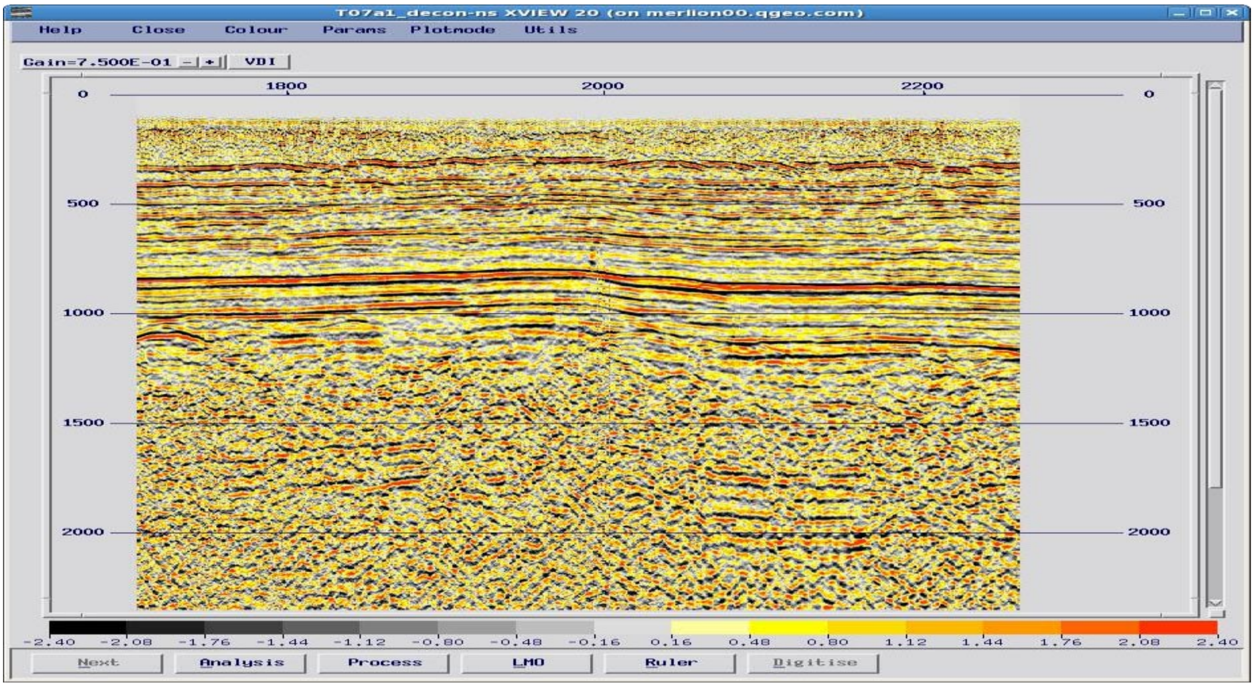
No deconvolution (**2009-GEL-01)**



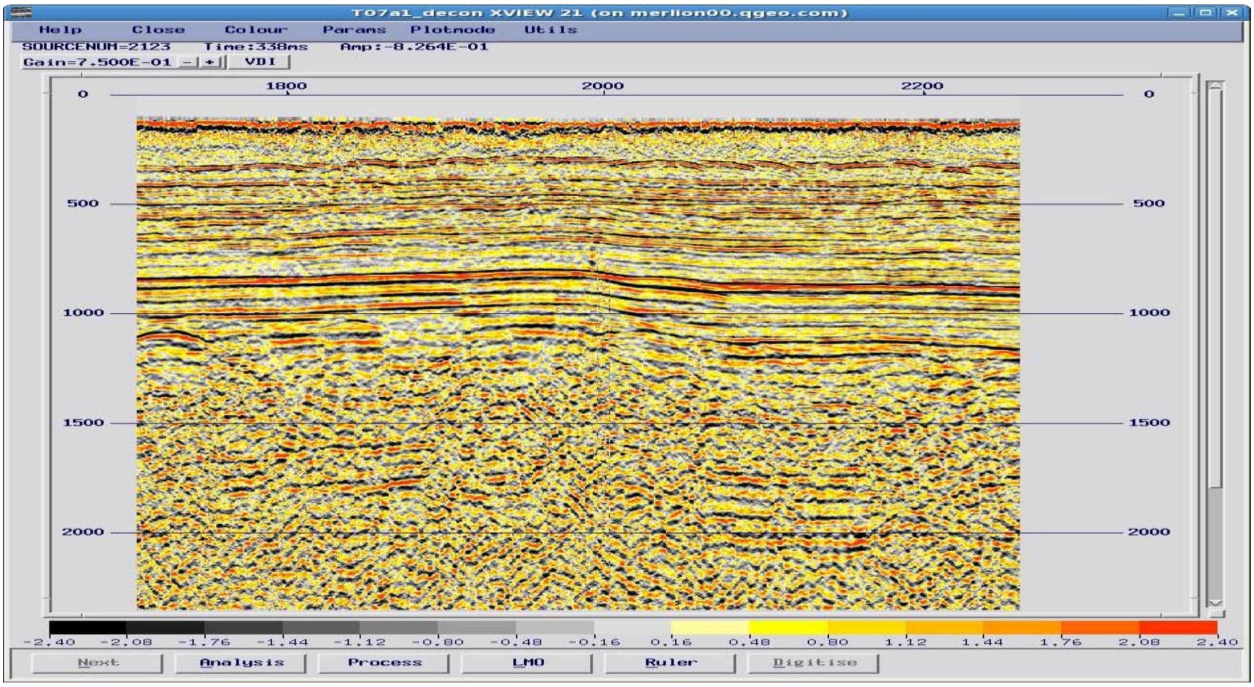
Surface consistent spiking deconvolution, 100 ms operator (**2009-GEL-01)**



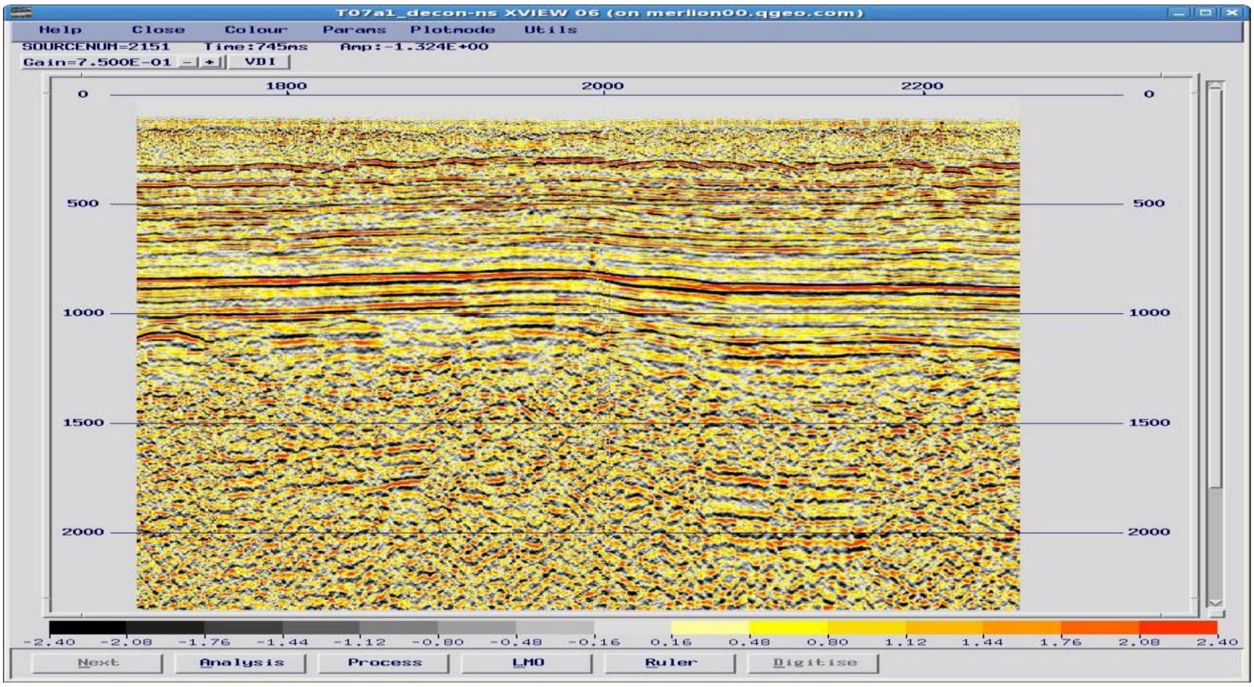
Surface consistent spiking deconvolution, 100 ms operator, followed by spectral whitening (**2009-GEL-01)**



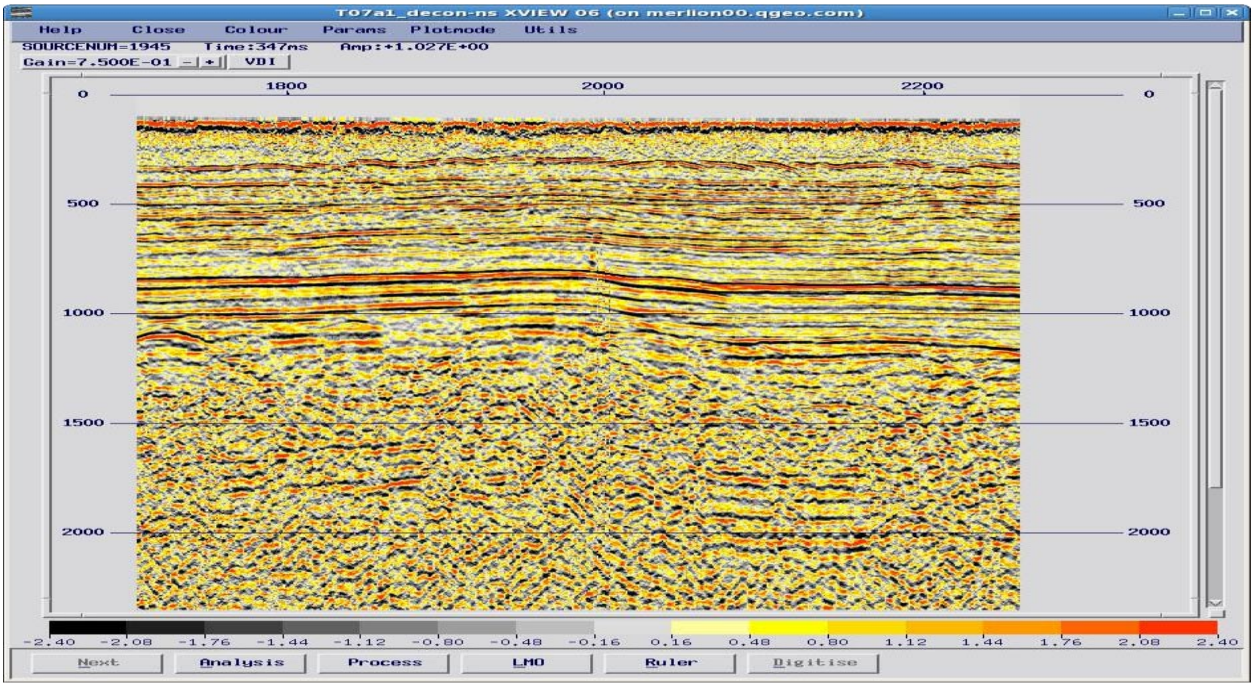
Surface consistent gap deconvolution, 4 ms gap, 100 ms operator (**2009-GEL-01)**



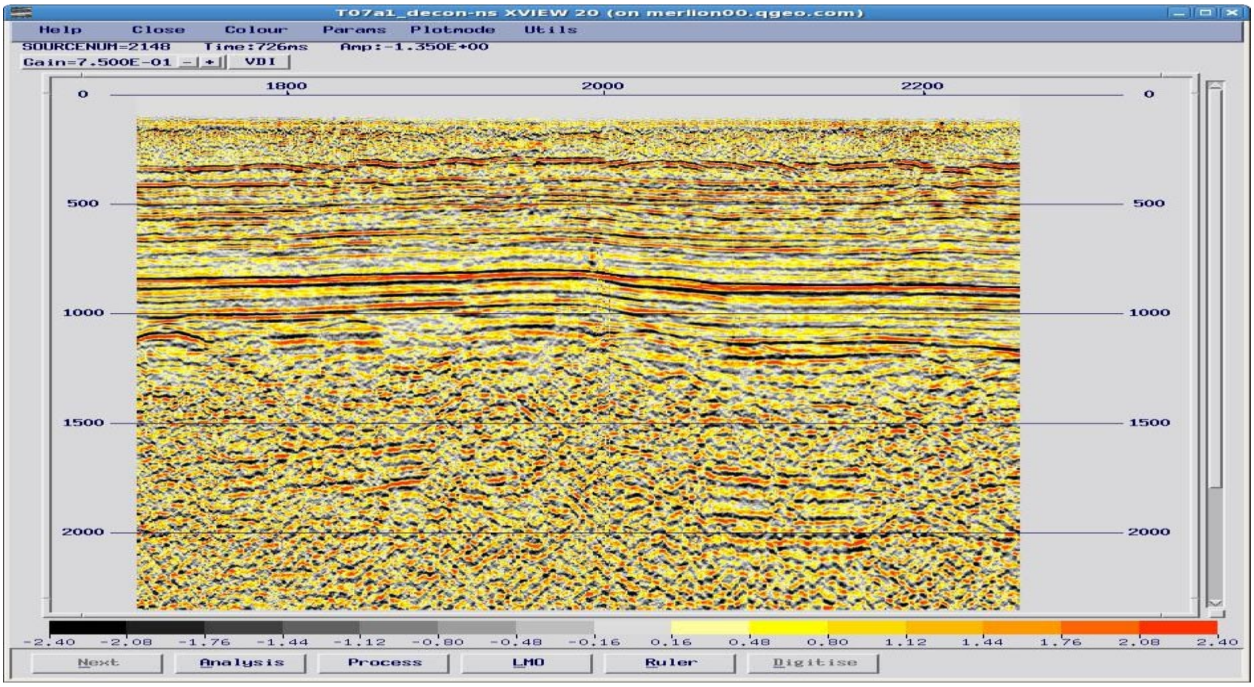
Surface consistent gap deconvolution, 4 ms gap, 100 ms operator, followed by spectral whitening (**2009-GEL-01)**



