

GLOBE *Claritas*

seismic processing software



2D MARINE TUTORIAL

VERSION 6.8



Connect. Build. Grow.

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1 Getting Started

This tutorial is designed to get you up and running quickly with the GLOBE Claritas™ seismic data processing package. It's based around a 2D marine seismic line from offshore Taranaki, New Zealand. While it is straight forward enough for inexperienced processors to get good results, there are also enough challenges to make it interesting for more experienced people.

As well as this document, you will need:

- To have installed GLOBE Claritas V6.8 or higher
- The Marine Tutorial dataset V68_2DMarine.ca, in a suitable folder on your system

If you are missing either of these, please contact claritas.support@gns.cri.nz

2 The Launcher, Getting Started with Projects and Finding Help

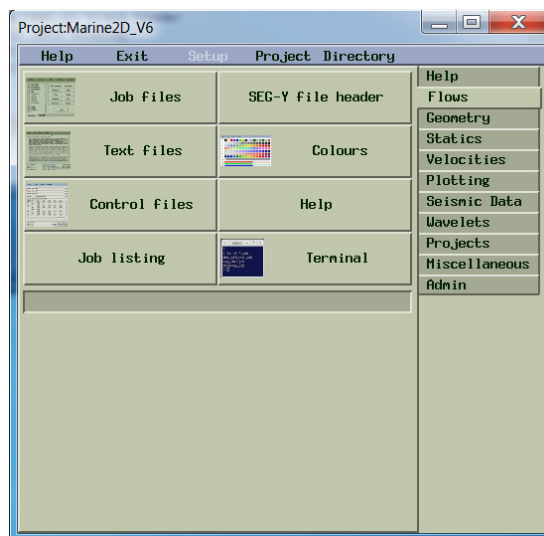
2.1 The Launcher

GLOBE Claritas™ is a suite of applications and utilities for analysing and processing seismic data. These tools all read and write a common set of formats, which are based on “open standards” like SEG-Y, HDF5 and ASCII. There is no underpinning database, and so other applications can read these files directly.

You can get access to all the applications and utilities via the Launcher.

On the Windows operating system you can start the Launcher by **clicking on the GLOBE Claritas™ icon** on the desktop; on Linux simply type **'launcher'** at the prompt in a terminal window.

The Launcher tabs (down the right side) allow you to select the different types of application or utility. In some cases, the same application may be under several tabs but operating in different modes.



The GLOBE Claritas™ Launcher.

Q. Do I have to use the Launcher?

A. No, you don't. You can also start applications and utilities from the command line or prompt if you want to. The launcher does help you to manage your data by grouping it into "Projects", so it is recommended.

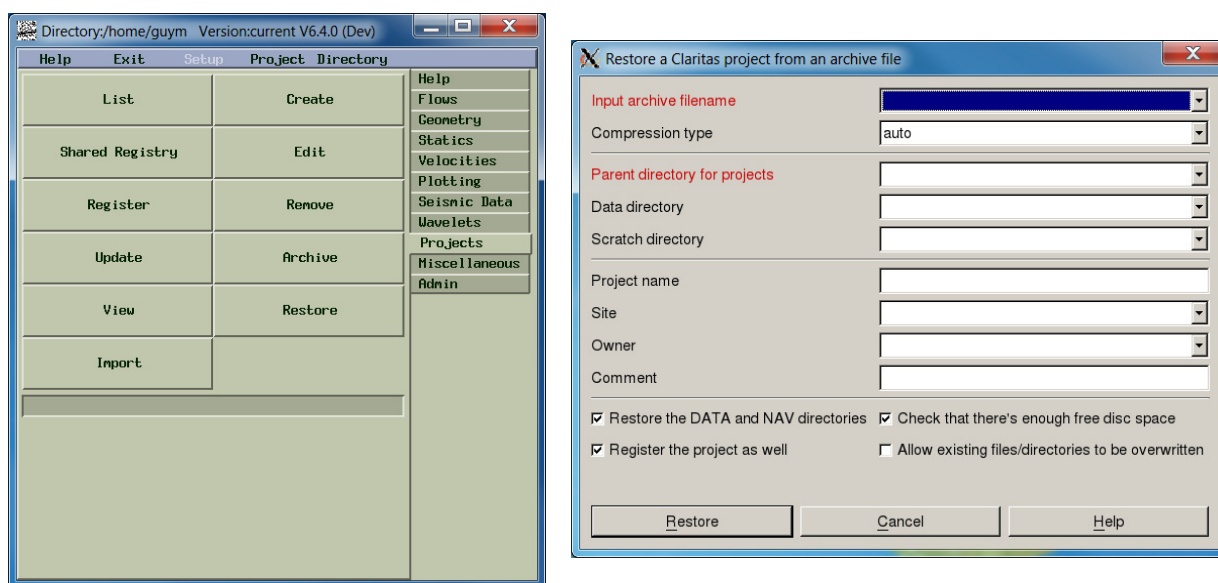
2.1.1 GLOBE Claritas Projects and the Marine Tutorial

To help you to keep your processing work organised, GLOBE Claritas™ groups files into "projects". Each project is a fixed structure of folders or directories, with a defined home for each type of file.

You don't have to work with projects, however when you do work in a project, the folder names are all managed for you automatically – each tool knows where to look for a given type of file, and where to write it out to.

The marine tutorial is an **archived project**; this can be restored by a special utility under the "Projects Tab"

- Click on the Projects tab
- Click on the Restore button



The GLOBE Claritas launcher showing the "Projects" view (left) and the "Restore Project" dialogue (right)
In GLOBE Claritas forms, only items in red are mandatory, the others can be left blank or default.

The only things that have to be specified on the "Restore Project" dialogue box is the name of the parent directory (or folder) for the project, and the name of the project archive being recovered. The "Browse filesystem" option, select the down arrow on the right, allows you to search the file system.

The project archive should be called **V68_2DMarine.ca**, if you don't have access to this please contact your system administrator, or the support team on claritas.support@gns.cri.nz.

You can also provide a unique Project Name, as well as comments, and identifiers like “Site” and “Owner” to help manage large numbers of projects.

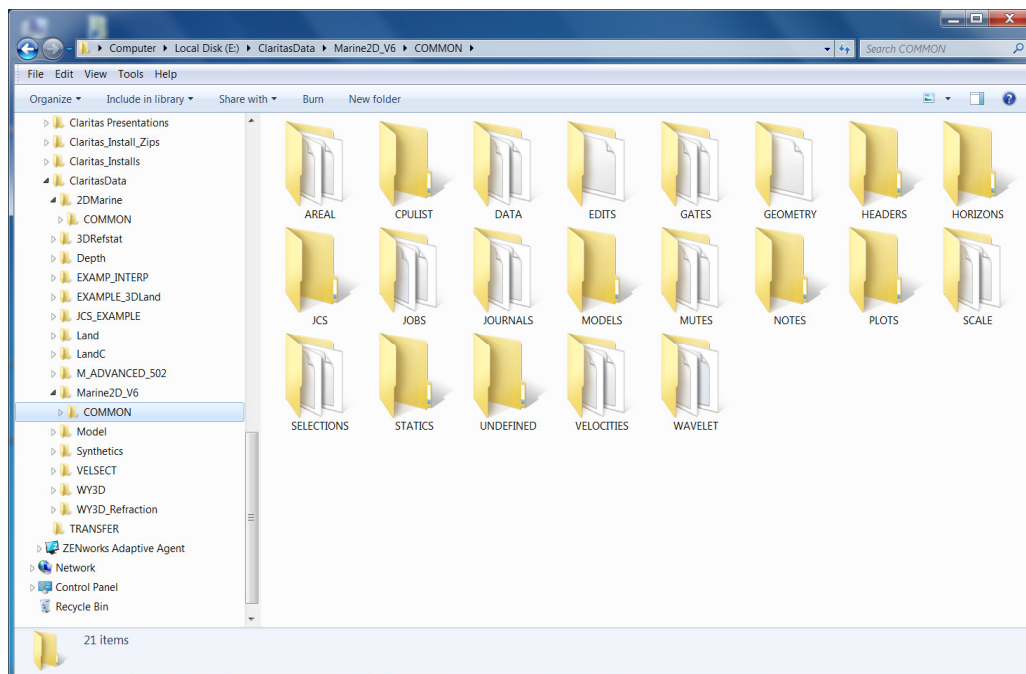
This project archive was created using the “Archive” option. The Archive option is also available on the “Projects Tab”.

- **Click on Restore on the Restore Project Dialogue**

The utility will now unpack the project archive and store it in the directory you specified. There is a list of projects called the “project registry” – the new project will be added to that. If you didn’t specify a name and so on for the project, it will be read from the archive as well.

- **When the project has restored, close the dialogue**

Here’s an example of a project structure, on a Windows system:



The directory structure for a GLOBE Claritas™ project (Windows 7); the project name is MARINE2D_V6, below this is the COMMON directory and then directories for each of the main data and file types. This is created and populated automatically by the project restore process.

You shouldn’t usually need to go into the project structure, but it can be useful to know where individual files are placed.

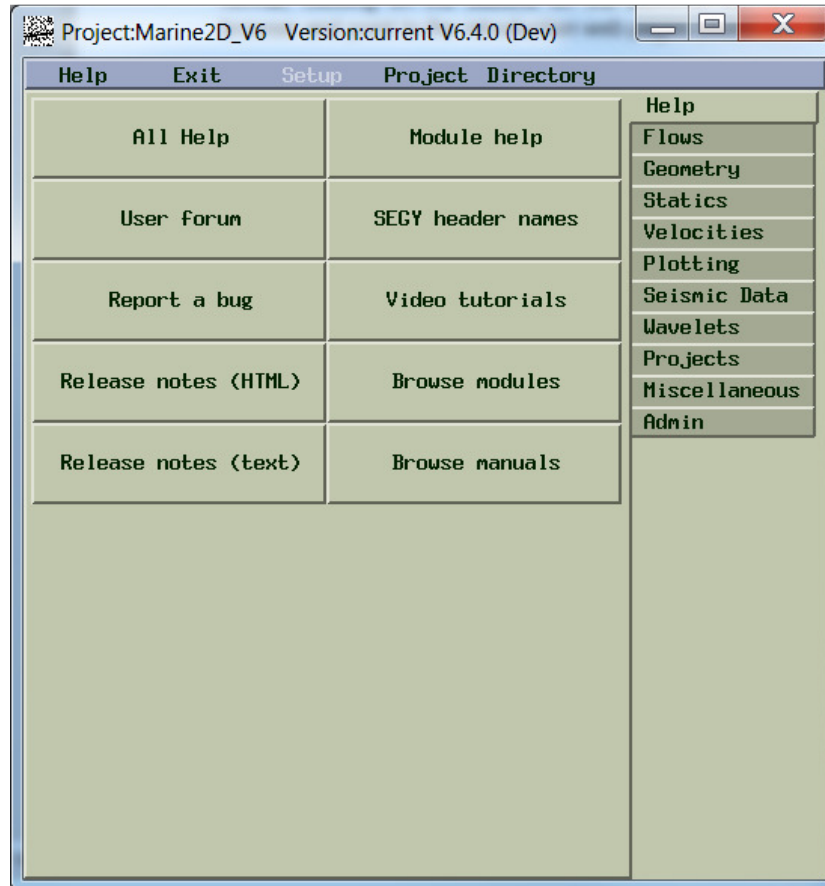
Now you can select the project you restored to be active

- **Click on the Project option in the toolbar menu at the top of the Launcher (between Setup and Directory). In the new window that opens select the project you just recovered. The ‘Filter’ button can be used to search the list of projects**

When you have selected this the name of the project should appear on the Launcher.

2.2 Getting Help

The Launcher also has a tab marked “Help”



The Help tab on the Launcher, allowing access to text based or web-based manuals and support information.

The “Browse modules” and “Browse manuals” buttons open up the web-based version of the manual and support information, which has full search and cross-linking of key topics.


The same information is also available in the text-based application “Seishelp” through the “All Help” button. This is also fully searchable, and uses a menu-driven approach.

This help also functions in applications and utilities, providing a third way to access the same information.

3 Seismic Line TRV-434 – Viewing the Raw Data

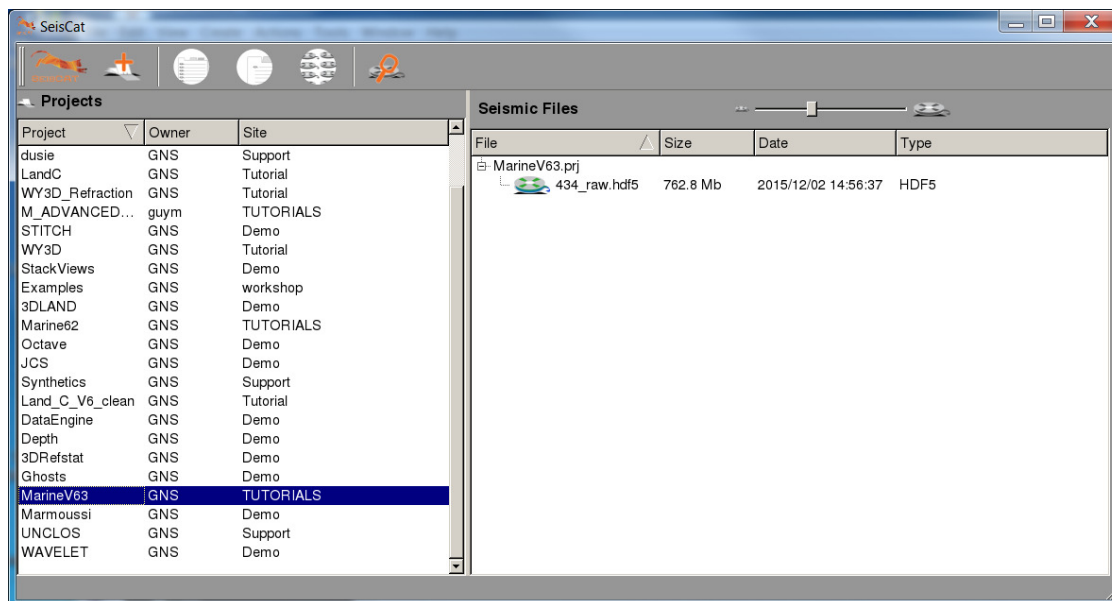
3.1 Seiscat and SV

Once you have unpacked the project, you can start to look at the raw seismic data. The data has already been converted into the GLOBE Claritas **HDF5** format.