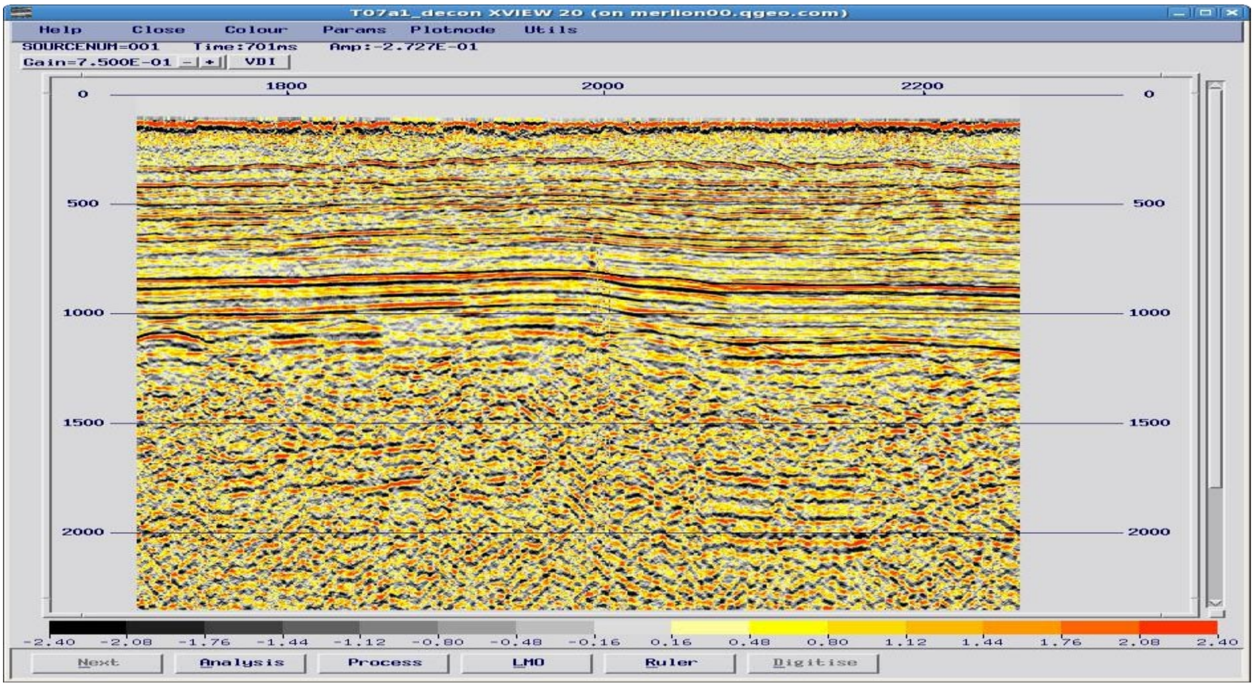
Surface consistent gap deconvolution, 6 ms gap, 100 ms operator (**2009-GEL-01)**



Surface consistent gap deconvolution, 6 ms gap, 100 ms operator, followed by spectral whitening (**2009-GEL-01)**



Surface consistent gap deconvolution, 8 ms gap, 100 ms operator (**2009-GEL-01)**



Surface consistent gap deconvolution, 8 ms gap, 100 ms operator, followed by spectral whitening (**<u>2009-GEL-01)</u>**

Test 8: Deconvolution operator length (source record displays)

Test Line 2009-GEL-01

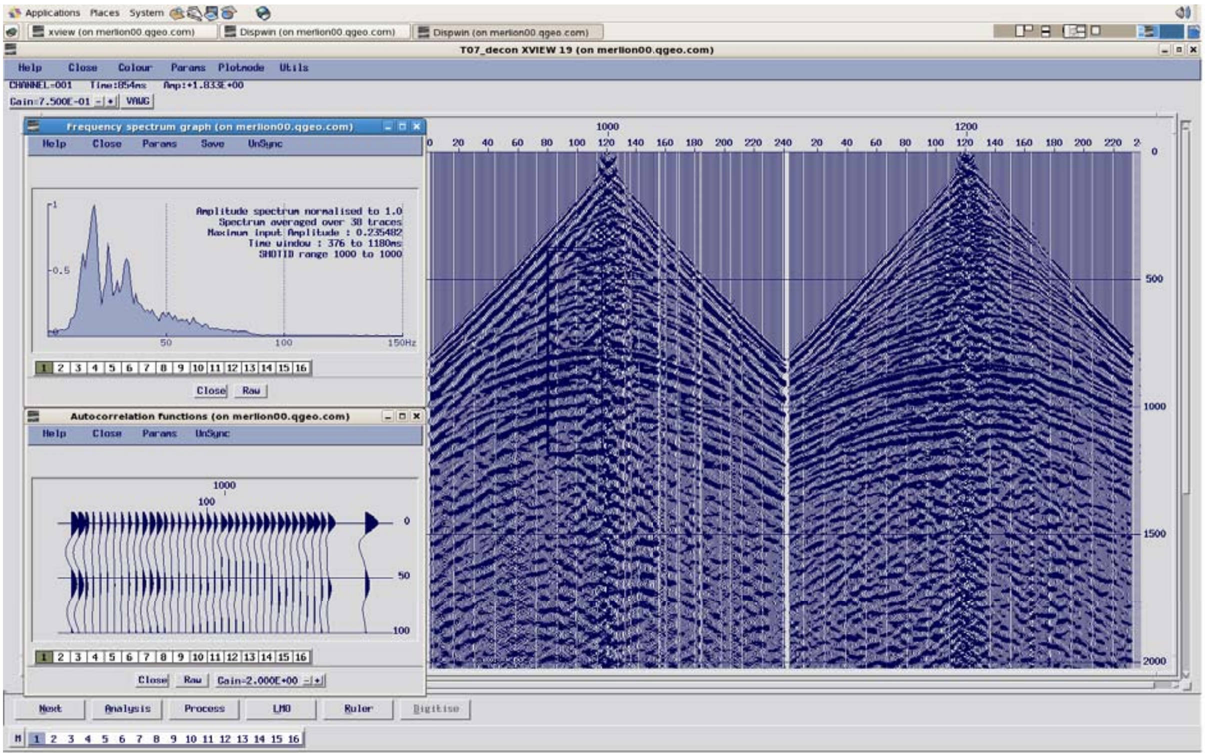
Objective:
To determine an optimum deconvolution operator length.

Procedure:
Surface consistent spiking deconvolution was applied to a set of records from the test line following noise attenuation. The operator length was varied.
Additionally, the effect of post-deconvolution spectral whitening was tested.
For each case, the autocorrelations and spectra are shown.

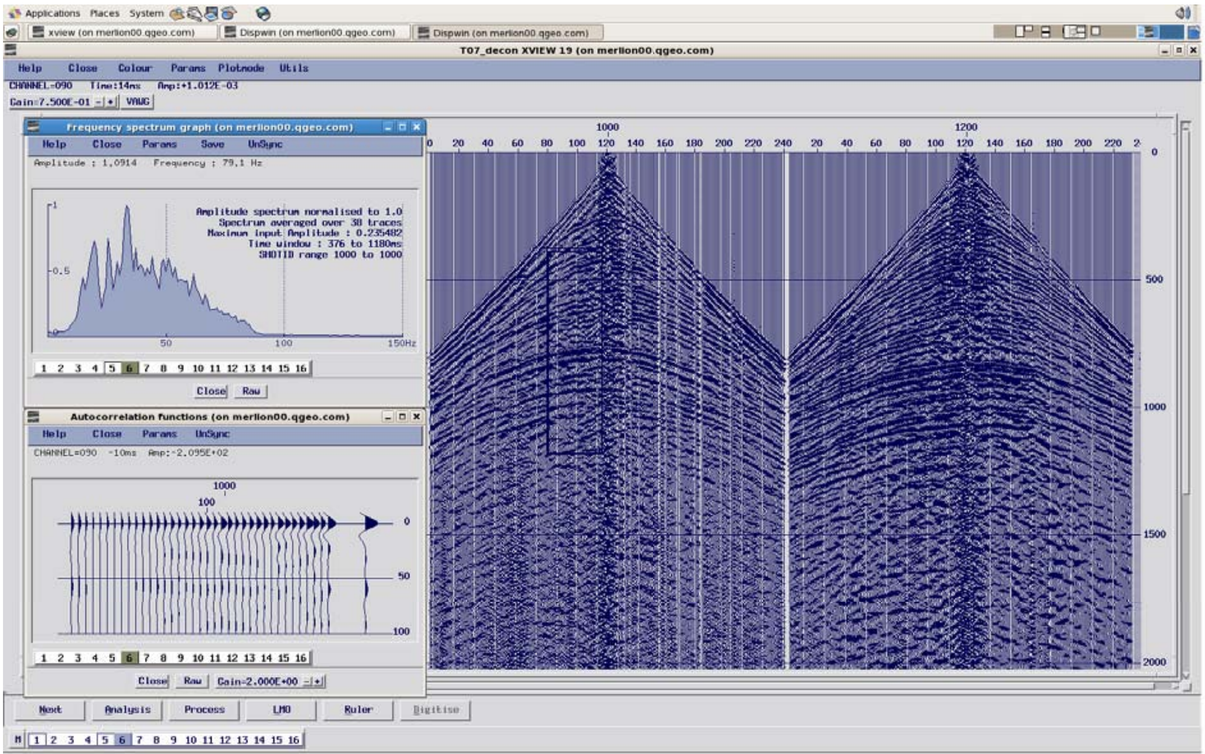
Comment:
An 80 ms operator length seems optimum.

Processing flow for source records in Test 8

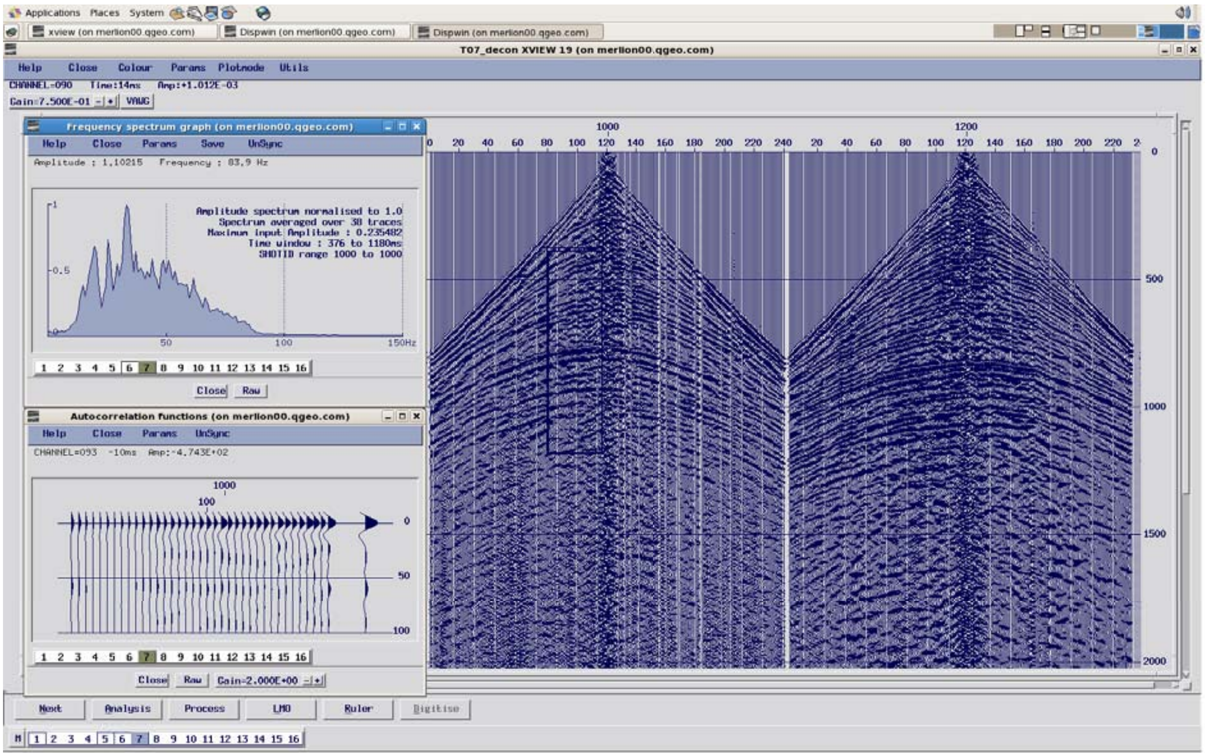
- Reformat SEG-Y data to Claritas internal format
- Resample to 2 ms
- Minimum phasing filter
- Spherical divergence correction (rough velocities), $G(T)=V^2T^{1.4}$
- AGC, 500 ms operator
- F-K filter, with cut-velocities as shown
- Remove AGC
- Coherent noise attenuation and air blast attenuation
- **Surface consistent spiking deconvolution, various operator lengths**
- **Spectral whitening (or null)**
- Bandpass filter, 10 – 90 Hz



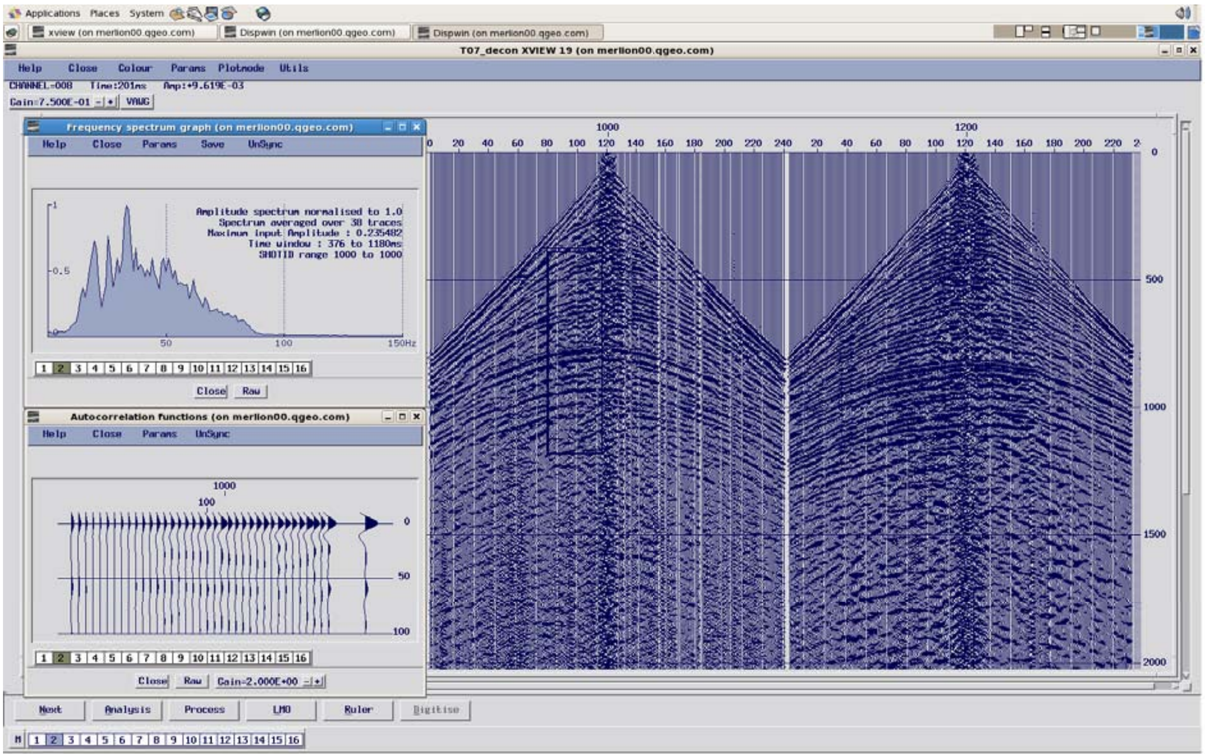
No deconvolution



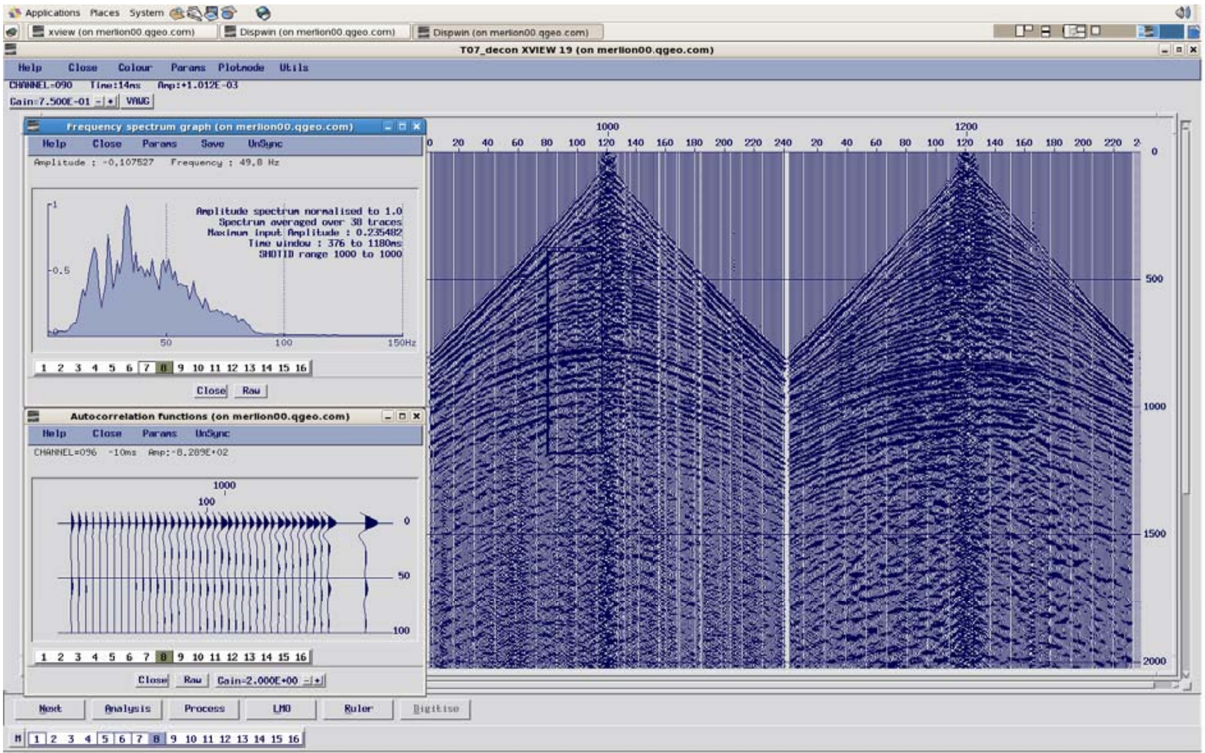
Surface consistent spiking deconvolution, 60 ms operator



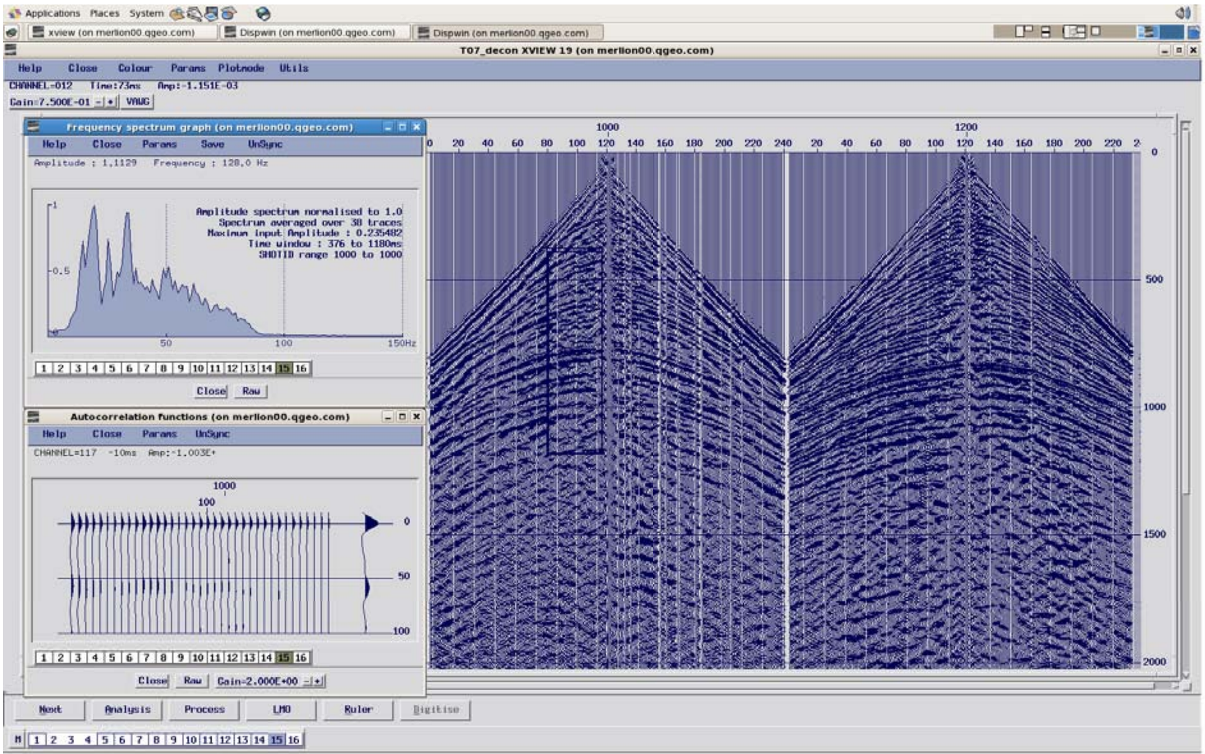
Surface consistent spiking deconvolution, 80 ms operator



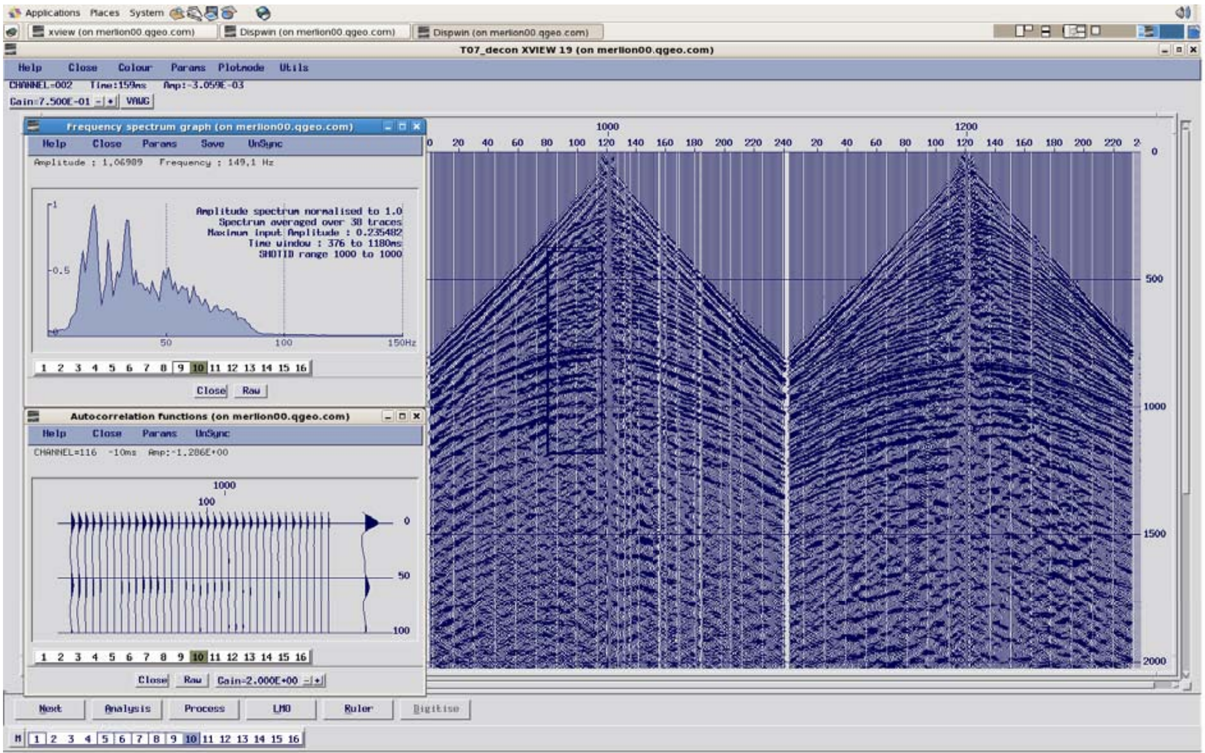
Surface consistent spiking deconvolution, 100 ms operator



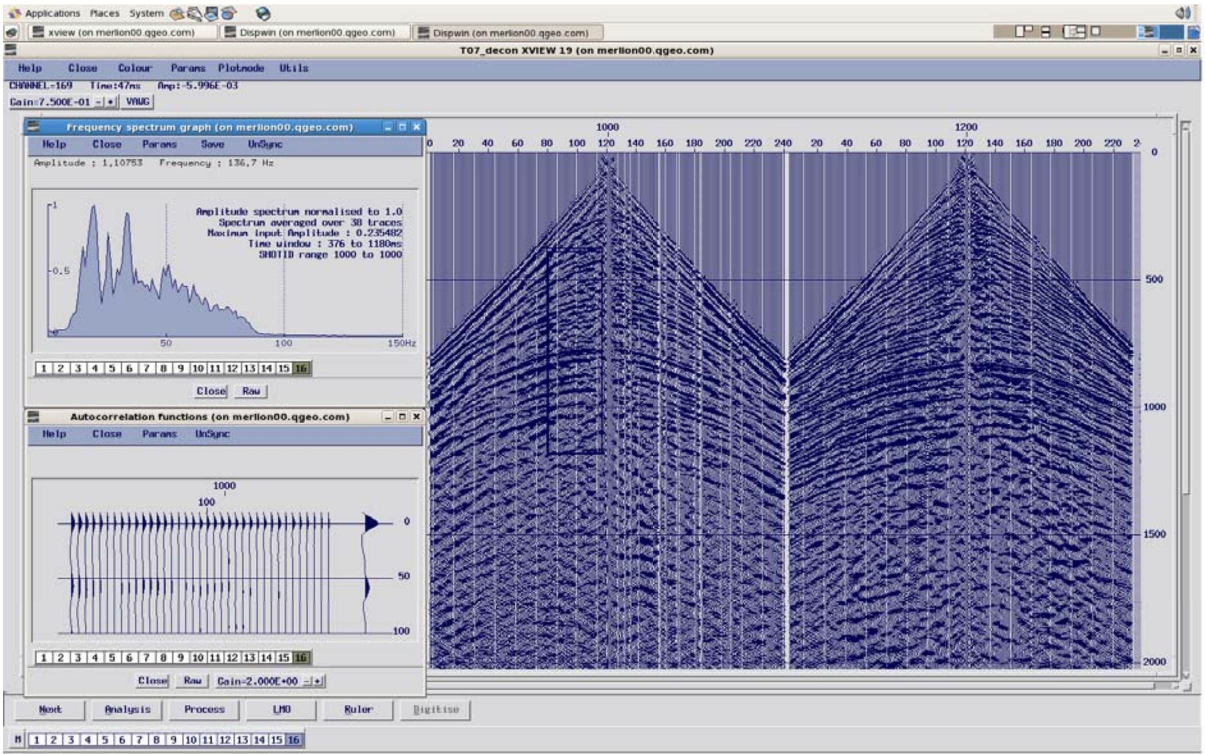
Surface consistent spiking deconvolution, 120 ms operator