- Click on the **Seismic Data** tab on the launcher
- Click on the **SeisCat** button
- Update the view by pressing this icon : 

SeisCat is a data management tool that automatically locates seismic files in your projects – in SEGY, SEGD, GLOBE Claritas SEGY or HDF5 format, and allows you to sort, display and interact with them.

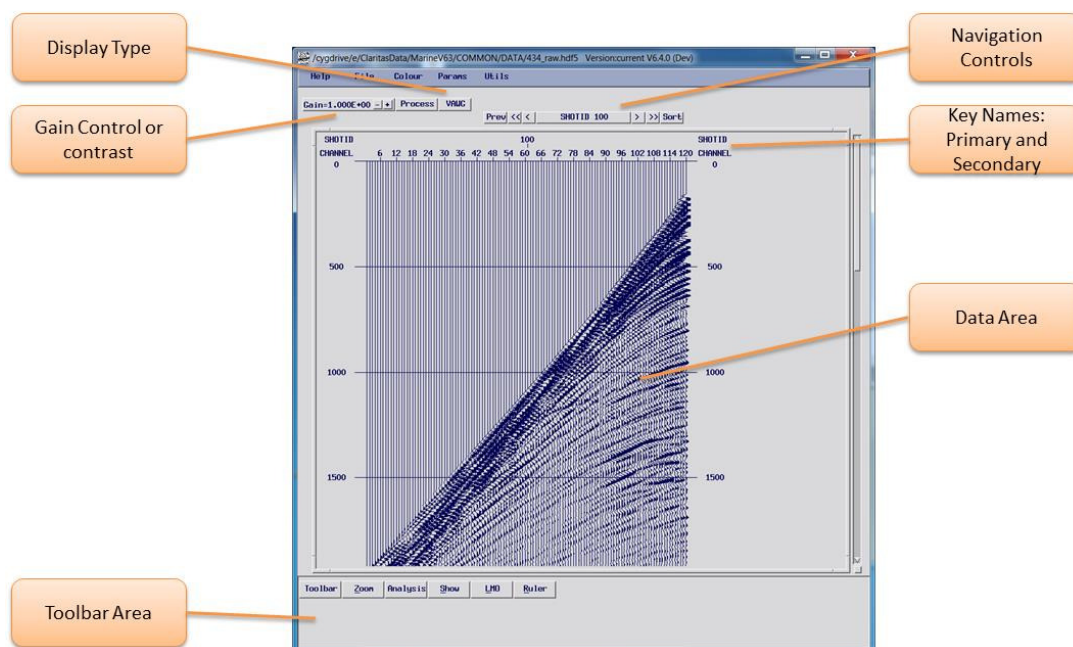
The initial view will look something like this, if you already have some projects defined (however, this tutorial might be the only project you have at this stage):



The SeisCat display. Projects are on the left hand side, with the data files displayed on the right

- Highlight the file **434_raw.hdf5** by clicking with the left mouse button
- Right click to get the interaction menu
- Select **“Open with sv”**
- When the dialogue window opens, enter **“OP1”** into Output Files and ignore the other parameters for now
- Click **OK**, and then press **“Continue”** on the pop-up window about **COORD_SCALE**

SV is one of the seismic viewing tools in GLOBE Claritas™. It is designed mainly for creating some key types of information used in processing, such as horizons, picking “first breaks”, creating mute files and so on, which is why it needs an output file name.



The SV seismic display tool displaying the dataset 434_raw.hdf5

A seismic trace has a number of “trace headers” that are used to help identify it. There are some standard headers – ShotID, Channel and so on – which are commonly used, but in GLOBE Claritas™ the user can also make new headers.

Data are usually displayed in groups, defined by a trace header. Within a group (also called ensembles or gathers) data can also be ordered by a sub-group.

The groups and sub-groups are referred to as the “Primary key” and “Secondary key” of the dataset

In this dataset the original order is to have a Primary Key of SHOTID, and a Secondary Key of CHANNEL. SHOTID represents the original file number on tape, and the CHANNEL is the recording channel number.

You can find a full list of the seismic trace headers that can be used for Primary and Secondary keys in Appendix A of the Manual

3.1.1 Exploring the Data – TRV434

Line TRV-434 was shot off the West Coast of New Zealand’s North Island in the Taranaki Basin by Norpac International for NZOG (New Zealand Oil and Gas). The data was collected by crew #503 in January 1986, and is available from the New Zealand government as Open File data.

The first thing to notice is there are 120 channels, and that the highest number channels are closest to the vessel.

Some of the other acquisition parameters for this line are:

Source Type:	Airgun Array
Source Tow Depth:	6 metres
Shotpoint Interval:	25 metres
Receiver Type:	Streamer cable
Group Interval:	25 metres
Number of Groups:	120
Receiver Tow Depth:	13 metres
Near Offset:	258 metres
Far Offset:	3233 metres
Recording System:	DFS-V
Data Format:	SEGD 3480 Cartridges
Sample Interval:	2 milliseconds
Record Length:	6000 milliseconds

The line has a total of 876 shot records, numbered from 100 to 975.

- In SV click on the **Display Type** button to go from VAWG¹ display to VD²
- Use the – and + keys to change the display scales
- Use the < and > keys to change the horizontal display scales
- Click on the colour bar (in VD mode) to change the colour scheme (Left Mouse Button for a menu)
- Use the navigation controls (<<, <, >, >>) to step through the data in either direction
- Click on SHOTID to enter a shot number to skip to.

Geophysics Comments:

- Look at the shots; they are dominated by linear direct arrivals and refraction energy in terms of amplitudes, but you can still see some hyperbolic reflections in the gathers, especially in the shallow part of the data (under two seconds)
- On SHOTID 200 there is a significant low frequency “sea swell” noise burst between channels 36 and 42, which will need to be addressed
- You can also see “tail buoy jerk” on SHOTID 400, especially above the seismic data; it is caused by the end of the cable being moved about by the swell. This sets up pressure waves in the cables, which are oil-filled for neutral buoyancy. “Tail buoy jerk” is low frequency and dips from “tail to head” on the cable.

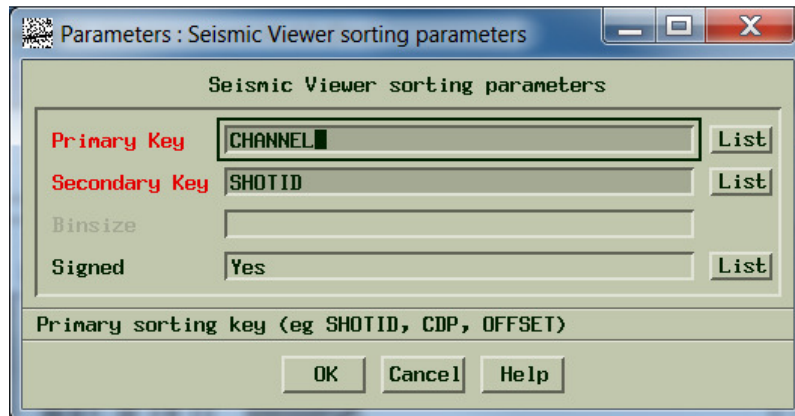
¹ Variable Area Wiggle – amplitudes are represented by the size of the wiggle, with positive value shaded black

² Variable Density- amplitudes are mapped onto a colour palette.

As you move the cursor around, the trace amplitude, secondary key and the time in milliseconds are displayed in the top left corner.

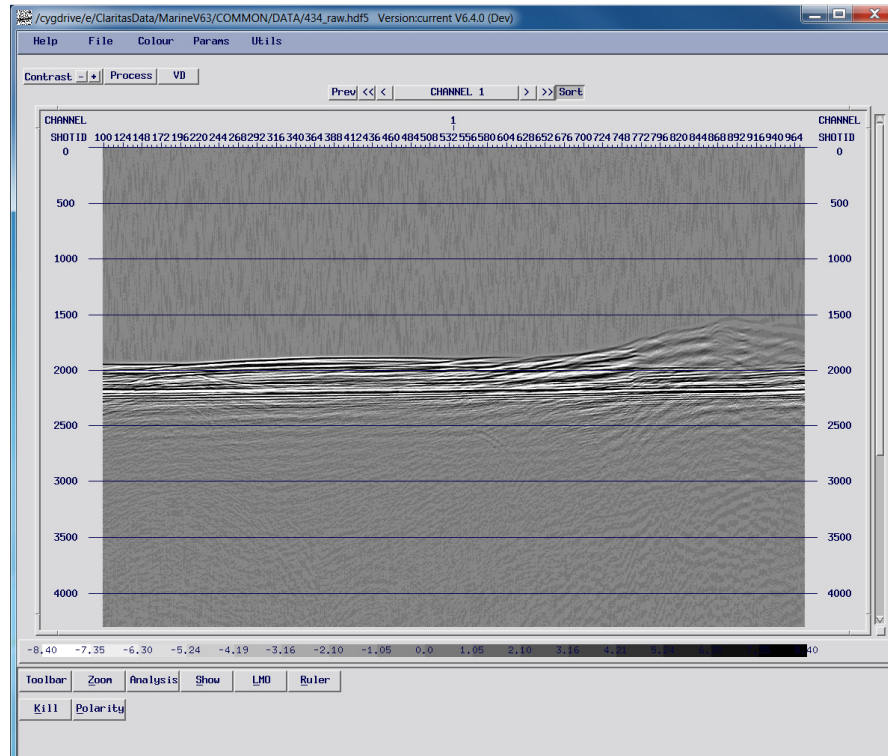
You can also look at data in different ways in SV.

- **Click on the Sort button**
- **Specify the Primary Key as CHANNEL, and the Secondary Key as SHOTID**



- **Click OK**

The display will change to show a single channel across the whole seismic line (remember to adjust the scales if you want to see the whole line.)

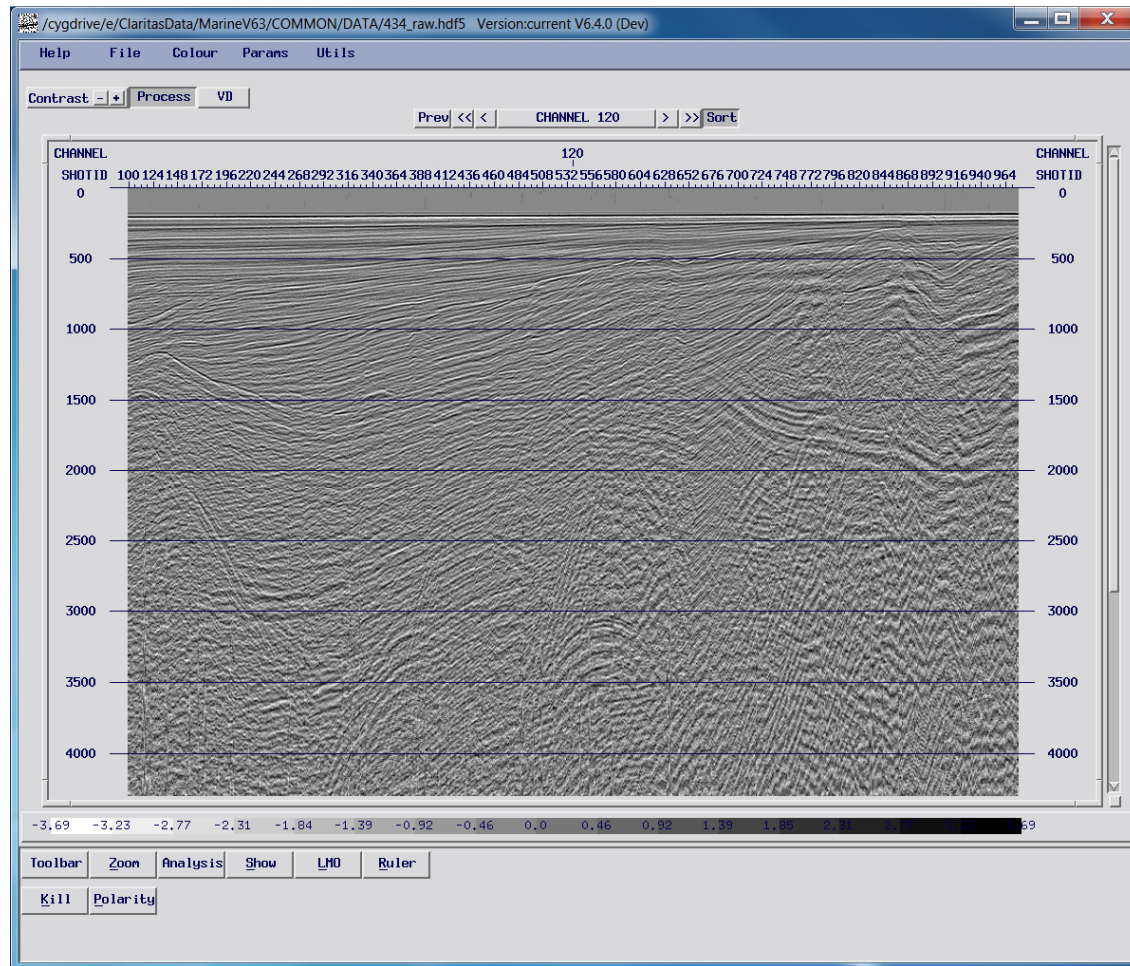


After sorting the display to Primary Key CHANNEL, secondary key SHOTID we are looking at a common channel display – effectively a one-fold image of the sub-surface.

- **Skip to channel 120 in order to display a near-channel plot**

This gives a good basic display of the seismic line, so that you can see an idea of the structure. The data is completely raw at the moment, so it's difficult to see detail. You can apply some basic processing such as an AGC (automatic gain control) to improve this.

- **Click on the Process button**
- **Type AGC into the processing sequence**
- **Press OK, and then OK again to accept all the defaults**



Channel 120 (the near trace plot) displayed with an AGC applied, so that we can get some idea of the sub-surface structure. There's a lot of noise and reverberation, but we can get an idea of the overall sub-surface complexity on this line.

Geophysics Comments:

- Automatic Gain Control (AGC) is used to control amplitudes in a processing flow.
- Data is scaled within a window so that the RMS value of the data is 1; typically this means the majority of the traces lie between amplitudes of +/- 5.
- The window slides down one sample at a time, with a different scalar calculated for each window.
- AGC is a crude tool, it is good for showing up strong signals and weak ones at the same time, but relative amplitudes are lost.
- Without an AGC, we might focus only on the strongest events; with an AGC applied, we may miss key amplitude anomalies or artefacts.

There are many more things that you can do in SV, including picking mutes, which we'll look at later.

4 Creating and Running Processing Flows

4.1 Why Use Processing Flows?

While it is useful to be able to apply a single processing stage like AGC interactively, more complicated processes can take time. It's usually much more efficient to combine a series of processing steps into a "processing flow" that can be run in the background while we do other things.

There's essentially two types of processing flow in GLOBE Claritas; those that run through to completion, and those that create an interactive display on the screen.

In general, the processing flows that run to completion produce outputs that we can then look at or analyse with an interactive tool later on. The main reason to use an interactive display is that it allows a quick and easy way to test different processing sequences.

Where these tests take a long time, however, it can make more sense to run them as separate processing flows with no interactive output.

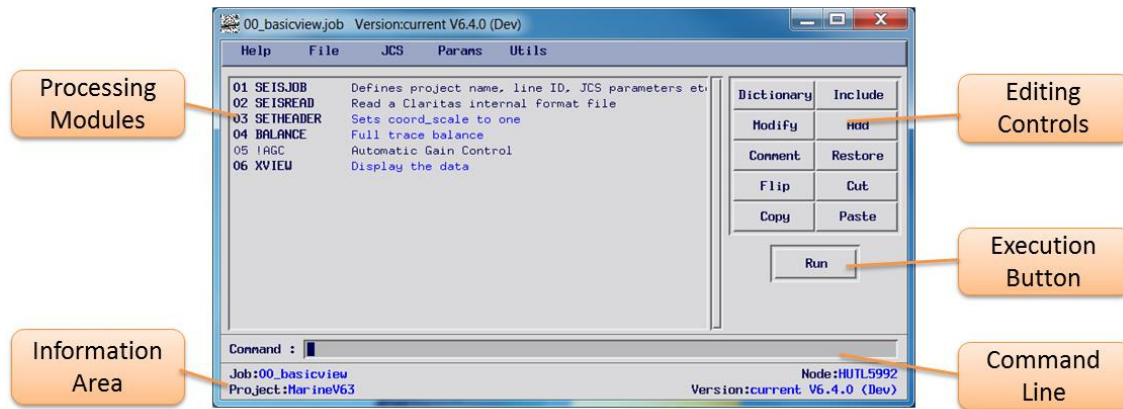
4.2 Getting started – the XSJE Seismic Job Editor

A processing flow in GLOBE Claritas is also called a "job". Each job is effectively a short program, written in a specialised high-level language designed for seismic processing.

While they are saved as simple ASCII text files (and you could manually edit them if you really had to) there is a special editor called XSJE that makes this process much easier.

- On the Launcher, select the Flows tab
- The button marked “Job Files” starts the job flow editor
- Select the file called 00_basicview.job using the “Job file” button or file browser.

Note that XSJE automatically “looks” for processing flows in the JOBS folder within the project structure. Any changes will be saved in that same folder.



The XSJE Seismic Job Editor. In this flow there are six processing steps or modules, with the 5th step, AGC, currently deactivated.

Each processing flow comprises a series of steps, called “modules” which act on the seismic data in a different way. In this flow there are 6 steps in total, numbered from 01 to 06.

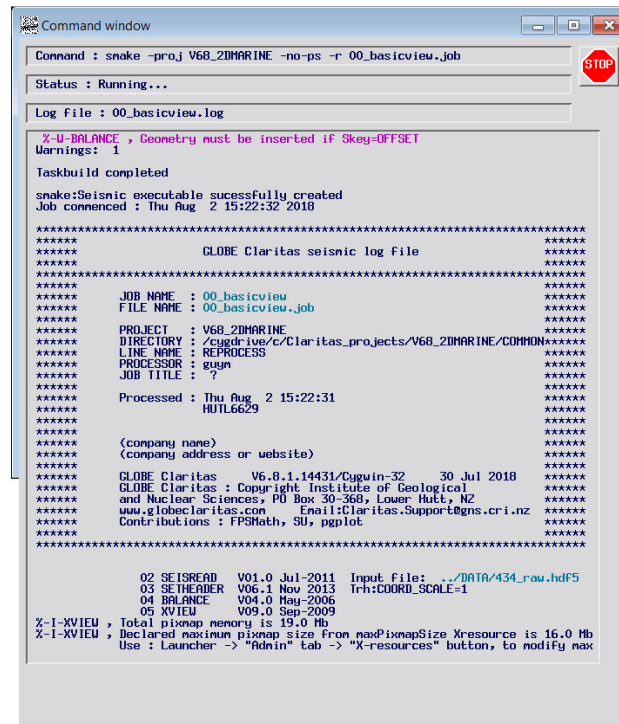
Each module has a unique name in capitals, followed by a brief comment that describes what the module does. These comments can be edited just by double clicking on them so that you can make your own notes on the flow. Comments in blue are ones that have been edited.

The first module “SEISJOB” is always present, and is used to store key “metadata” about the processing flow.

The information area helps you to keep track of what this flow is called, what computer it will run on, as well as the current project – all of which can be useful if you are working on multiple projects.

- Click the Run button

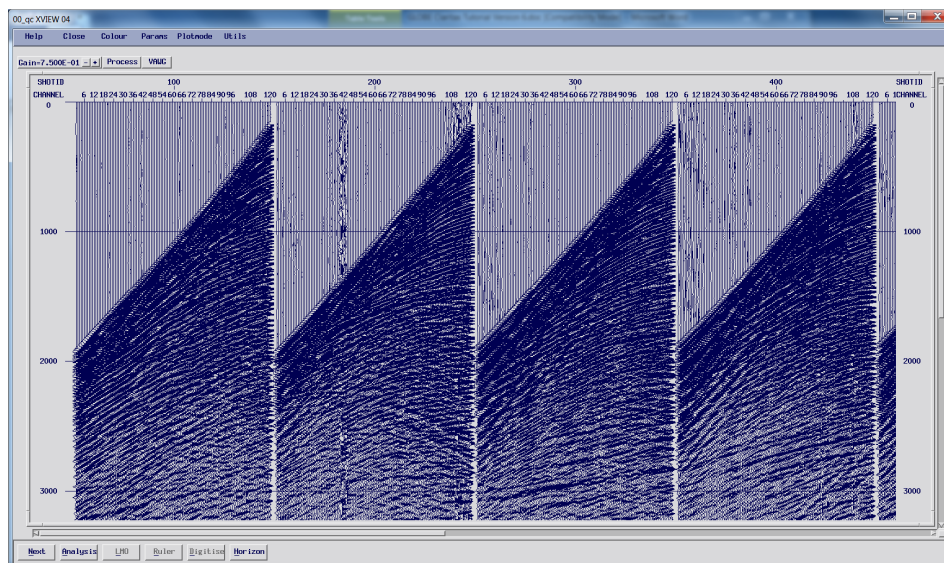
When you run a processing flow, it is checked, compiled into an application and then run on the computer. A pop-up window called the “Command Window” appears which gives you information on this process.



The Command Window which appears when a job is running, letting you know how things are progressing. Warnings appear in purple, with any error messages in red, and support or data files highlighted in blue - when the job has completed these act as hyperlinks and using the Right Mouse Button users can choose suitable editing/display tools.

This processing flow includes an interactive display, which is the module called XVIEW at the end of the processing sequence.

An XVIEW display will open; it is similar to the SV display, only without any toolbar options or navigation controls.



The XVIEW display generated by the processing flow 00_basicview.job

When you run the job, the XVIEW window will appear within a few seconds and a grey vertical progress bar (on the left hand side) will indicate how much of the data has loaded. After enough data has been collated to fill the display, a green bar will show the progress in rendering the display. On most systems this will happen almost too fast to see, but if you have a lot of modules in the flow or a slow display speed from a remote location, you may see both the grey and green coloured bars.

The data will start to display, but you will need to use the scroll bars to see it all. Note that once the data has all been loaded for display, the cursor changes shape to a cross.

As you move the cursor around, the trace amplitude, secondary key and the time in milliseconds are displayed in the top left corner. This processing flow is configured to only show a selection of the data, with nine shots in total in the display.

You can change this display in the same way you modified the SV display earlier, however you cannot navigate, or change the data selection in an interactive flow.

- **Click the Next button**

The processing flow will complete when you do this. The command window will remain until dismissed, allowing you to see some performance metrics such as how many traces were passed through each module. These can be helpful in troubleshooting flows that don't work as anticipated.

4.3 How to Edit and Build Flows

Dismiss the command window, and go back to the processing flow display.

- **Click the module 02 SEISREAD**
- **Press the Modify button**

Each module has a series of user-defined parameters that control how it behaves. The SEISREAD parameters control the order in which the processing flow will read the data, and can be used to make selections.

The SEISREAD parameter form

In this example you can see the filename that is being read in, which is the same file that we looked at earlier. The PKEYNAME and PKEYLIST parameters define the primary key to be read, as well as which primary keys we are interested in.

If you click on 'Module Help' you can see a description of how the PKEYLIST parameters work; in this case we are telling the module we want to read from SHOTID 100 to 900, with an increment of 100.

We also define the secondary key (CHANNEL), and with no secondary key list specified the module will read everything.

Click on OK to close this form. Note that you can also open a parameter form directly just by double clicking on the module name, which is usually more convenient.

- Click the module **04 BALANCE**, and holding down the left mouse button also highlight the module marked **05 !AGC**
- Click on the **Flip** button

Modules that are "deactivated" are shown with less emphasis (not bold) and a "!" in front of them; we have just deactivated the BALANCE module and activated the AGC. Run the job again to see what effect this has.

If you highlight the two modules and click the right mouse button, you get access to a menu which includes the FLIP option.

This is useful in trouble-shooting flows; as you can deactivate a module without losing the parameters you have entered.

4.4 Adding and Removing Modules From a Flow

The XSJE flow editor allows you to remove one (or more) modules with the “Cut” button – just click on the module name (or hold down the left mouse button to highlight a group of modules) and then click on Cut.

You can also “paste” this selection – complete with parameters – elsewhere into the flow.

The Add button is used to add a module into the flow.

- Click the module 05 AGC
- Click the Cut button to remove this module
- Click on the Add button
- Click on “Alphabetic Listing” and click OK
- Select AGC from the list, and click OK; the pointer will change shape (to a pencil icon)
- Position the pointer between the module 04 (BALANCE) and 05 (XVIEW) and click
- The module AGC will be inserted in position 05, and you can edit as before

Expert User Tips:

- You can double-click to avoid having to click ‘OK’ after each step above.
- You can also insert a module using the keyboard by typing commands.
- In the ‘Command’ field, type “add AGC 05” and press enter to add the AGC module between the BALANCE and XVIEW modules.
- Use **append** or **app** to add a module to the end of the flow; **app AGC**.
- If you just type **app** or **add** this opens a selection dialogue, exactly as if you had pressed the Add button.

You’ll notice how modules could; also be listed out by type as well as alphabetic listing; there’s over 200 different processing modules you can use, so sometimes looking via “category” can be useful.

Expert User Tips:

- To look at the files created while we have been working, open a terminal window from the Launcher by clicking on the ‘Terminal’ button on the ‘Flows’ tab.
- Here you can enter UNIX/Linux commands – even if you are running GLOBE Claritas™ under Windows. If you type “ls -latr 00_basicview.*”, you will see a complete list of all of the files associated with running this job. The *.**job** file contains the workflow, and the *.**log** file is the log output from the **Command window**.
- Note that each time you run a job, the log file will have the same name, even if you have added modules or changed parameters. The current log file is called 00_qc.log; if the job is re-run a new log is created and the old version is renamed to 00_qc.log~. When running a testing sequence it is a good idea to save each job under a different name as you edit or change the flow, using the “File: Save As” option. This avoids losing old tests and examples.