Surface consistent spiking deconvolution, 80 ms operator, followed by spectral whitening



Surface consistent spiking deconvolution, 100 ms operator, followed by spectral whitening



Surface consistent spiking deconvolution, 120 ms operator, followed by spectral whitening

Test 8a: Deconvolution operator length (stack displays)

Test Line 2009-GEL-01

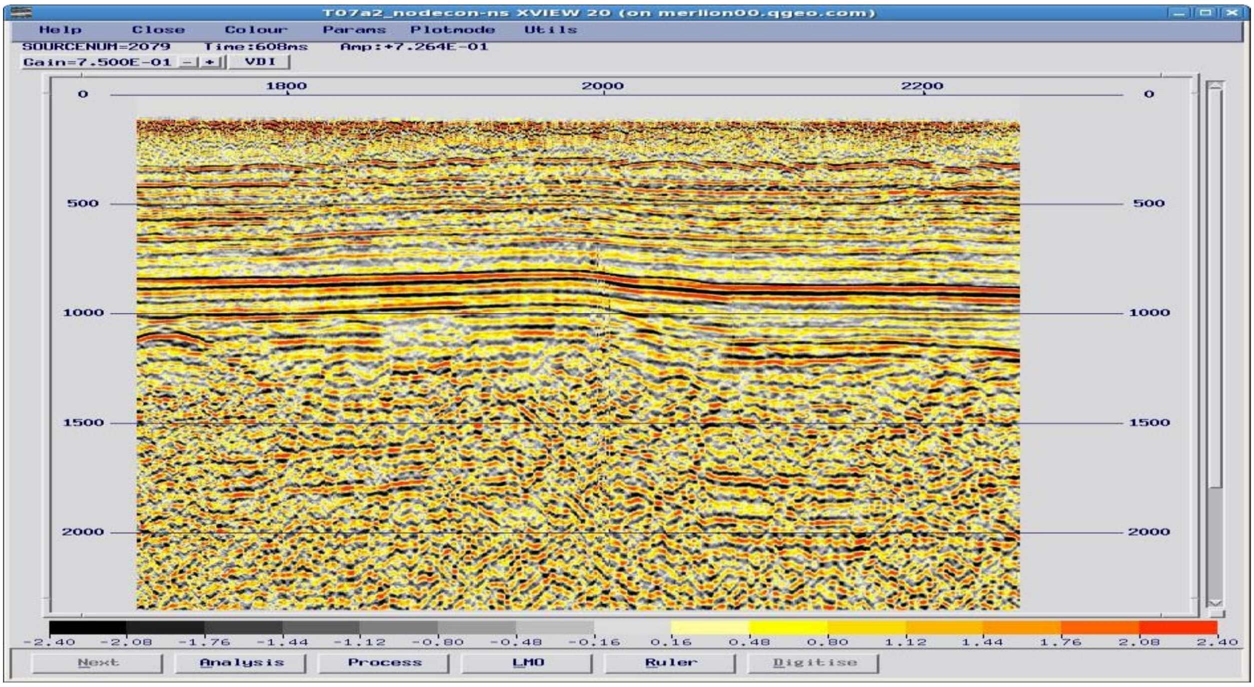
Objective:
To determine an optimum deconvolution operator length.

Procedure:
Surface consistent deconvolution, with various operator lengths, was applied in the creation of stacks.
Additionally, the effect of post-deconvolution spectral whitening was tested.

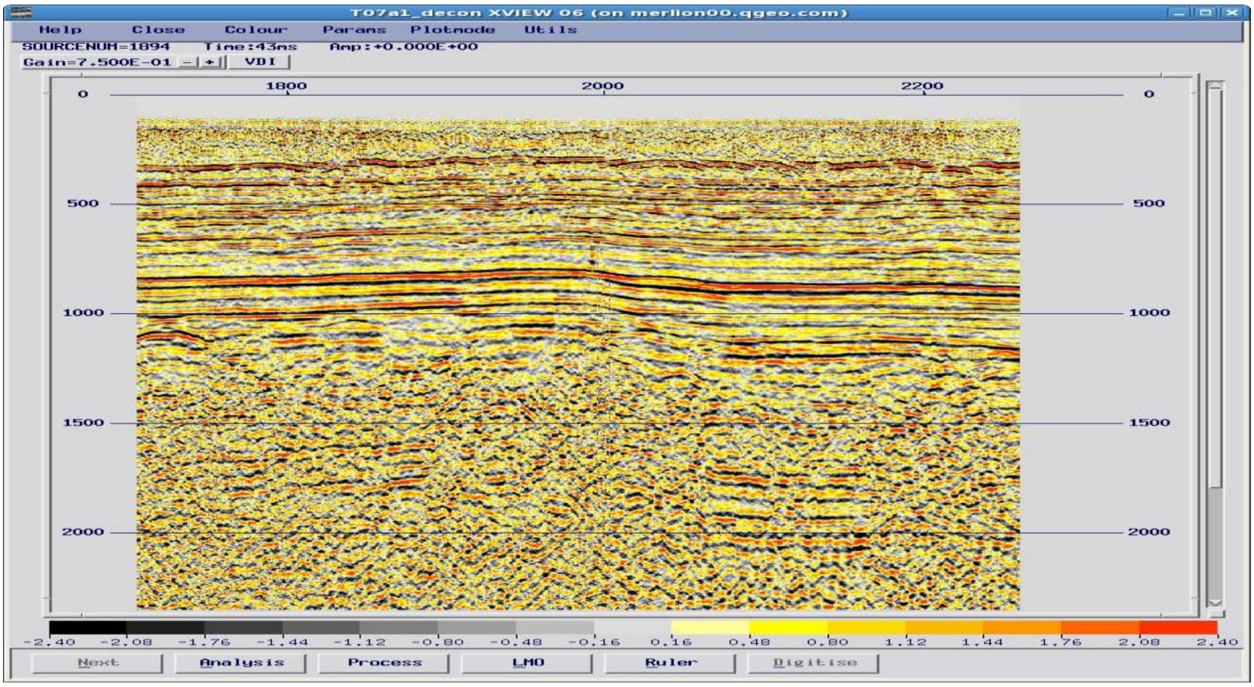
Comment:
An 80 ms operator length seems optimum.

Processing flow for stacks in Test 8a

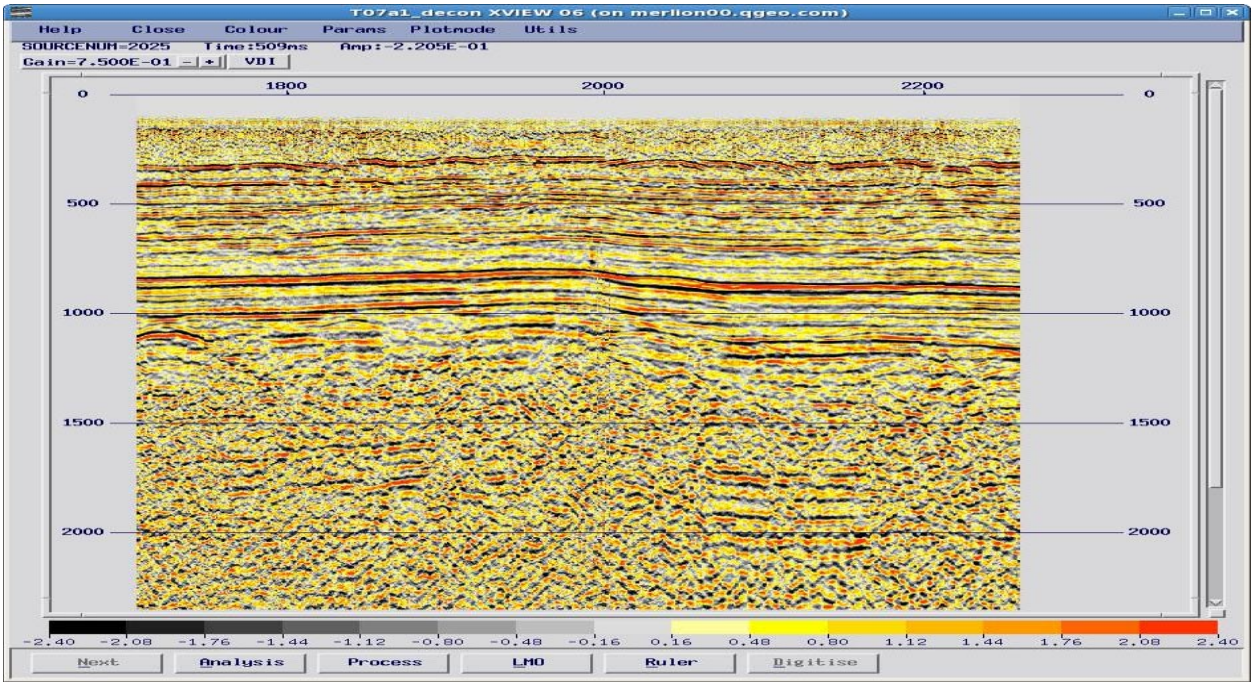
- Reformat SEG-Y data to Claritas internal format
- Resample to 2 ms
- Minimum phasing filter
- Spherical divergence correction (rough velocities), $G(T)=V^2T^{1.4}$
- AGC, 500 ms operator
- F-K filter, with cut-velocities as shown
- Remove AGC
- Coherent noise attenuation and air blast attenuation
- **Surface consistent spiking deconvolution, operator length as shown**
- **Spectral whitening (or null)**
- Refraction statics application
- NMO, 40% stretch mute, (rough velocities)
- AGC, 500 ms operator
- Stack, shift to final datum
- Mild coherency filter
- Bandpass filter, 10 – 90 Hz



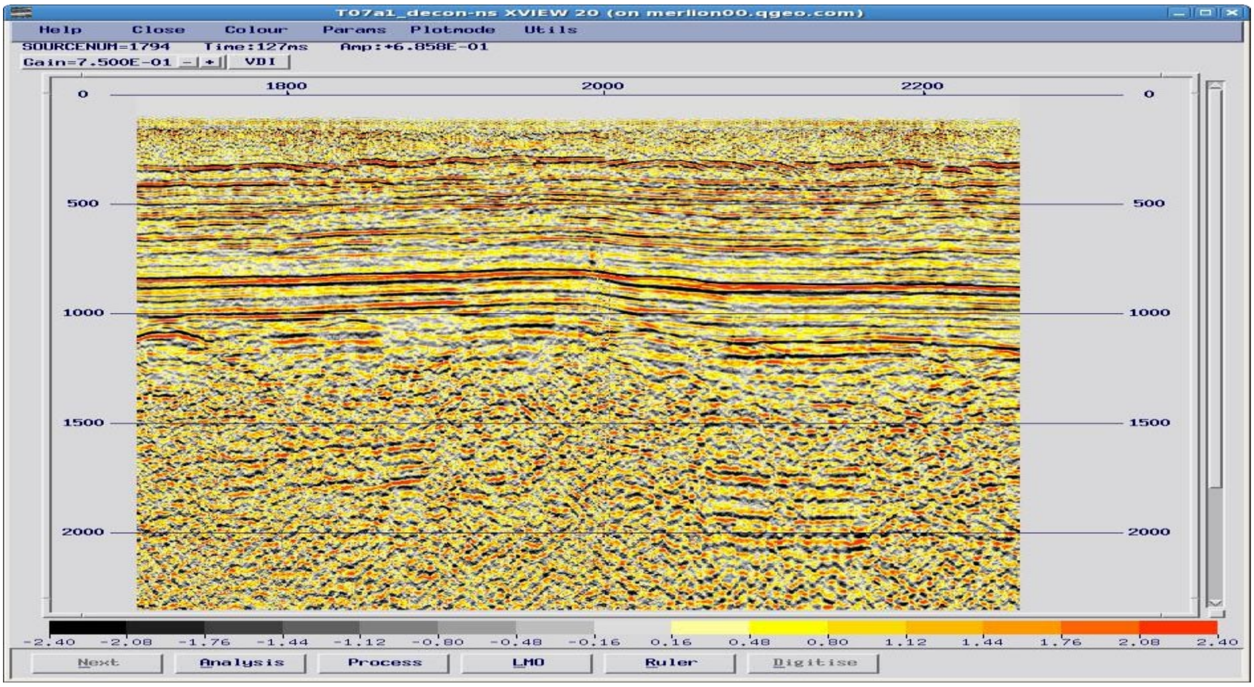
No deconvolution (**<u>2009-GEL-01)</u>**



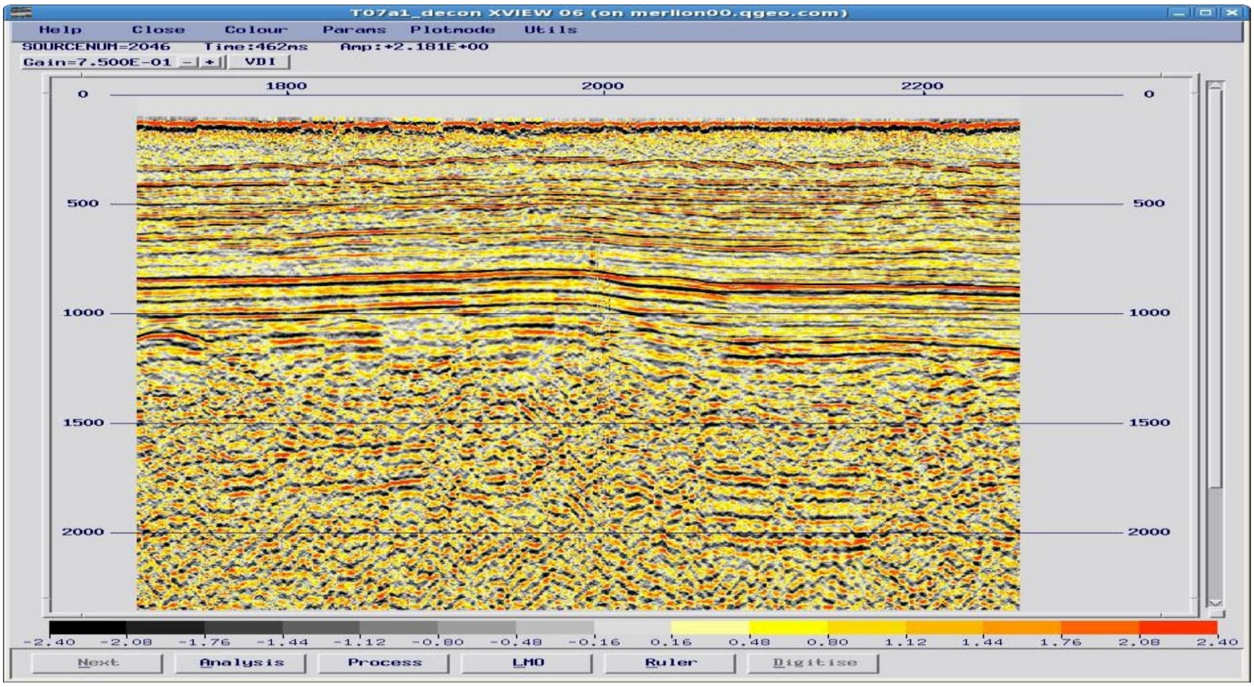
Surface consistent spiking deconvolution, 60 ms operator (**<u>2009-GEL-01)</u>**