5 Shot Based Pre-Processing and Noise Suppression

5.1 Goals of Pre-Processing

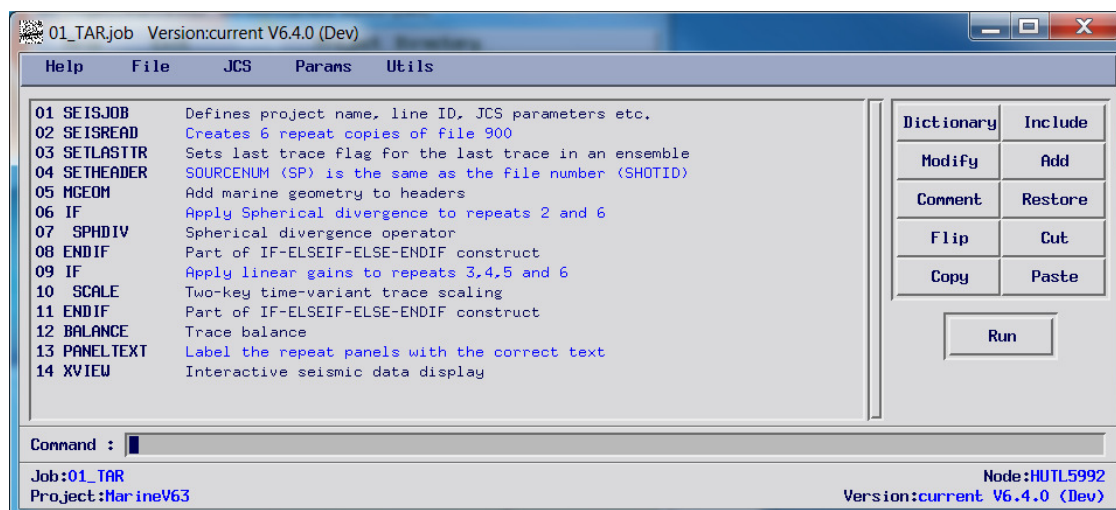
In the pre-processing stages the main goals we have are to boost the seismic amplitudes deeper in the record (without resorting to the automatic gain control) and to remove some of the unwanted noise. This includes the “random” noise burst caused by the sea-swell, any bad channels, and the refracted energy that dominates the upper part of the seismic records.

5.2 Testing Amplitude Recovery Parameters

In order to create a processing flow, we need to determine the best parameters to use, usually on a sub-set of the data. GLOBE Claritas allows you to create repeated copies of a dataset – or part of a dataset – and then apply different processing parameters to each copy.

The processing flow **01_TAR.job** demonstrates a more sophisticated testing sequence using the REPEAT and IF options, and creates six different copies.

- Go to the “Flows” tab on the launcher
- Click on “Job Files” and select the flow **01_TAR.job**



The processing flow for testing amplitude recovery using selected shots

Geophysics Comments:

- True Amplitude Recovery (TAR) involves correcting for the reduction in seismic amplitudes over time; the signals we receive first are stronger than those we receive later. The majority of the reduction occurs because of the spherical spreading of the wavefield as it propagates – the same amount of energy is spread over a larger area. Additional losses are caused partially through scattering and inelastic responses, but also from mode conversion (creation of refractions, S-waves and so on) at layer boundaries.
- We usually apply corrections for these losses in two stages. The first is a ‘spherical divergence’ correction, usually expressed as a function. This function is a power of: two way time (T), and/or the sub-surface velocity (V), e.g. T^2V . The second stage is applied as a linear gain, in decibels and two-way-time (1dB/second, 2dB/second and so on).

Key things to note in this flow are:

5.2.1 How to set up “REPEATS” in SEISREAD

The NREPEAT parameter at the bottom of the SEISREAD form is set to create 6 copies of the nine shots being read; the REPEAT seismic trace header will be set from 1 to 6 for each of these copies

5.2.2 The MEGOM Module for Assigning 2D Marine Geometries

The MGEOM module is only used in the “simple” 2D marine case, where we assume the cable is in a straight line (optionally with a perpendicular offset) behind the vessel.

It is usually run based on shot point numbers (the SOURCENUM headers), which in this case match the File numbers (SHOTID); this has been configured with the SETHEADER module.

MEGOM uses or updates the following trace headers:

Header name	Usage	Mandatory name?
RECORDNUM	The file numbers as recorded on tape; on older data this may loop to zero at 99 or 9999	NO
SHOTID	The renumbered file numbers, updated to match the FFID numbers in the observer’s logs; may be the same as RECORDNUM	YES
SOURCENUM	The shot point number as referenced in the navigation and observer’s logs; may be the same as the FFID (SHOTID) or need remapping	NO
SPARE4	The position of a given CDP, expressed as a shot point number; created by MGEOM	YES
CDP	The common depth point (midpoint number), created by MGEOM	NO
CDPTRACE	The trace number within a CDP gather, created by MGEOM	NO

REC_PEG	The common receiver location for the data, to enable sorting to receiver gathers, created by MGEOM	NO
OFFSET	The distance from the source to the receiver. Created by MGEOM	NO
COORD_SCALE	Defines the units (metres, decimetres) used for OFFSET. Created by MGEOM	NO
CDP_X and CDP_Y SOURCE_X and SOURCE_Y REC_X and REC_Y	X, Y co-ordinates of the CDP, shotpoint and receiver, relative to the start of the line. Created by MGEOM	NO

The key information for the acquisition geometry configuration is stored in a separate file called **trv-434.geom**; you can access this directly from the module by clicking on the “Edit” button, or from the Launcher using the **Marine** button on the **Geometry** tab.

Parameters : Regular Marine Geometry Version:current V6.4.0 (Dev)

Regular Marine Geometry

Line name/number: trv-434

Comment:

Streamer Parameters

Number of channels: 120

Near channel: 120

Near offset: 258.000

Streamer perp-offset: 0.000

Streamer depth: 13.000

Shot spacing: 25.000

Group spacing: 25.000

CDP spacing: 12.500

First Shot ID: 100

First CDP ID: 100

First and last shots in profile: 100 975

SEG-Y Coordinate scalar: Metres/Feet (x 1.0) List

SEG-Y height scalar: Metres/Feet (x 1.0) List

Length units: Metres List

Character string (up to 40 characters) for the Line ID

OK Cancel Help

The simple 2D marine geometry definition, which calculates offsets, CDP numbers and relative coordinates based on the acquisition parameters listed earlier.

5.2.3 The use of IF/ENDIF Pairs

We can use IF and ENDIF to apply different processing sequences to data within the same flow. In this case, the IF/ENDIF pairs use the REPEAT key, so that we can have a number of different tests in a single flow, and compare the results. The modules inside the IF/ENDIF loop are only applied to data which satisfies the conditions in the “IF” part.

5.2.4 Spherical Divergence

This flow applies the spherical divergence correction with the SPHDIV module; it’s applying a T^2 function, and because it is nested “inside” the IF/ENDIF pair, the correction is only applied to two of the repeats, numbers 2 and 6. For the spherical divergence correction we need to know the source-receiver offset of each channel, and in this flow the previous MGEOM module adds these values to the data.

5.2.5 Applying SCALE parameters Based on a Spreadsheet

In GLOBE Claritas, parameters that can vary with space and/or time are usually defined in separate spreadsheets. There’s a special editor for these (the “**control files**” button on the **Flows** tab) where you can select the type of file and use a number of tools and utilities to help you to create it easily.

In this case, the SCALE module is using a file called 01_TAR.scl; if you open the SCALE module and click on the **Edit** button you can see the general form for this type of spreadsheet.

xsde ../SCALE/01_TAR.scl Version:current V6.4.0 (Dev)

Help File Options Commands

Process name: SCALE [List](#)

Primary key: REPEAT [List](#)

Secondary key: CHANNEL [List](#)

Qualifier: INTERPOLATE/END [List](#)

Comment:

P_key	S_key	{T1}	{x1}	{T2}	{x2}	{T3}	{x3}	{T4...}	{x4 (etc)}
3	1	0	0	6000	6				
4	1	0	0	6000	12				
5	1	0	0	6000	18				
6	1	0	0	6000	6				

[EOF]

[< Find](#)
[Search](#)
[Find >](#)
[Open line](#)
[Mark](#)
[Go to](#)
[Learn](#)
[Repeat](#)
[Set increments](#)
[Selection math](#)
[Sum select](#)
[Column math](#)

Line : 1/4
 Cell : 1:1
 Text : 3

Mode : overwrite
 Automatic incrementing off
 Go to start of field

A spreadsheet “control” file used for varying the linear scalars applied to the data.

In this case the file is not really varying the parameters spatially – instead it is using REPEAT as a primary key, so that each value of repeat can have a different linear scalar applied.

Each line in the spreadsheet corresponds to a different value of REPEAT (the primary key or P_key), and has a series of (time, scalar) pairs. In this case, all of the lines in the spreadsheet start at (0,0) and then ramp to a second value at 6000ms TWT. Repeats 3 and 6 correspond to a linear gain of 1dB/second, and repeats 3 and 4 will have gains of 2dB/second and 3dB/second applied.

The spreadsheet format allows for complex variation of parameters with primary and secondary key, as well as two-way-time if needed.

5.2.6 The Use of Panel Text to Label Displays

When you are running a series of tests it can be useful to label them on the display; this can be done with the PANELTEXT module.

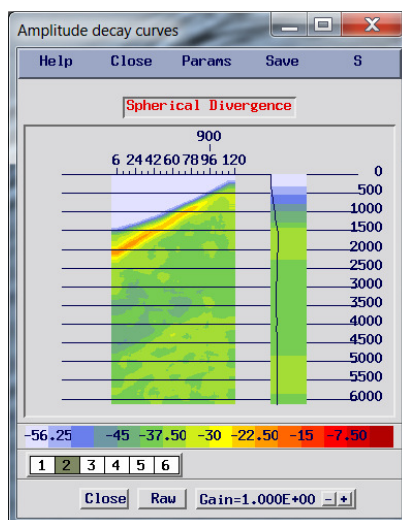
When you run the flow, each one of the “REPEAT” copies will appear on a different “panel” in the XVIEW display, which are numbered at the bottom of the display.

- You can step between panels using the arrow keys
- You can toggle between panels using the number keys
- You can click on panels with the mouse

You can use these options to compare the panels, and look at which combination of scaling parameters best balances the amplitudes in the data from top to bottom.

For a more quantitative analysis, we can use the amplitude decay curve analysis window.

- Click on the ‘Analysis’ button at the bottom of the XVIEW display window
- Select ‘Amplitude Decay Curves’
- Left click on a shot record display to see the decay curve for that whole shot
- Click on AllPanels to generate the curve for each of the repeat panels we have
- Click on SyncPanels so that the seismic display and analysis window change together



The amplitude decay curve analysis window, showing how well spherical divergence alone corrects for the amplitude decay on these data

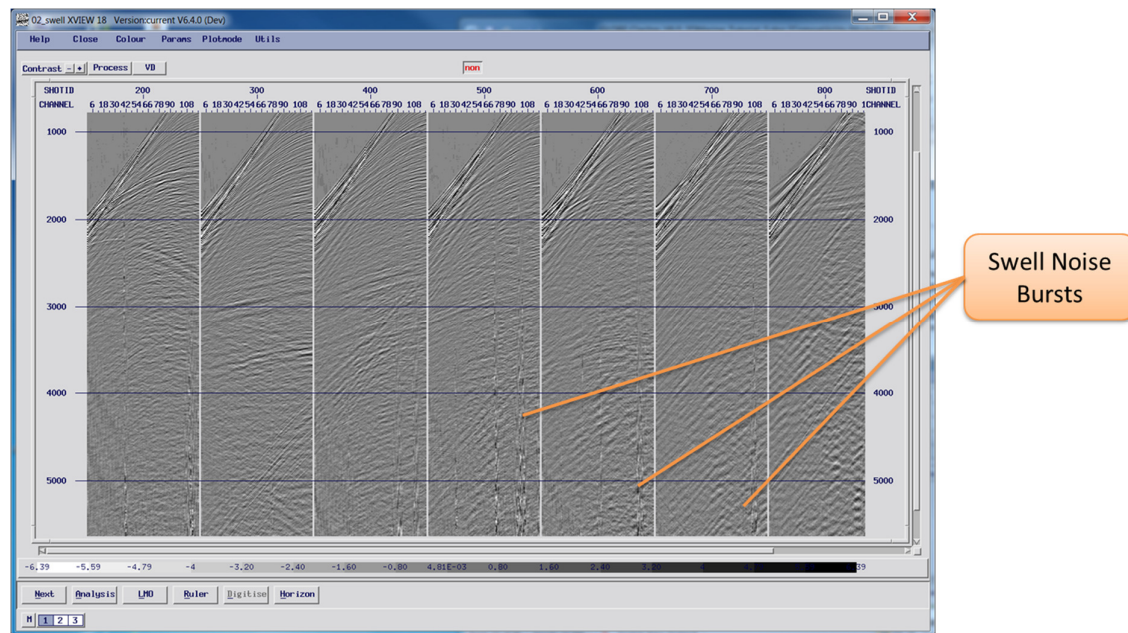
5.2.7 Creating a PowerPoint Display of the Tests

If you need to share the results of the tests or create a report, it can be time consuming to make screen captures of every panel. One of the Utilities on the XVIEW display (under **Utils** at the top of the screen) speeds this process up by capturing all of the panels (and any analysis windows) directly into a “PPTX” format presentation that can be opened with Microsoft PowerPoint or the LibreOffice Impress presentation packages.

The images can be saved separately, and are “trimmed” and scaled to fit the presentation.

5.3 Swell Noise Analysis and Suppression

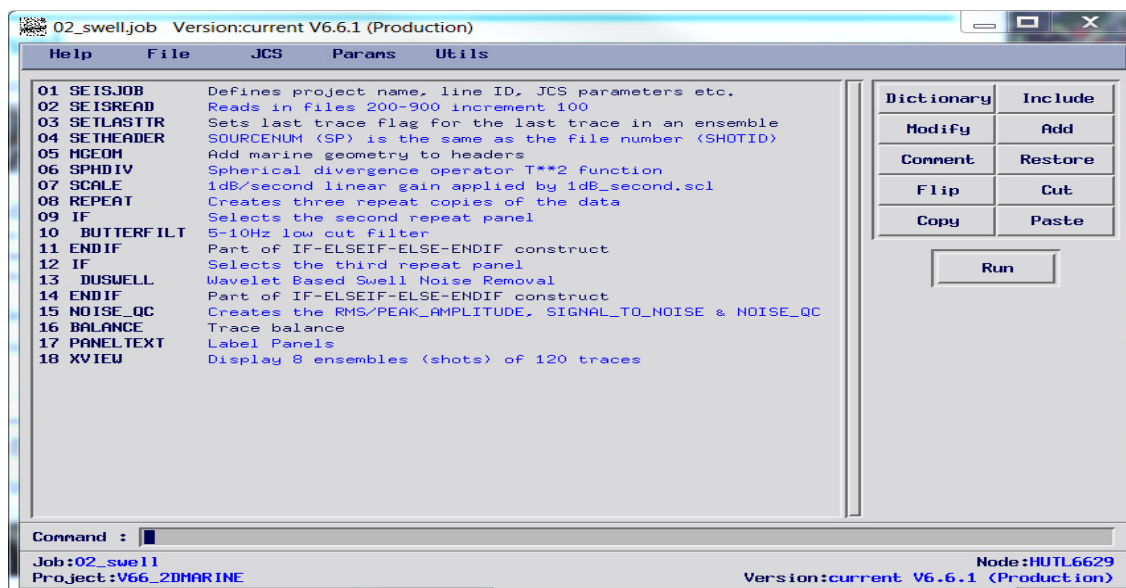
Now that we have an approach selected for balancing the amplitudes in the traces, we need to start to address some of the noise. The low frequency noise bursts we can see on the shot records are a result of the sea-swell, and we need to look at how we can suppress or attenuate these.



Displayed shot records showing the low-frequency swell noise bursts disrupting the data

The processing flow 02_swell.job has been set up for testing two different approaches to swell noise attenuation.

The first is a simple high-pass (low cut) filter, which rejects data at low frequencies, and the second uses the wavelet transform to estimate the swell noise content within a “box” and remove this from the data



The processing flow 02_swell.job, designed to test swell noise suppression methods

Some key things to note in this flow are:

5.3.1 The use of the REPEAT module

This is an alternative way of generating “repeat” copies for testing; it is useful when there are initial processing stages which take some time.

5.3.2 The BUTTERFILT Module

This module can apply low pass, band pass or high pass Butterworth filters to the data; in this case a zero phase high pass (or low cut) filter has been used to remove frequencies below 5Hz.

5.3.3 The DUSWELL Module

DUSWELL is the primary swell-noise reduction module. Unlike simple frequency filtering it uses a window in time and space as the basis for looking at the content of the data in different frequency bands

5.3.4 The NOISE_QC Module

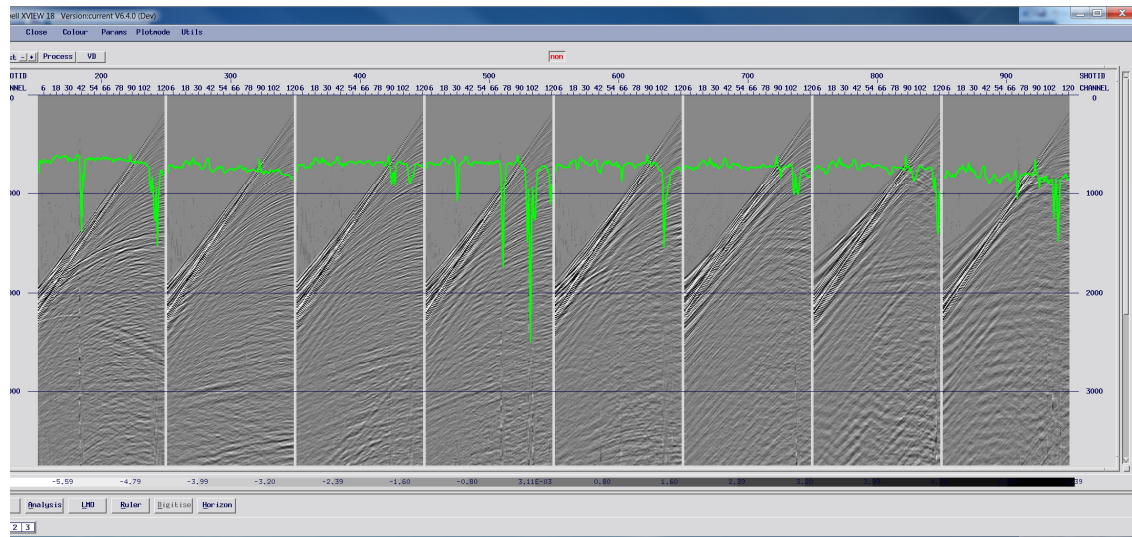
The main use of the NOISE_QC module is to create separate graphical displays of trace headers for QC or analysis; this module creates new peak amplitude, RMS amplitude, noise-qc and signal_to_noise trace headers within a given window. In this case the header we are going to use is RMS_AMPLITUDE derived from a “deep” window (from 3500-6000ms).

5.3.5 XVIEW configuration

XVIEW has been set up to display “Fixed fold” data, with 120 traces in each “ensemble” and a total of 8 ensembles.

As before, when you run the flow, the three “repeat” copies of the data will be displayed on three separate panels, with the appropriate label. To look at the RMS amplitudes that we defined with the NOISE_QC module, you need to plot this header over the data

- Click on the **Utils** menu
- Select **'Overlay Trace Headers'**
- Set the header name to **"RMS_AMPLITUDE"**, T0 to 500, TSCALE to 50 and Colour(s) to 6



The shots with amplitude recovery applied, and the RMS of the traces in a deep window plotted over the data

Note how the RMS amplitude can be used to easily identify where there are swell noise bursts on the data, and monitor how effectively these are being addressed.

You can also use other analysis tools (under the **Analysis** button) such as the **FK spectrum** or **Frequency Spectrum Graph**. Remember that you can either select a window for these analyses with the left mouse button, or click once to look at a whole shot, as well as using the "All Panel" button to compare results.

You can adjust the effectiveness of the filter by raising the low boundary of the "high pass"; for example by changing the FREQS parameter in the BUTTERFILT from 5 10 60 70 to 7 15 60 70 will remove higher frequencies.

You can adjust the effectiveness of the DUSWELL filter by changing the threshold values (THRESH_TOP and THRESH_END) from 7 and 0.8, lowering the thresholds has a more powerful effect.

Make a note of the parameters you select.

5.4 Picking a Refraction Mute

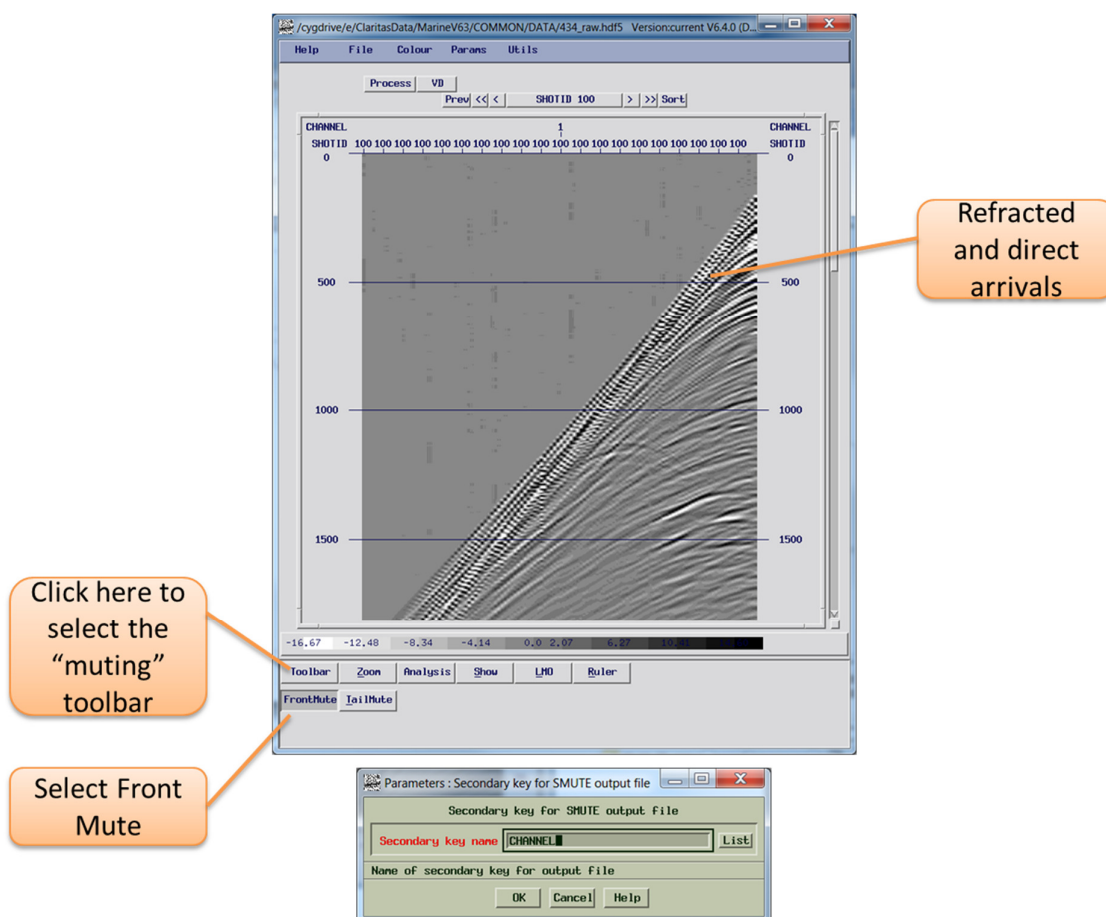
We also need to address the strong refraction and direct arrival energy, which we'll do by simply "muting" it from the start of the trace. In seismic processing a "mute" is usually used to zero the trace samples in a given region.

The refraction energy has very high amplitudes, so by removing this from the data we'll be able to look in detail at the seismic reflection amplitudes further down the trace.

We'll use SV again to pick the mutes on this line. The mute will then be saved as a parameter file that we can use later as part of a processing flow.

This time, start SV in a different way, by using the **Launcher**; clicking first on the Seismic Data tab, and then on the **sv** button. On the initial parameter form, select the 434_raw.hdf5 dataset to be the **Input seismic file** and set the **Output Files** parameter to "refraction" - as we'll be picking a refraction mute.

- **Activate the "Muting Toolbar"**
- **Select "Front Mute"**
- **Specify the secondary key as "Channel"**

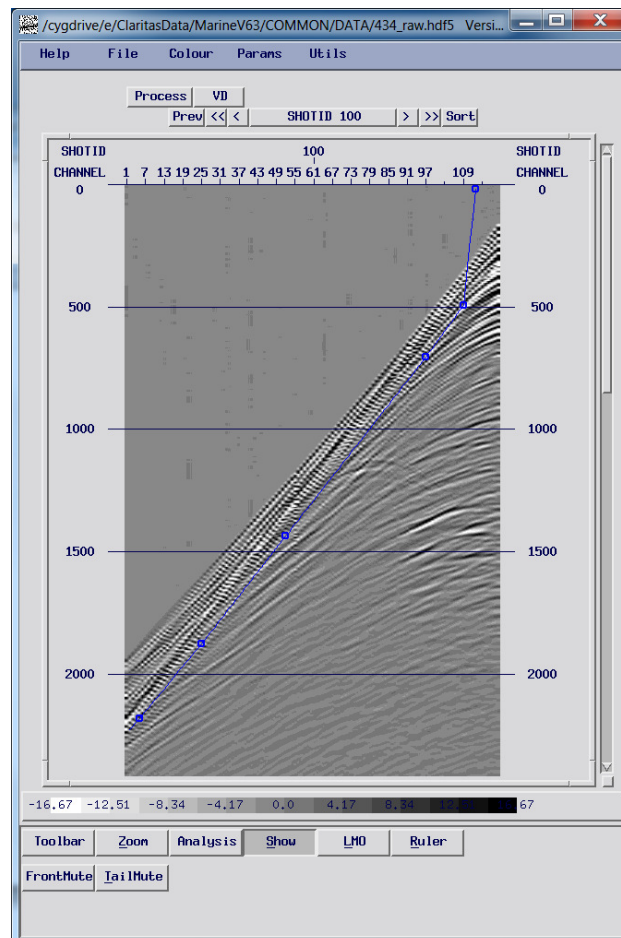


Setting up SV for picking a "front mute" – activate the muting tool bar, click on "Front Mute" and specify the "secondary key" to use

A "Front mute" is used to zero the samples above the picked mute line, where a "tail mute" can be used to zero the samples below the mute line – these are also sometimes called "outer trace mutes" and "inner trace mutes" respectively.