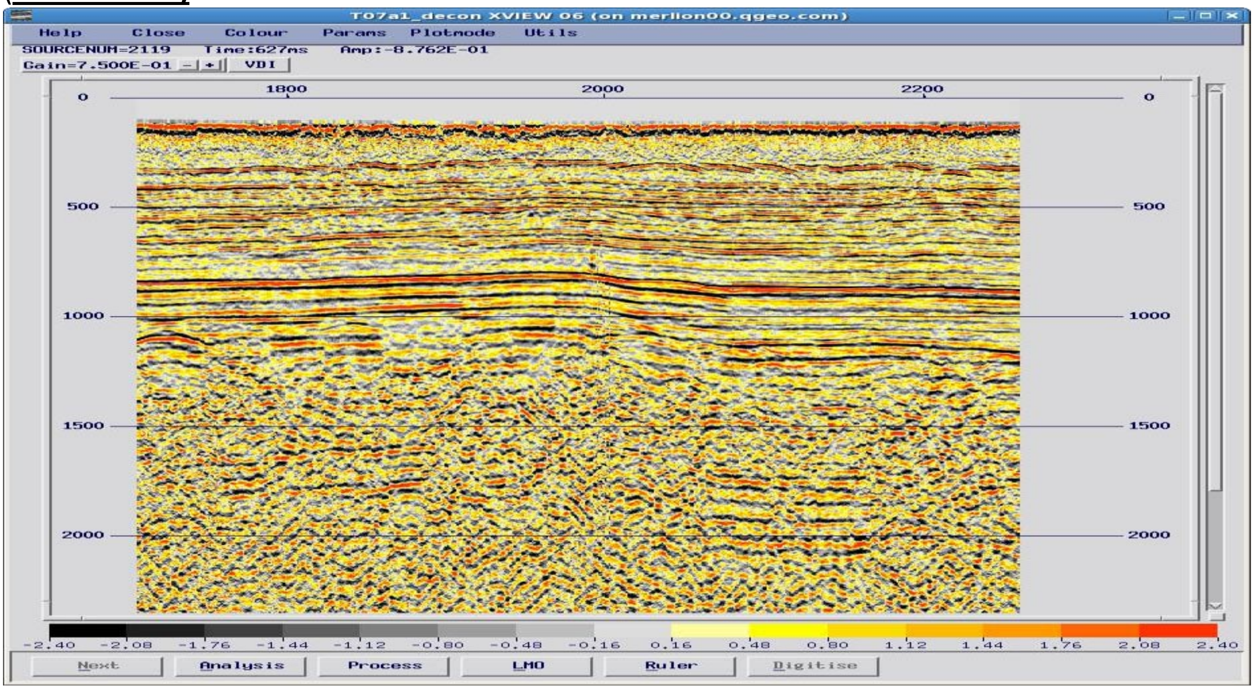
Surface consistent spiking deconvolution, 80 ms operator (**2009-GEL-01)**



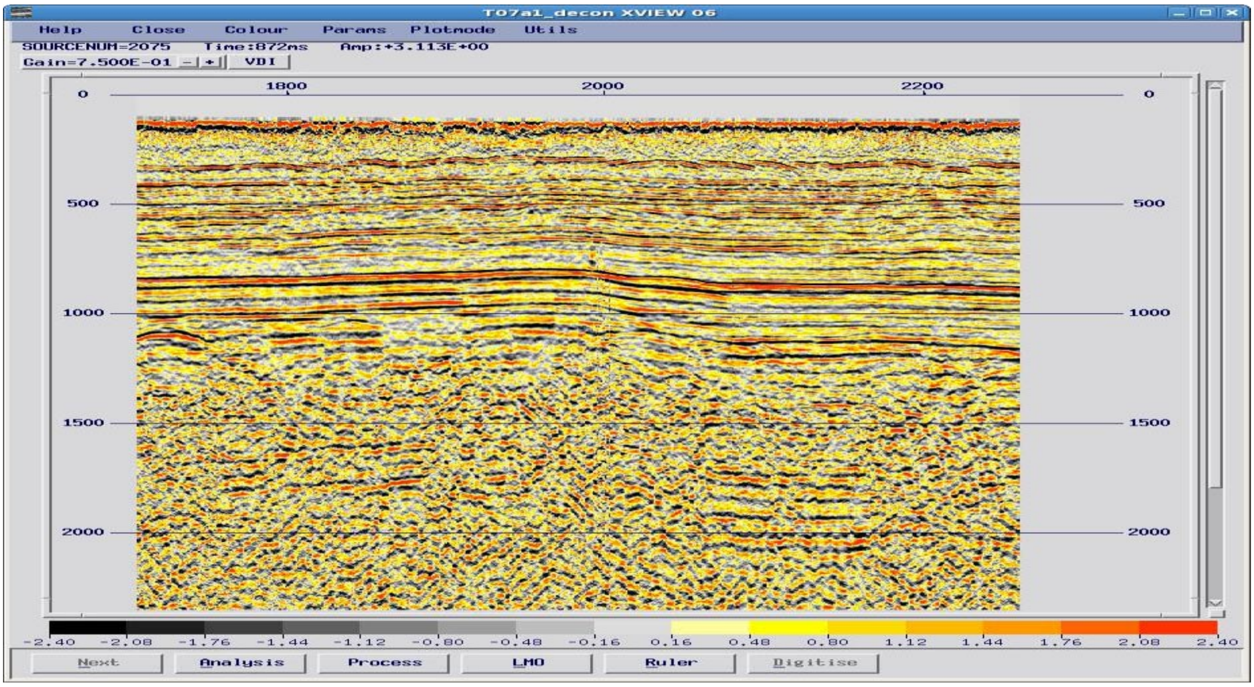
Surface consistent spiking deconvolution, 100 ms operator (**2009-GEL-01)**



Surface consistent spiking deconvolution, 60 ms operator, followed by spectral whitening (**<u>2009-GEL-01)</u>**



Surface consistent spiking deconvolution, 80 ms operator, followed by spectral whitening (**<u>2009-GEL-01)</u>**



Surface consistent spiking deconvolution, 100 ms operator, followed by spectral whitening (**2009-GEL-01)**

Test 10: Stretch mute

Test Line 2009-GEL-01

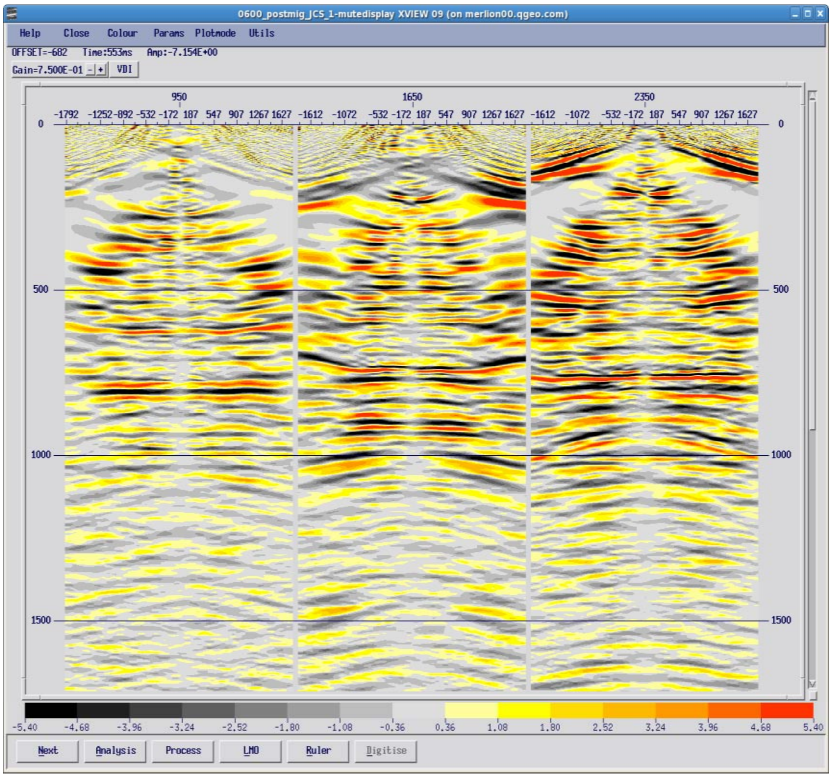
Objective:
To determine an appropriate final mute.

Discussion:
A subset of CDP gathers from the test lines were subject to various stretch mutes in order to aid the decision on a final stretch mute. The mute is chosen to include the maximum amount of useful reflection energy while excluding the overstretched or post-critical far-offset limbs of reflection events.
The decision is also made on the basis of stacked sections.

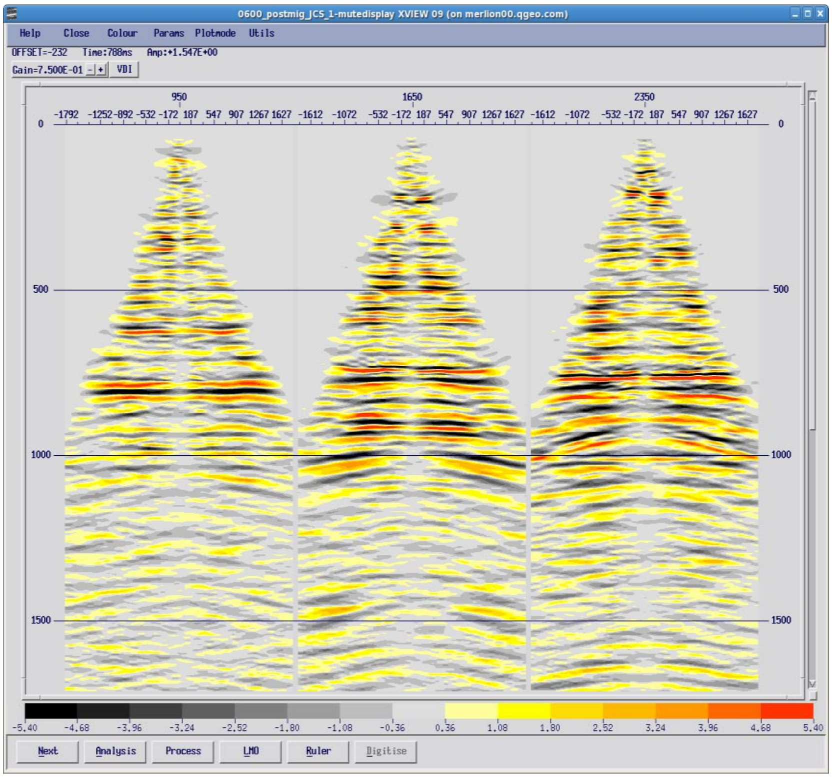
Comment:
A 25% stretch mute seems optimum.

Processing flow for gathers in Test 10

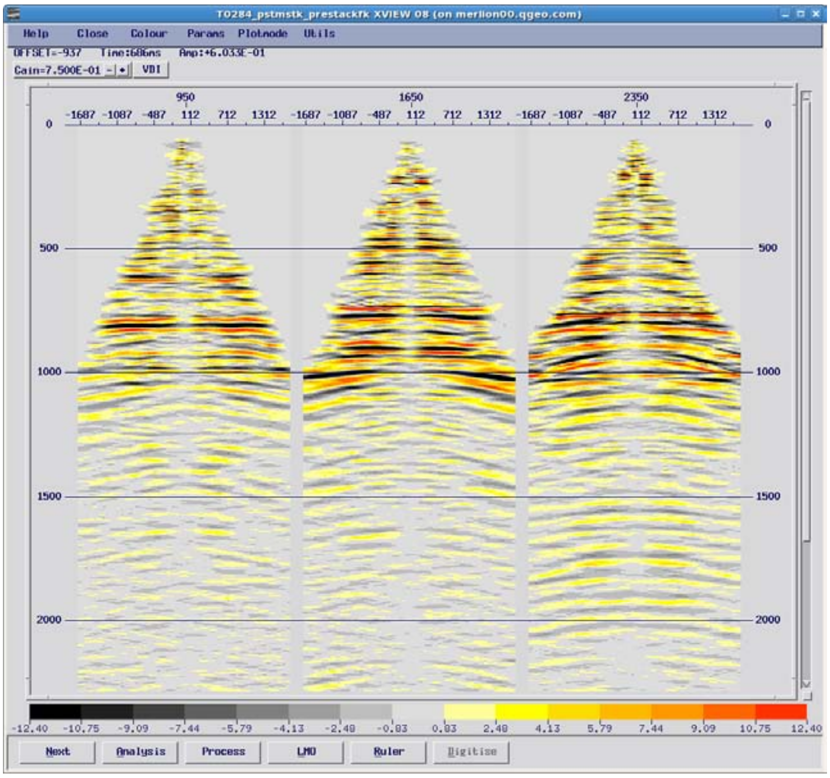
- Reformat SEG-Y data to Claritas internal format
- Resample to 2 ms
- Minimum phasing filter
- Spherical divergence correction, $G(T)=V^2T^{1.4}$
- AGC, 500 ms operator
- F-K filter, with cut-velocities as shown
- Remove AGC
- Coherent noise attenuation and air blast attenuation
- Surface consistent spiking deconvolution
- Spectral whitening
- Pre-stack Kirchhoff time migration (smoothed 2nd pass velocities)
- Inverse NMO on 2nd pass velocities
- Apply NMO on 3rd pass velocities
- **Mute (as shown)**
- F-K dip filter



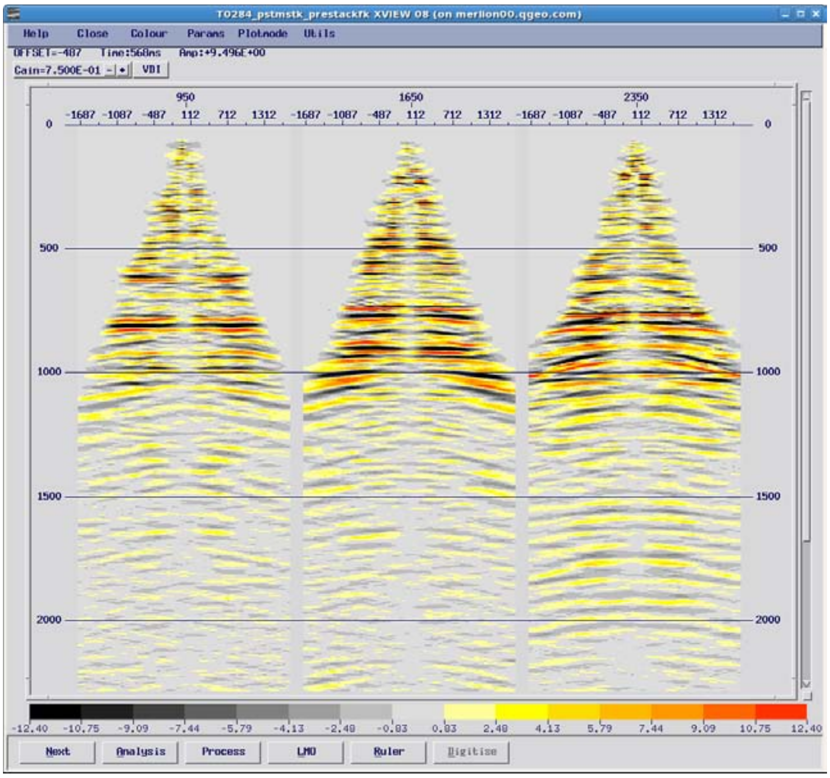
CDP gathers: No stretch mute



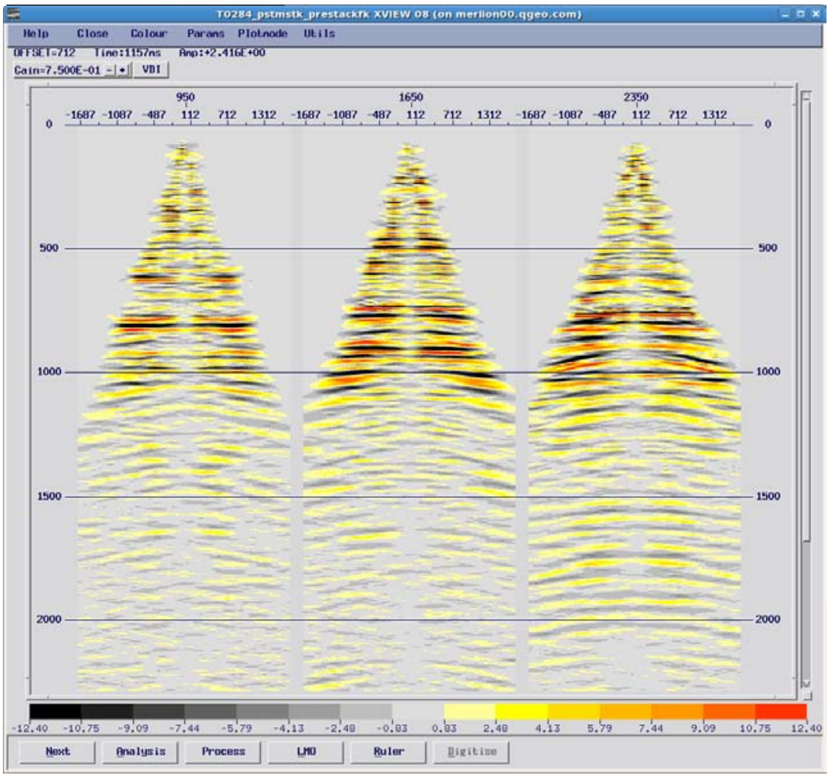
CDP gathers: 30% stretch mute



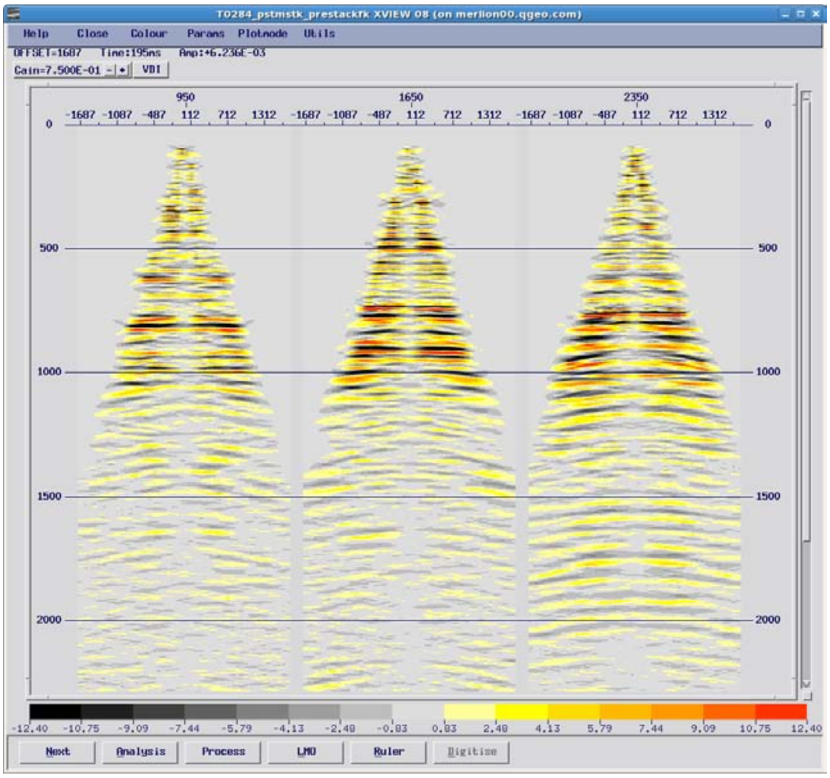
CDP gathers: 25% stretch mute



CDP gathers: 20% stretch mute



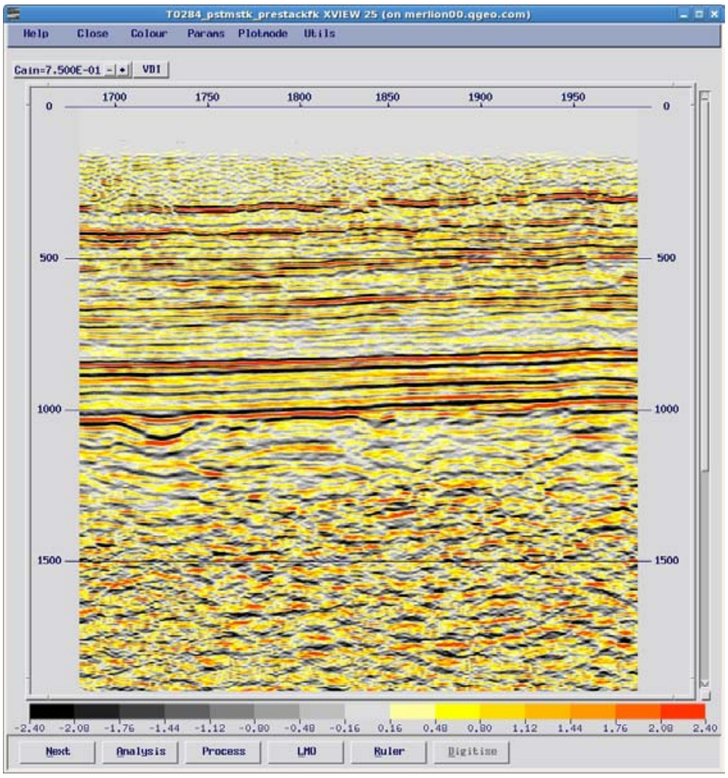
CDP gathers: 15% stretch mute



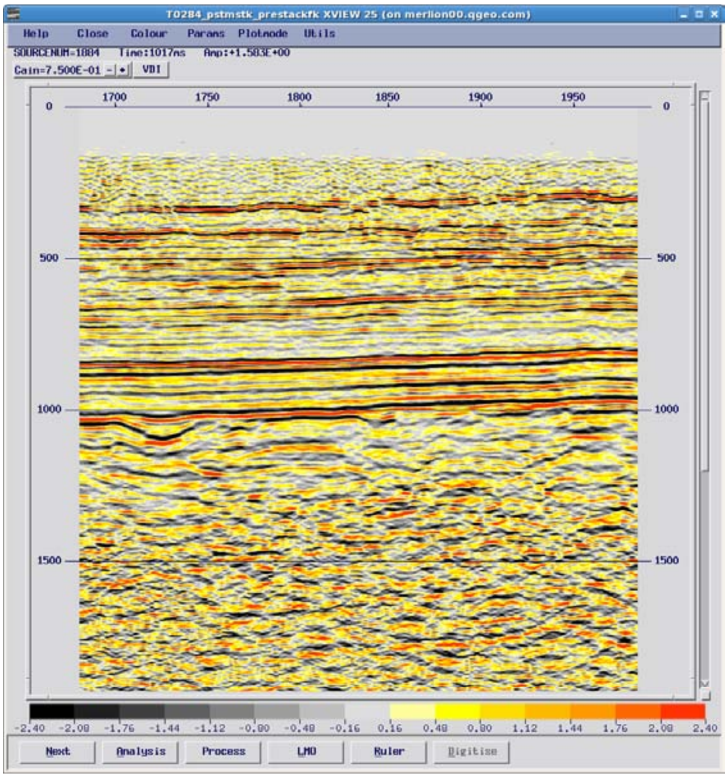
CDP gathers: 10% stretch mute

Processing flow for stacks in Test 10

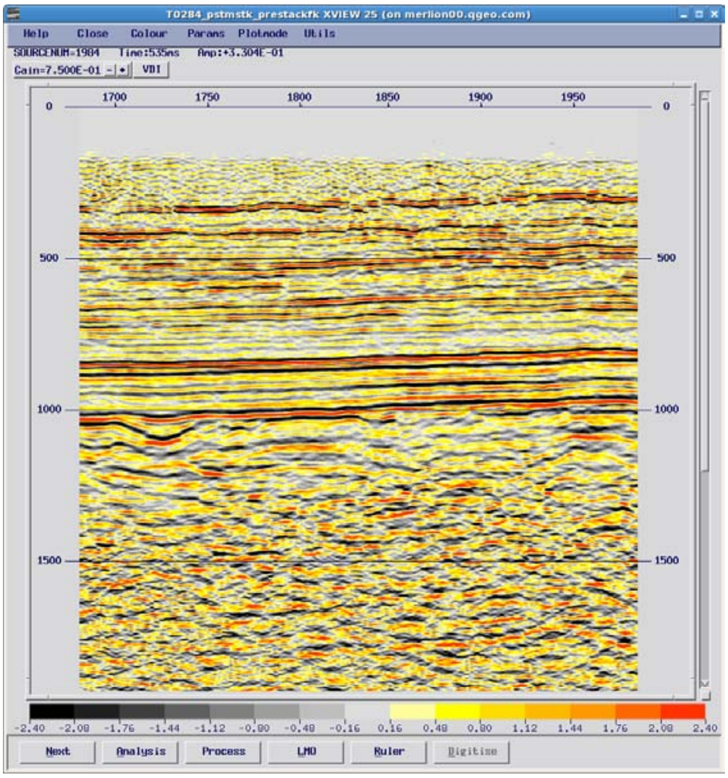
- Reformat SEG-Y data to Claritas internal format
- Resample to 2 ms
- Minimum phasing filter
- Spherical divergence correction, $G(T)=V^2T^{1.4}$
- AGC, 500 ms operator
- F-K filter, with cut-velocities as shown
- Remove AGC
- Coherent noise attenuation and air blast attenuation
- Surface consistent spiking deconvolution
- Spectral whitening
- Pre-stack Kirchhoff time migration (smoothed 2nd pass velocities)
- Inverse NMO on 2nd pass velocities
- Apply NMO on 3rd pass velocities
- **Mute (as shown)**
- F-K dip filter
- AGC, 500 ms operator
- Stack
- Post-stack spectral whitening and bandpass filter
- AGC, 500 ms operator