Geophysics Comments:

- We are primarily interested in seismic reflections – so direct, and refracted arrivals (refractions) must be excluded. These tend to have relative high amplitudes and intersect the reflection data.
- The refractions are obscuring the reflections – they dominate the minimum and maximum values of the colour scale (in variable density mode) leaving only a narrow range of colours available for the reflections.
- Refractions are linear, so signal processing techniques such as working in the FK or Tau-P domain can be used to isolate and remove these events. In this tutorial though, we are going to employ a simple X-T domain mute.



Picking a refraction mute; the picked points are shown as blue squares, and the interpolated mute that will be applied as a blue line

One of the things to think about when picking a mute is that once you have “thrown away” part of the data, you can’t recover it later on. As a result, it’s a good idea to keep the mute quite “loose” at first. Note that in the near surface (on short offsets) you can’t really split the direct, refracted and first reflected arrivals; making the mute too tight at this stage would “delete” the sea-floor reflection.

In this dataset the refractions vary quite a lot. If you use the double arrow (>>) button to step towards the end of the dataset (SHOTID 975) you can choose whether you need to pick a different mute.

You can pick mutes at as many locations as you want to – when they are applied, the processing module will automatically interpolate.

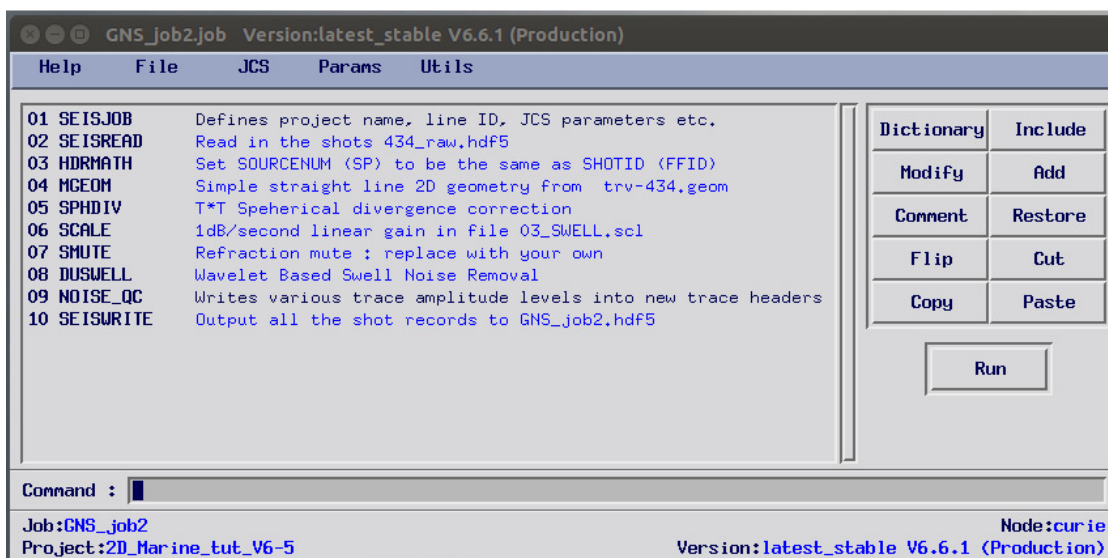
When you “Exit”, (File -> Exit) the mute is automatically saved in the appropriate format (and with the appropriate extension) in the MUTES folder for this project.

5.5 Creating a “Production Processing Flow”

When you are testing a processing sequence it is very easy to create a large number of processing flows that you edit and update. Keeping track of these – for example numbering each test as we have done in this tutorial – as well as the parameters that have been tested and the preferred outcome is very important.

It’s also useful to create a “production flow” that is clearly labelled and represents the actual sequence applied to the data. This allows us to apply multiple processing stages at the same time, minimising the use of disc for storage (as well as any input/output bottlenecks); with a single line this is less important, but with larger surveys it can be critical to efficiently processing data.

The processing flow **GNS_job2.job** puts together all of the elements we have seen so far – geometry assignment, swell noise removal, muting of refractions as well as generating some QC statistics for the peak and RMS trace amplitudes in the dataset.



The processing flow **GNS_job2.job**, which applies shot-based pre-processing

If you want to use the parameters we have selected (including refraction mute) then you can run this job directly, however if you want to make your own version (and use different parameters) then you need to:

- Click on the **Job Files** button on the **Flows** tab
- Enter a new name for the flow and press **Enter**
- Click on **Include**, and select the flow **GNS_job2.job**
- Select all of the modules from that flow with the **LMB**
- Press **“Enter”** to paste them into the new flow
- Click on **File and Save**

This is the simplest way to make a copy of the flow to edit; you can include other modules (such as the **BUTTERFILT** for Swell noise removal from the flow **02_swell.job**) in the same way, or to include modules where you have modified the parameters as part of your testing.

The things to note in this flow are:

5.5.1 Use of the **NOISE_QC** Module

In the processing flow **02_swell.job** **NOISE-QC** was used to create the RMS amplitude trace header over a deep time window from 3500 to 6000ms.

This time the **NOISE-QC** module is called to write the peak and RMS amplitude headers from a whole trace window and these QC's can then be reviewed in the **AREAL** application.

5.5.2 Use of **SEISWRITE**

So far we haven't written any data to disc; the **SEISWRITE** module performs this role, with the user specifying the folder and file name to write the data to.

- When you are happy with the, flow, press **Run**

5.6 Quality Control Checks on the Shot Pre-Processing Flow

When you are first processing a seismic line it is always a good idea to do some quick checks to make sure that you have all of the data you expect. While we are assuming we will have 876 shots (from 100 to 975) it is always worth checking this against the log file created when the job runs.

The log file can be viewed interactively when the flow ends in the command window; at the end of the flow you can see how many traces have passed through each module – there should be 876 shot records with 120 traces each, or 105120 traces.

5.6.1 Checking the Seismic Data

If you launch **SeisCat** from the **Seismic Data** tab, you should be able to see the newly created dataset. (You may need to refresh the display by right clicking on the project name and selecting **“Refresh file listing”**)

- Highlight both datasets – **434_raw.hdf5** and **GNS_job2.hdf5**
- Right click and select **“View with seisview”**

- **Display 5 ensembles at a time, with an increment of 5**

SeisView is a stand-alone form of the XVIEW display tool that allows us to easily compare datasets; as with the tests using “REPEAT”, the datasets are display on different panels. Like SV, we can step forward and backward through the dataset – at the moment the display is configured to show 5 shots at a time, with an increment of 5 between each displayed shots.

Adjust the vertical and horizontal scales on the display to fit the screen easily (Params – Main plot; horizontal display of 30.0), select a variable density display and make sure the Raster Mode (Params – Main plot) is set to XImage (local).

It’s difficult to compare the data because of the amplitude recover that we have applied; you can resolve this by applying an AGC.

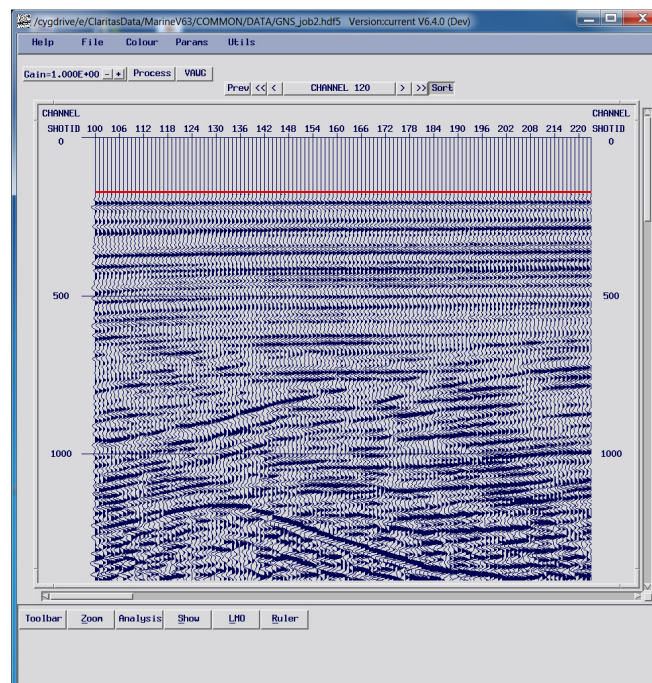
- **Click on the Process button**
- **Enter AGC as the processing sequence, and press Enter (or click OK)**
- **Accept the parameters (Enter or OK)**

You can now look in detail at how the swell noise attenuation has performed.

You can also review the new file using SV.

One useful check here is to sort the data to CHANNEL, SHOTID order (as we did before) and then to jump to a near trace display (channel 120); on this display there is an option to “Overlay offsets” under the Utils menu.

If you specify the ‘refractor velocity’ as 1500, then this will plot a line corresponding to the direct arrival time based on the offset assuming a sea-water seismic velocity of 1500ms^{-1}



The near trace plot from the dataset GNS_job2.hdf5, displayed in SV and sorted to CHANNEL, SHOTID order.
The direct arrival time calculated from the offsets is displayed as a check of the geometry.

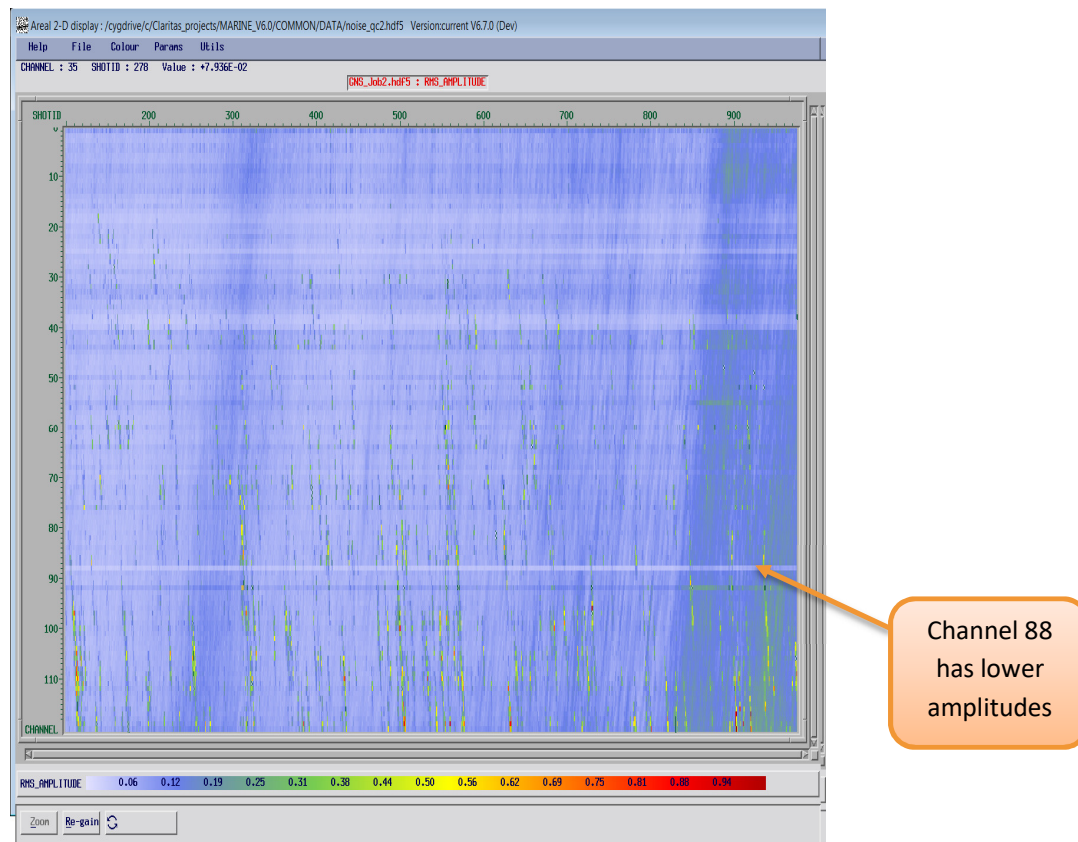
Finally, we can review the amplitude QC plots generated by the NOISE_QC module.

- Click on the 'Miscellaneous' tab on the Launcher
- Click on 'areal'
- Open the file GNS_job2.hdf5
- Set the 'Display header' to be either RMS_AMPLITUDE or PEAK_AMPLITUDE
- Use the 'List' button to select SHOTID/CHANNEL for the 'Axes headers'

Expert User Tips:

- Alternatively you can open the AREAL display by right clicking on the file GNS_job2.hdf5 in SeisCat and selecting the 'Trace header cross-plot (Areal)' option from the drop down menu.

Areal displays the amplitude data as a grid, with the CHANNEL axis vertical and the SHOTID axis horizontal. The RMS amplitude values are colour coded for each trace.



Areal display of the RMS amplitude of each trace; the vertical axis is the channel number and the horizontal axis is the SHOTID. Channel 88 has lower amplitudes than its neighbours, as indicated

If you keep the **SV** display of the data running alongside **areal**, then you can quickly identify anomalies from the areal maps and then look at the corresponding shots or channels.

Set the 'Colour for flagged cells' to be 'Black' on the 'Params' – 'Areal display parameters' form.

Immediately you should notice that:

- CHANNEL 88 seems to be "quieter" than the others.
- There are two spiked traces at the start of SHOTID 114 (CHANNEL 115 and 116).

Any long "noise trend" that dips from (in this case) from bottom left to top right indicates a strong signal that is moving down the cable as the boat moves; this probably corresponds to reflections or diffractions in the analysis window. Short noise trends, or those dipping in the opposite direction, are usually a result of swell-noise bursts or other bad data areas.

If you click on the circulate button (with arrows on it), you activate the mouse button settings. Clicking again on the button cycles through the options.