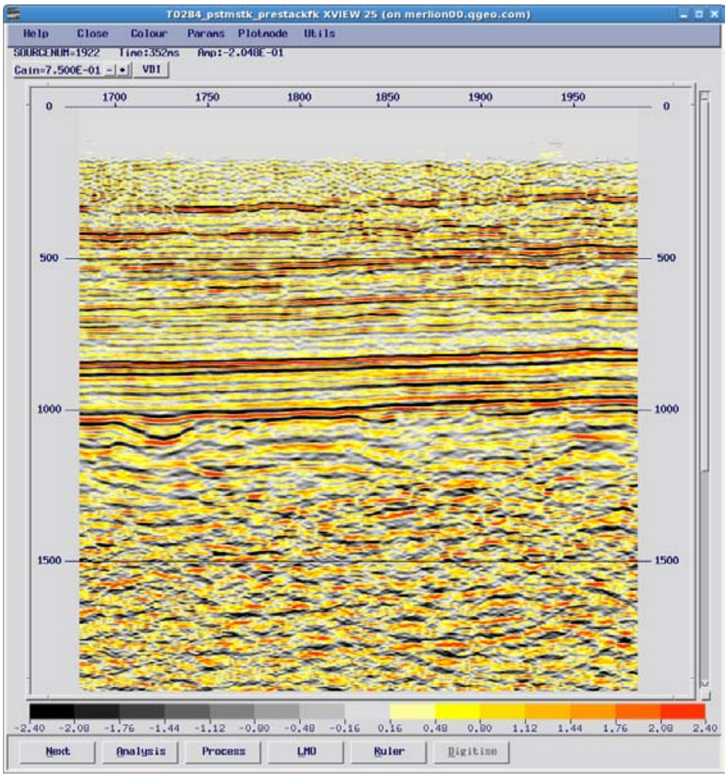
Stack: 30% stretch mute (**<u>2009-GEL-01 part)</u>**



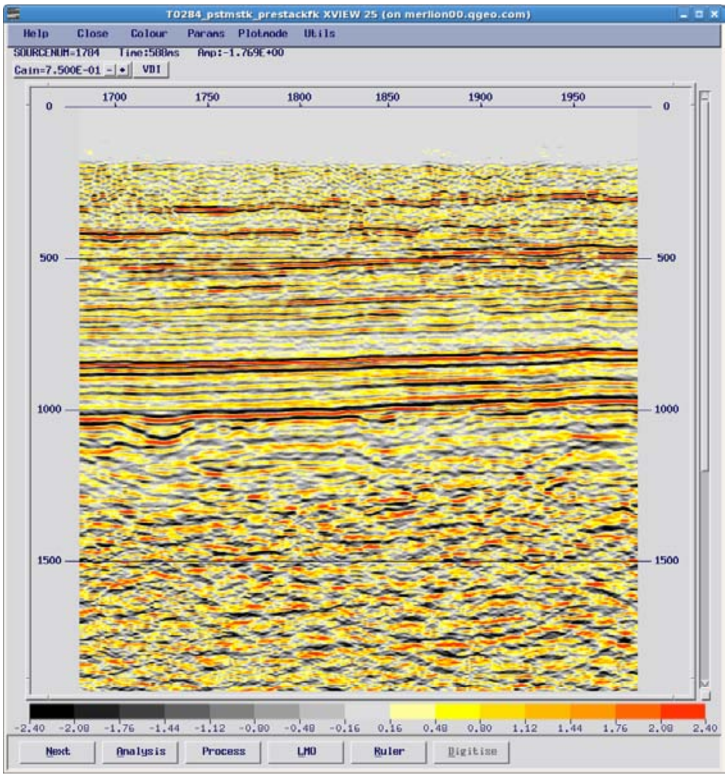
Stack: 25% stretch mute (**<u>2009-GEL-01 part)</u>**



Stack: 20% stretch mute (**<u>2009-GEL-01 part)</u>**



Stack: 15% stretch mute (**<u>2009-GEL-01 part)</u>**



Stack: 10% stretch mute (**2009-GEL-01 part)**

Test 10a: Inner mute

Test Line 2009-GEL-01

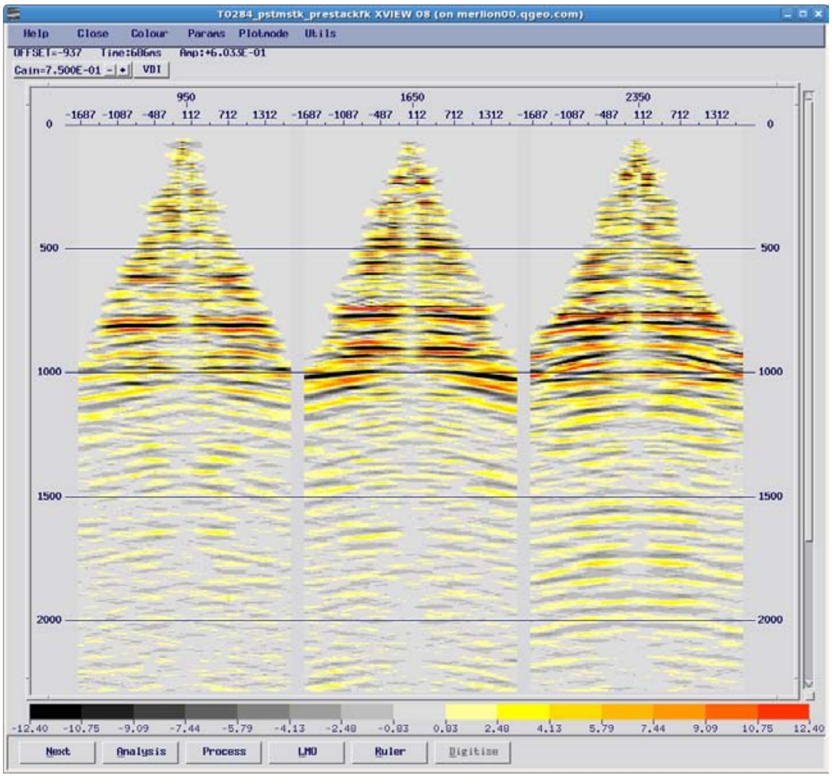
Objective:
To determine whether a deep inner mute will aid multiple attenuation.

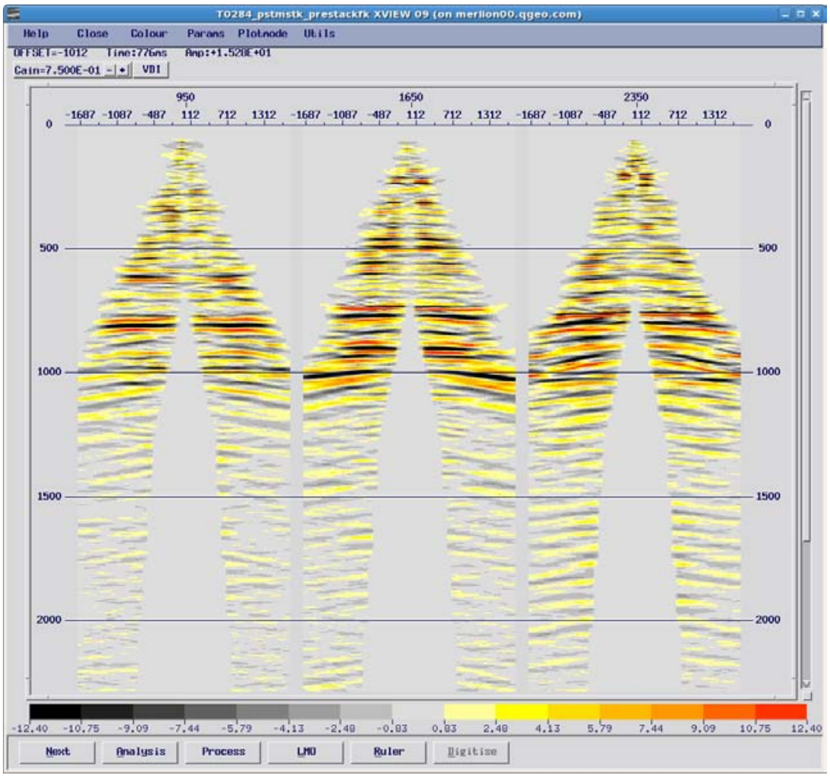
Discussion:
In CDP gathers moved-out with an appropriate velocity function, primary reflection events appear flat while multiple reflection events appear as hyperbolae. Stack attenuates multiples, relatively. An inner mute can further weaken the appearance of multiples in stacked sections, by removing that part of the multiple reflection event that is fairly flat.
The effect on stacked sections of a hand-picked inner mute is shown in these slides.

Comment:
It may be that the mute weakens the appearance of some deep multiples.

Processing flow for gathers in Test 10a

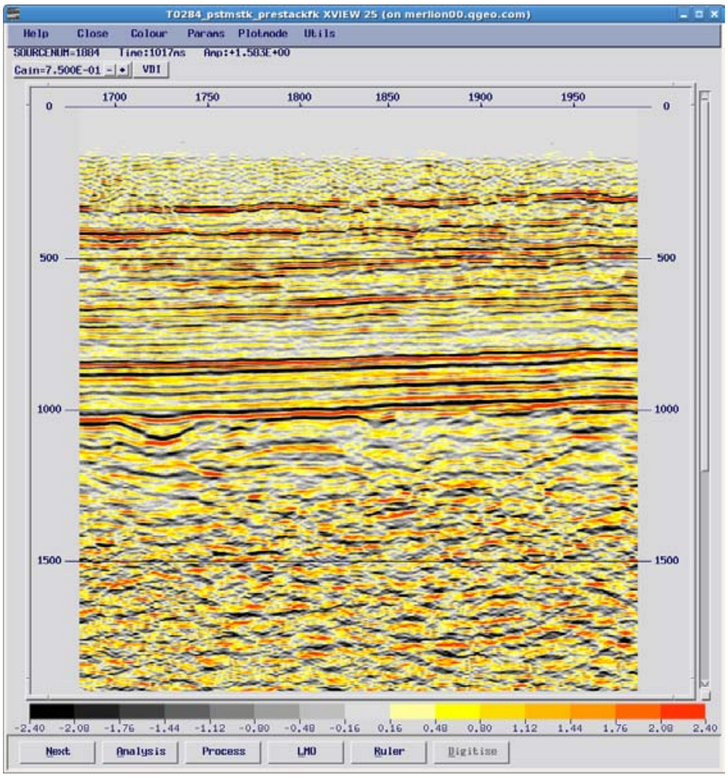
- Reformat SEG-Y data to Claritas internal format
- Resample to 2 ms
- Minimum phasing filter
- Spherical divergence correction, $G(T)=V^2T^{1.4}$
- AGC, 500 ms operator
- F-K filter, with cut-velocities as shown
- Remove AGC
- Coherent noise attenuation and air blast attenuation
- Surface consistent spiking deconvolution
- Spectral whitening
- Pre-stack Kirchhoff time migration (smoothed 2nd pass velocities)
- Inverse NMO on 2nd pass velocities
- Apply NMO on 3rd pass velocities , with 25% stretch mute
- **Inner mute (as shown)**
- F-K dip filter


CDP gathers: 25% stretch mute

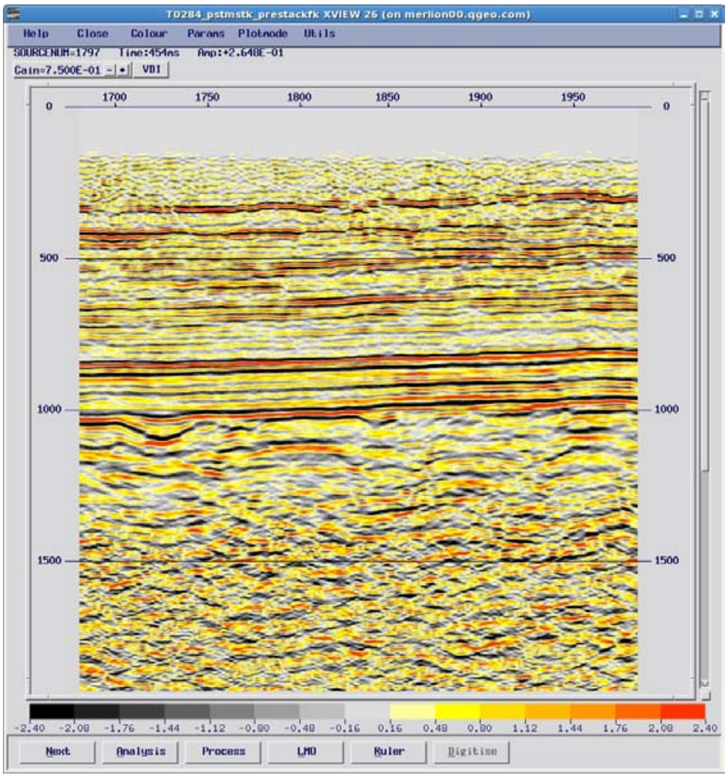

CDP gathers: 25% stretch mute and inner mute

Processing flow for stacks in Test 10a

- Reformat SEG-Y data to Claritas internal format
- Resample to 2 ms
- Minimum phasing filter
- Spherical divergence correction, $G(T)=V^2T^{1.4}$
- AGC, 500 ms operator
- F-K filter, with cut-velocities as shown
- Remove AGC
- Coherent noise attenuation and air blast attenuation
- Surface consistent spiking deconvolution
- Spectral whitening
- Pre-stack Kirchhoff time migration (smoothed 2nd pass velocities)
- Inverse NMO on 2nd pass velocities
- Apply NMO on 3rd pass velocities, 25% stretch mute
- **Inner mute (as shown)**
- F-K dip filter
- AGC, 500 ms operator
- Stack
- Post-stack spectral whitening and bandpass filter
- AGC, 500 ms operator