You can either "Set" marker flags, "Clear" them, or "Toggle" the flags on and off. There is also a "Test" option; hover the mouse across the colour-coded bar at the bottom and you can instantly test the effect of flagging cells above or below certain levels (specified by the mouse position).

When you click on a given cell in "Set" or "Toggle" mode, it is flagged and shaded black. A second click in "Toggle" or "Clear" mode removes the shading. You can also hold down the left mouse button and drag the cursor over a range of values to flag, or use the P and S keys on the keyboard to flag a whole primary or secondary key.

Set flags on the two noisy traces (SHOTID 114, CHANNEL 115, 116) then press the 'Re-gain' button (or press the R key on the keyboard); the display changes as the colour range is no longer dominated by the high amplitude traces you have flagged.

There is sufficient redundancy in this dataset (it will be 60 fold) that if any given channel is being noisy we can afford to kill the whole trace rather than just edit out the noisy segment, as long as there are not too many adjacent channels being killed.

As we are using the GNS_job2.hdf5 file the picked bad traces are automatically written to the trace header of this dataset so we do not need to save and apply a trace edit file.

Expert User Tips:

- You can use the space-bar as well as the mouse button to select data to flag (or unflag).
- Page-up and Page-Down can be used to step through the display.
- Open the output shot information (GNS_job2.hdf5) in SV (under the 'Seismic Data' tab) and visually inspect the shots at the same time, verifying what you are flagging. Click on the SHOTID label to jump to a shot number.
- AREAL can display multiple panels. These can be different headers from within one HDF5 file ('Params' – 'Add another panel') or the same header from multiple HDF5 files ('File' – 'Open new HDF5 file').

5.7 Creating a Stack and Velocity Analysis

With gain recovery and some noise removal completed, we can move on to creating and looking at a stack of the data. We could run a processing flow to do this, however, while we are working on just one line at a time it is quicker and easier to create a stack with the velocity analysis tool, CVA.

- Click on the **Velocities** tab on the Launcher
- Click on **CVA**
- Select **GNS_job2.hdf5** as the **UNSTACKED** data file (in red)
- Supply **brute.nmo** as the **Output velocity** file (also in red)
- Click **OK**
- When asked for a “Initial seed function” type the following:

- Fill in the next form as follows (the output file name is automatic)

CVA will automatically create (and save) a stacked seismic section based on these parameters. When this is complete the stack will display, and open a semblance velocity analysis window centred on CDP 240.

We are going to use the variable velocity approach as opposed to constant velocity. This means that we will start off with an estimated function (based on our seed, or extrapolated/interpolated from the velocities we have already picked) and search around this in a ‘fan’, as opposed to scanning across all possible velocities from minimum to maximum.

The variable approach is well suited to marine data with a good signal to noise ratio (SNR) and where we can clearly see reflections within a CDP gather.

On the main window (which displays the stack) click on the 'Params' menu and check that your 'Analysis calculation parameters' are correctly set.

Analysis calculation parameters

Variable velocity fan parameters

Variable-fan or constant velocity? [List](#)

Time/Percentage function

Number of functions in the fan

Seibance calculation parameters

Seibance velocity range

Number of seibance velocity traces

Seibance window length

Coherency measure [List](#)

Normalise plots? [List](#)

Plot sum of seibance functions? [List](#)

Eta scan range

Superbinning parameters

Weighting over CDPs

CDP (crossline) increment

Weighting over in-lines

Inline increment

Weighting shape [List](#)

CVS/CVG calculations

CVS display mode [List](#)

Number of CVS/CVG velocity panels

Percentage to widen CVS velocity limits by

Muting parameters

Apply mute type [List](#)

Stretch mute %

Mute taper length

Mute display mode [List](#)

AGC parameters

AGC window length for CVS and CVG displays

When to apply the AGC [List](#)

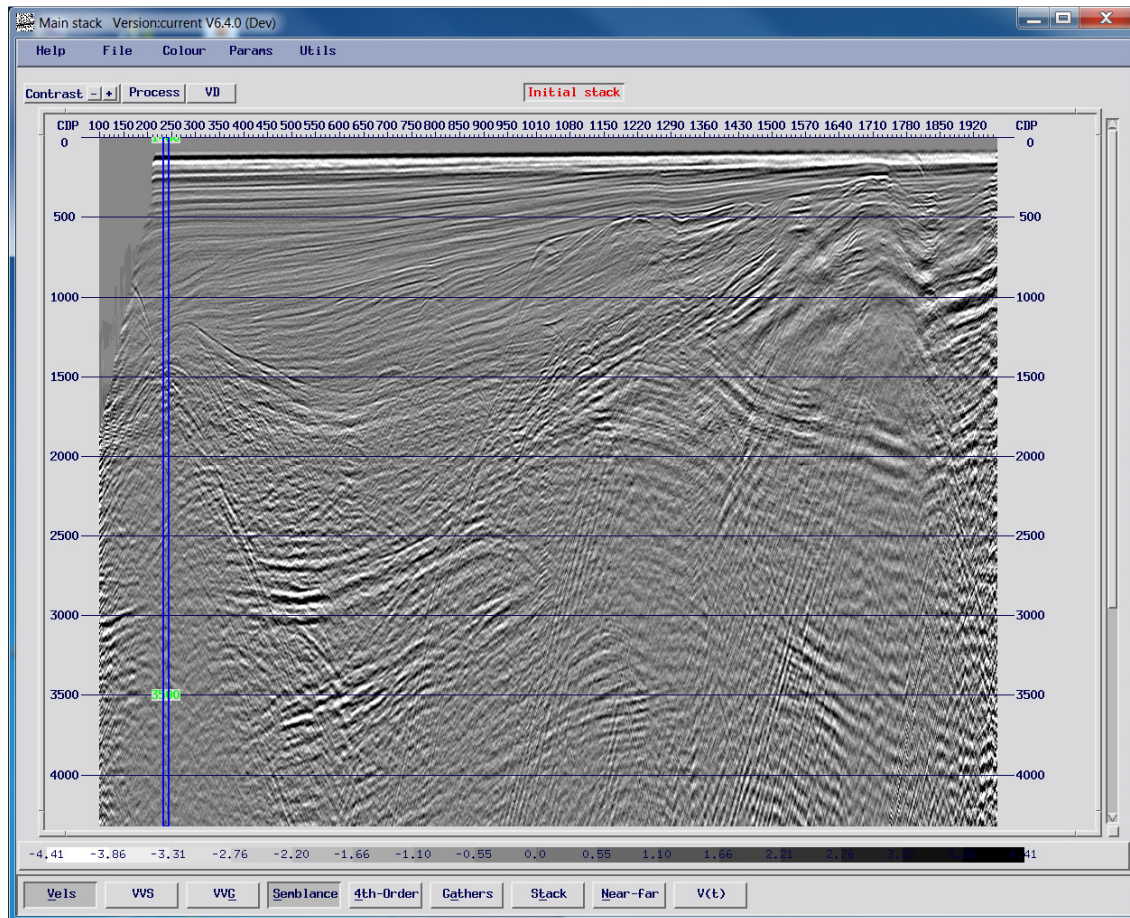
Specify variable to get VVS/VVG, and variable velocity seibance fans

The analysis calculation parameters for the first pass of CVA velocity analysis

Now that you know where the main controls are, and we have checked that they are correctly set, you can move on to picking velocities.

You can adjust the main stack display in the same way as you modified **XVIEW**; this includes applying an AGC or balance, modifying the colour maps and adjusting how they match to the amplitude ranges.

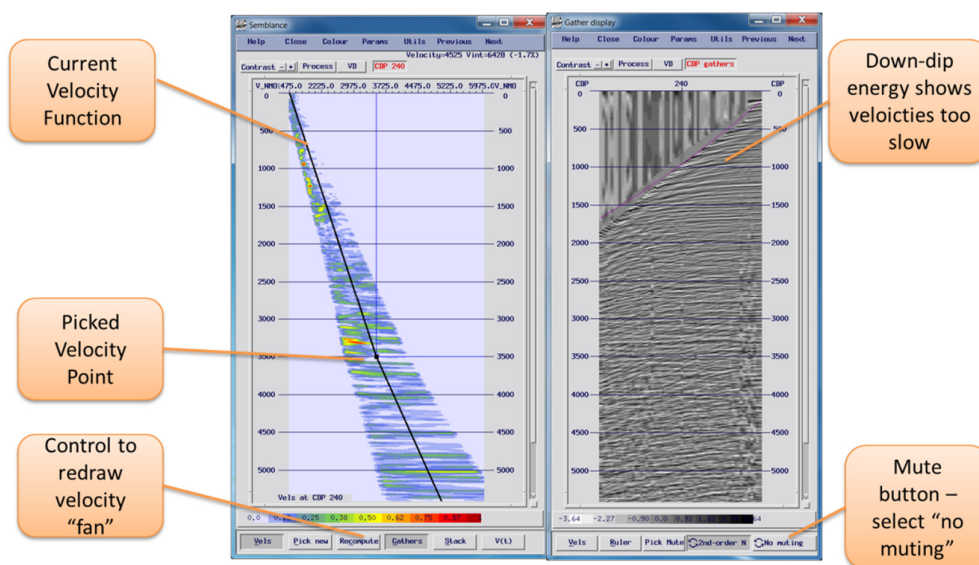
The current area for velocity analysis is marked by a blue box. As you pick velocities, these will also be labelled.



The main stack display in CVA; the currently active velocity analysis location is shown by a blue box, with the velocity values from the “seed function” in green.

While there are a number of velocity picking options available in CVA, we’re going to focus on using semblance analysis.

- Adjust the scale of the semblance display if needed, using the +, -, <, > buttons or the display parameters form under the “Params” menu
- On the semblance display window, click on the “Gathers” button
- Adjust the gather display scale and display type (from VAWG to VD) if needed



The CVA semblance analysis window displayed next to the “Gather” window. As you pick velocities the gather will automatically be corrected with the new velocity function.

The semblance display shows how well different velocities will “flatten” the hyperbolic reflections in the CDP gather. Warmer colours show velocities that will produce a flattened, coherent reflection.

The initial velocity “seed” doesn’t do a great job of “flattening” the hyperbolic reflections; between zero and 1500ms you can see a series of “bullseyes” on the semblance display that are slower (to the left of) the black line from the initial function; the reflections on the gather display are under-corrected and dipping downwards.

You can modify the velocity function using the left mouse button.

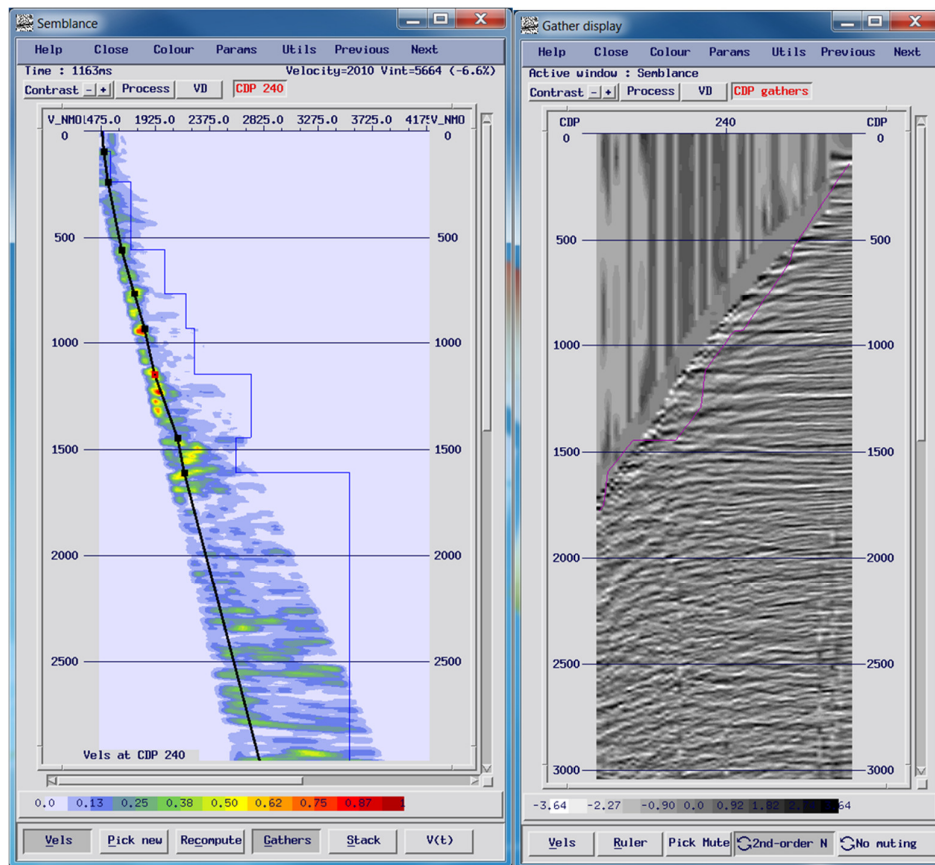
- Click the left mouse button to add a velocity control point
- If the cursor is close to a velocity control point it will highlight in red
- Hold the left mouse button down to move the point, or click again to delete it

When you pick velocities, the gather display is automatically updated, as is the annotation on the stack display. You will also notice a thin blue line appearing – this is the interval velocity value.

You can recalculate the velocity fan centred on the new function (as a check) with the Recompute button.

On this first CDP, it’s possible to repick the velocities pretty easily in the first 1500ms, but below this its harder to see what is going on.

When you are happy with the velocities, click on the “next” option on the toolbar on either the gather display or the semblance window.