Stack: 25% stretch mute (**<u>2009-GEL-01 part)</u>**



Stack: 25% stretch mute and inner mute (**<u>2009-GEL-01 part)</u>**

Test 12: Constant basement interval velocity tests

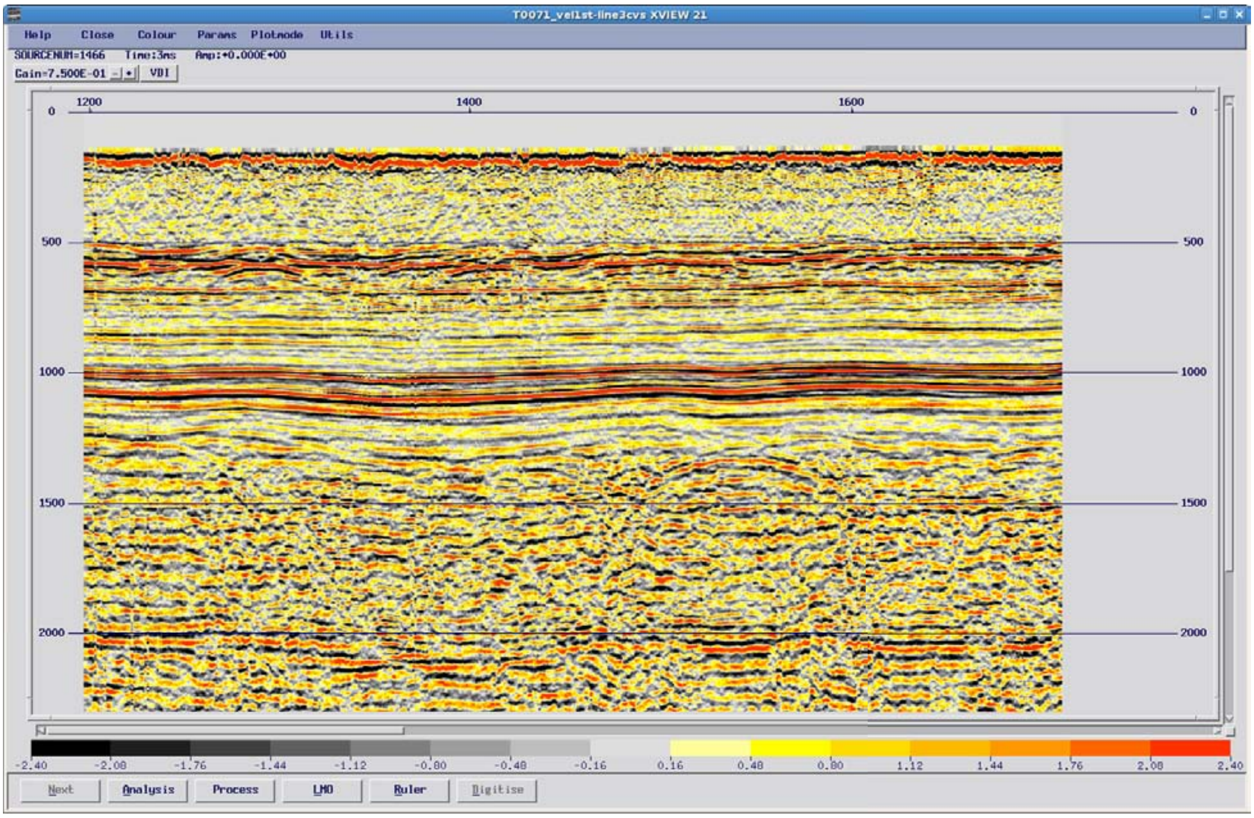
Test Line 2009-GEL-03

Discussion:
Multiple reflections from the target horizons are strong in line 03. In order to determine an appropriate basement velocity, and hence hopefully minimise the appearance of the multiples, a series a constant basement interval velocity stacks were created on a subsection of line 03. The velocity functions were edited such that below 1250 ms, the interval velocity was a constant (4000 m/s, 4500 m/s, 5000 m/s or 5500 m/s.)

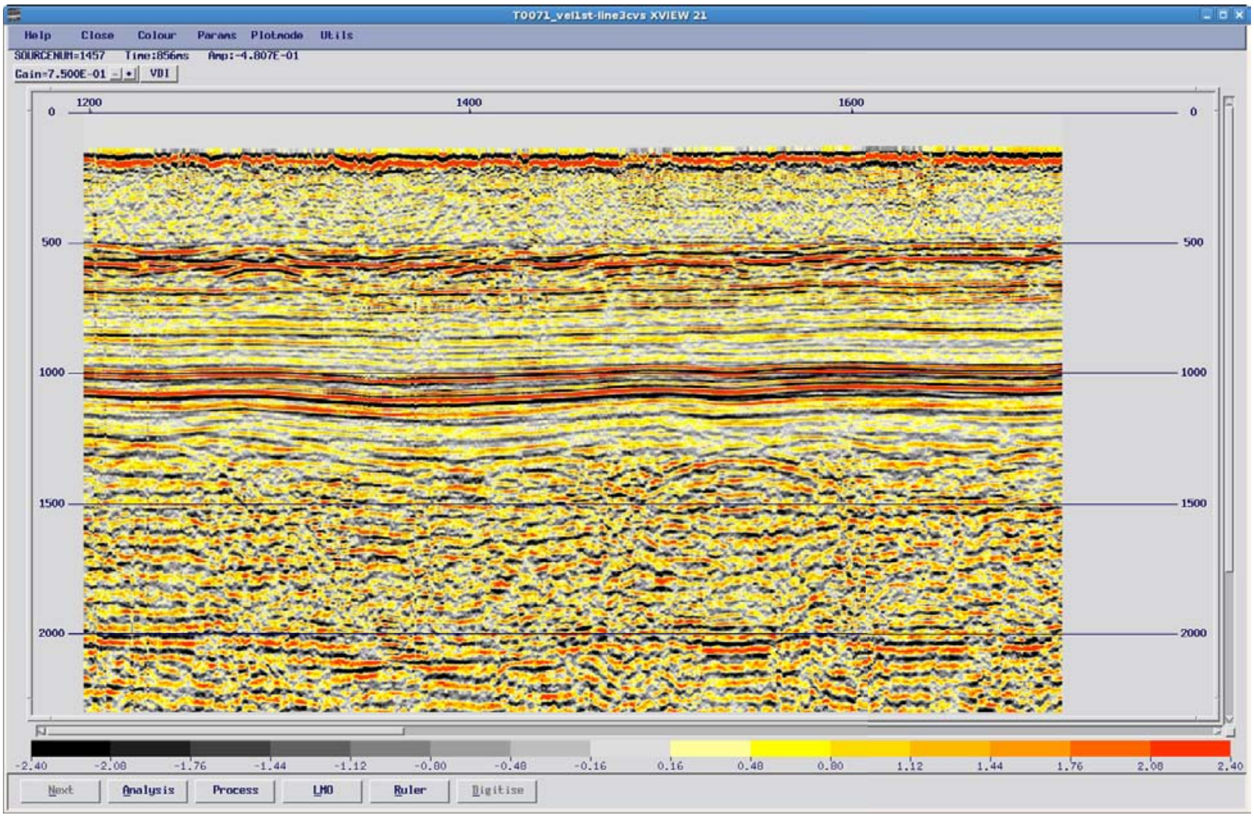
Comment:
Though a fairly fast basement interval velocity may be appropriate (~5000 m/s), the deep multiples appear fairly resilient, and increasing the basement velocity does not appear to bring any new primary reflection information to light.

Processing flow for stacks in Test 12

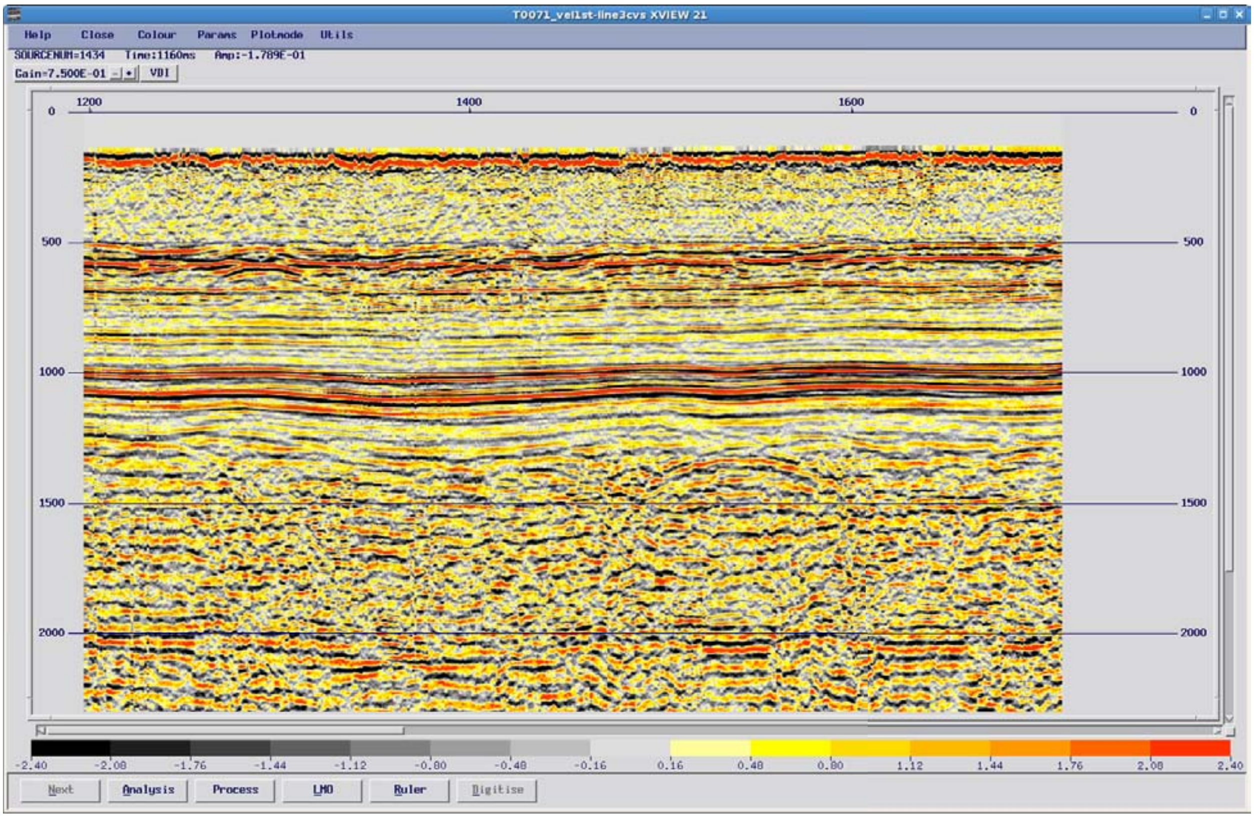
- Reformat SEG-Y data to Claritas internal format
- Resample to 2 ms
- Minimum phasing filter
- Spherical divergence correction, $G(T)=V^2T^{1.4}$
- AGC, 500 ms operator
- F-K filter, with cut-velocities as shown
- Remove AGC
- Coherent noise attenuation and air blast attenuation
- Surface consistent spiking deconvolution
- Spectral whitening
- **Apply NMO on 1st pass velocities, 25 % stretch mute, with basement velocities altered as shown**
- AGC, 500 ms operator
- Stack
- Bandpass filter
- AGC, 500 ms operator



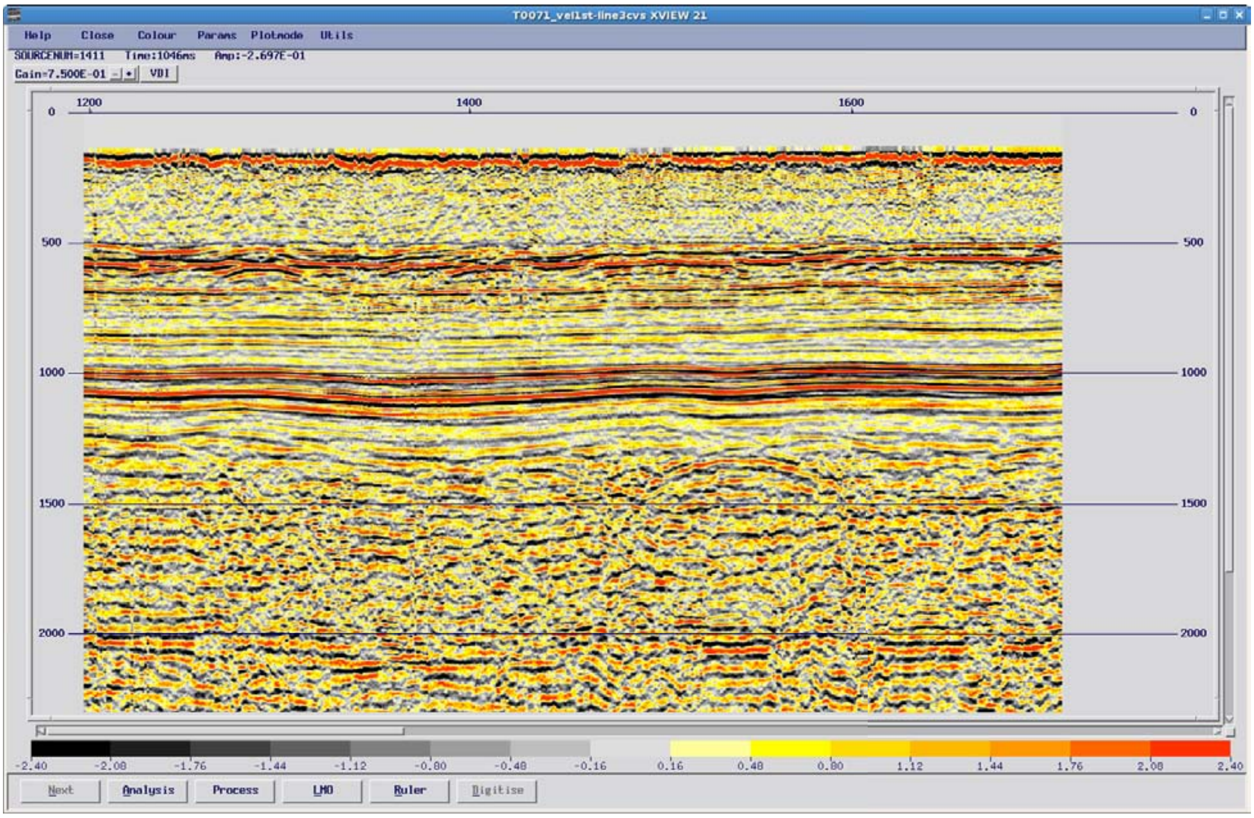
Basement interval velocity: 4000 m/s (**<u>2009-GEL-03)</u>**



Basement interval velocity: 4500 m/s (**<u>2009-GEL-03)</u>**



Basement interval velocity: 5000 m/s (**<u>2009-GEL-03)</u>**



Basement interval velocity: 5500 m/s (**<u>2009-GEL-03)</u>**