Improved velocity analysis at CDP240; the reflections in the first 1500ms are now flattened, and the velocity picks are on the “bullseyes” in the semblance display.

When you click on “next” you will jump to the next analysis location; the initial increment for this is set to 100 CDPs. The previous function is automatically copied across, so if the geology is only changing relatively slowly, it should be possible to simply adjust the function as opposed to picking a new one.

As you edit the velocities, the previous trend is shown as a dotted purple line.

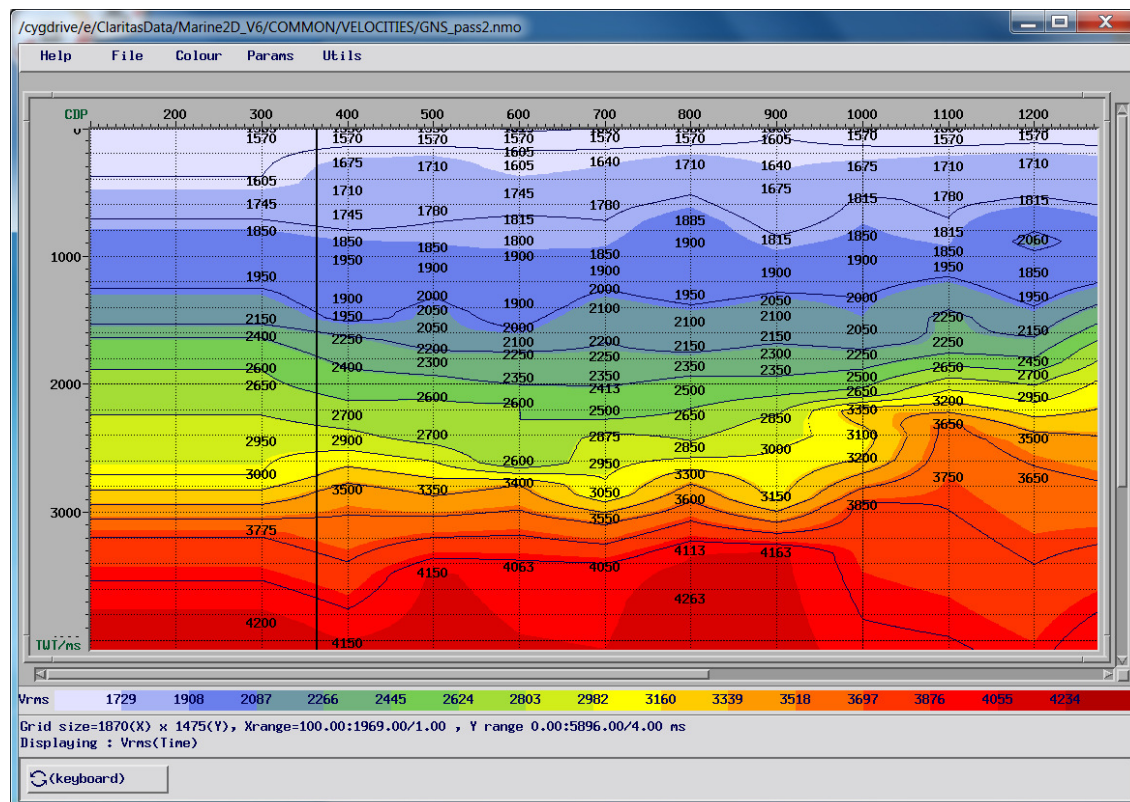
If you click on the “Vels” button, the velocities are shown on the gather display. Picked velocities are shown in blue, those that have been interpolated automatically are shown in green.

You can progress through the dataset, checking progress on the stack as you go.

Expert User Tips:

- The automatic interpolations options are designed to let you effectively and rapidly pick datasets. If you set the analysis positioning to be "At pointer", you can then set a velocity function at the start and the end of the line – simply click on the stack or the isovels plot where you want to pick.
- Set the picking increment to be coarse – double or four times the resolution you need – on the 'Analysis location' parameter form and then step quickly through the dataset. After this first pass, change the increment and step back through, infilling velocities.
- The interpolation allows you to make fewer and fewer picks, as you are simply modifying the automatically interpolated picks.
- Where you have channels or rapid variations of structure, you can simply add a new location outside of the fixed increment pattern.

The **isovels** display can be used to view and edit your velocity field. This view - coupled with the ability to view the previous and next velocity functions - helps you to get to a more accurate velocity model faster.



The isovels display; this is linked to your picking and updates as you make picks.

You can use the **isovels** display to edit or manipulate velocities. The options to add and delete velocity functions (or values), move velocity values, edit velocity values, and replace velocity values can be accessed using the ‘circulate’ button, marked with circular arrows and labelled “(keyboard)”.

The **isovels** display in **CVA** is a version with limited functionality, much in the same way that the stack is displayed in an **XVIEW** window with limited capabilities. The full version of **isovels** includes smoothing, editing and velocity conversion functionality and can be accessed from the ‘Velocities’ tab on the Launcher.

Geophysics Comments:

- In general, you need to make velocity picks at least 100ms TWT apart; closer than this can create instability in the velocity function and interval velocity analysis display.
- While picking, it’s worth keeping an eye on the interval velocity displays to see if they are realistic. For example, 1500m/s is the speed of sound in water; an interval velocity close to this value on marine data may indicate that you are picking multiples
- Sandstones and mudstones on the seafloor that have not been compacted and inverted tend to have low interval velocities, rising slowly from 1600m/s or so. Limestone tends to have a velocity of around 3000-3700m/s. Halite (salt) has a velocity of 4500m/s.
- Interval velocities are unlikely to be higher than 5500-6000 m/s, even in the hardest metamorphic and igneous rocks. Velocities higher than this are likely to be diffractions or out-of plane.
- The stacking velocity generally increases with depth; inversions are possible but unusual.

CVA has a range of picking approaches you can use, which are configured via the **Analysis Calculation Parameters** form (under the Params menu on the main Stack window) that we looked at earlier.

Variable Velocity Gathers (VVG) mode displays the selected CDP gather NMO corrected with a number of different velocity functions, spread over the same range (fan) as you see in the semblance spectra.

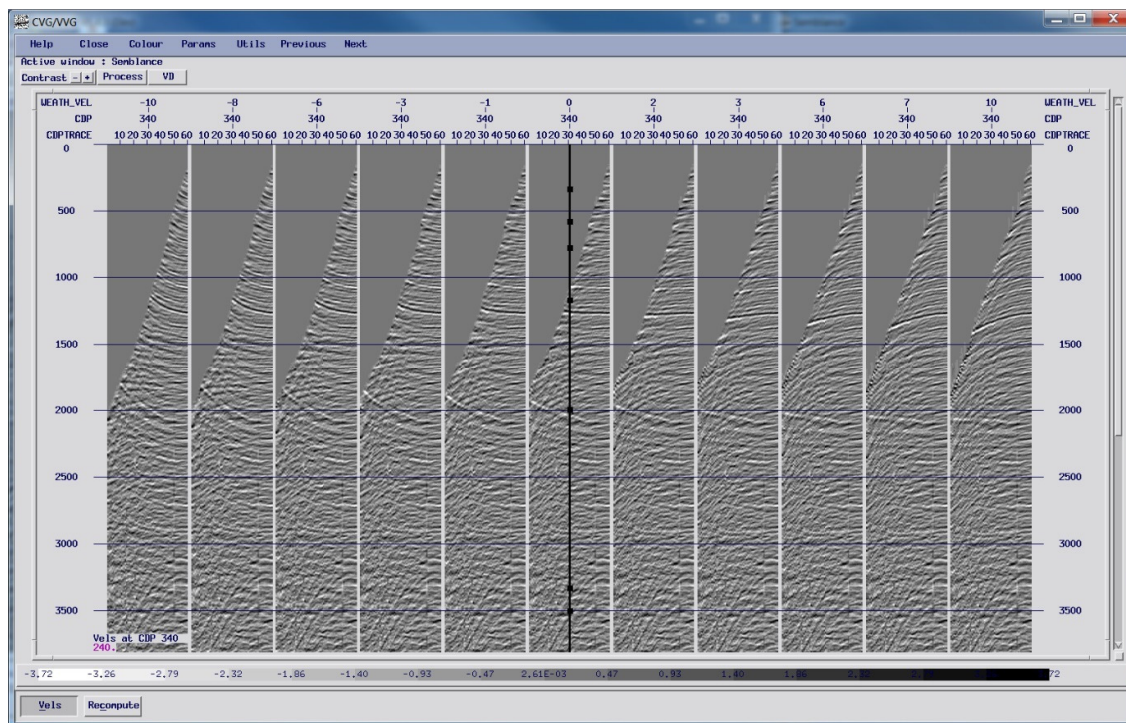
Variable Velocity Stacks (VVS) mode displays a “mini-stack” centred on the CDP location corrected and stacked for each of the velocity functions in the “fan”.

You can select to use **constant** velocities in place of **variable** velocities; this mode allows the use of constant velocity gathers (CVG) and constant velocity stacks (CVS), as well as populating all of the semblance spectrum, not just a “fan”. The CVS plots can be displayed side-by-side or overlaid as panels in an XVIEW-style display.

There’s also a full range of controls for choosing how to select analysis parameters, that you can adjust using the **Analysis Positioning** parameter form.

These include options to position the analysis at the pointer when you click on the stack or isovel display (as opposed to snapping to the closest $v(t)$ function that exists), as well as being able to click and drag to define a box (in CDP and time) for the analysis.

You can also limit the time range (useful with CVS or CVG displays) allowing you to pick velocities in a “layer stripping” way.



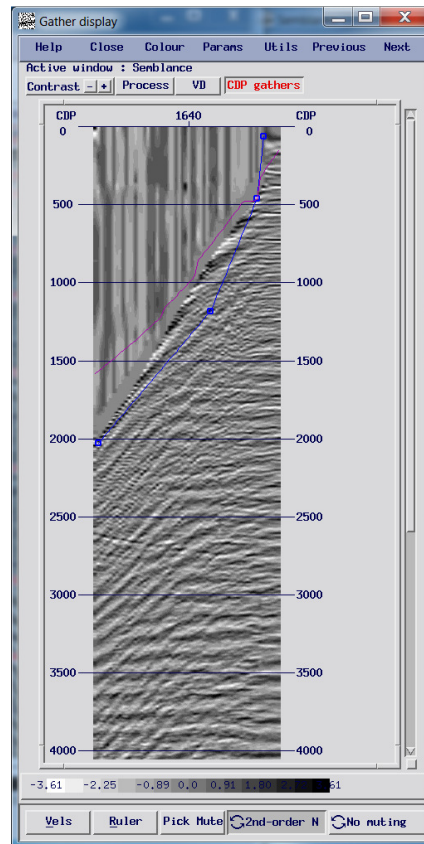
A side-by-side variable velocity gather (VVG) display; note how the data is over corrected (up dipping) to the left, and under corrected (down dipping) to the right. In this mode, you pick on the flattest event across the variable velocity gathers, and then use the “recalculate” button to re-centre the display on the new function.

5.8 Picking a Stretch Mute

Where the NMO correction is large (longer offsets, shallower two-way-times and lower stacking velocities) the difference in the correction at the top and base of a given reflector can become large; this in turn leads to “NMO stretch” – a broadening of the event which obscures detail.

In general we “mute” data that has become too stretched; in the initial configuration for CVA we set the automatic stretch mute to “200%” (which is effectively no muting) however we will get a better quality stack if we pick a stretch mute.

You can do this on the gather display in CVA, by pressing the “Pick Mute” button; this works in the same way as picking a refraction mute in SV.



Picking an NMO stretch mute in CVA. The blue line is the picked mute, with the squares showing where the (time, offset) picks have been made. The purple lines shows the automatic stretch mute.

The option to save the mute can be found under the “File” menu on the main (stacked) display.

Call the mute “**picked**” – CVA will save it in the correct location and with the right file extension automatically.

5.9 Checking Your Progress and Live Updates

When you have picked some velocity functions and an NMO stretch mute you can see the effect this will have on the stack as a whole by restacking the data.

- **Press the Restack button (bottom right) on the Main Stack display window**

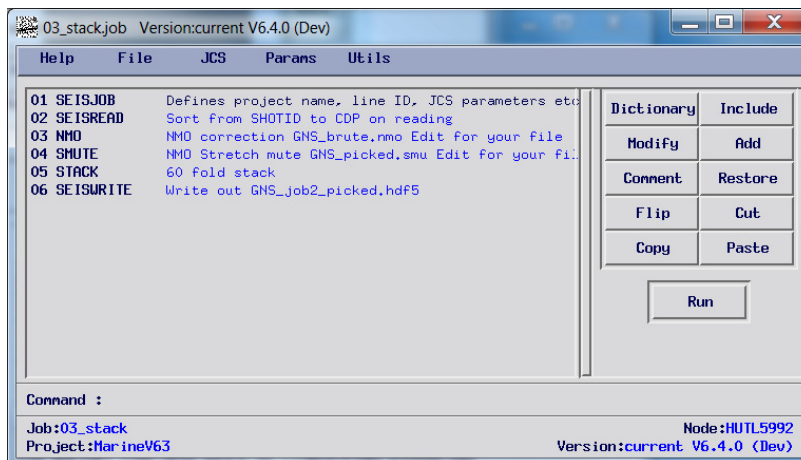
When you restack the data a second panel – labelled “Re-stacked” – is created on the Main Stack display window. You can toggle between these two panels using the mouse, arrow keys or by pressing “1” and “2” on the keyboard.

The “Re-stacked” panel will update automatically as you adjust velocities.

5.10 Stacking the data in a flow

While we used CVA to stack the data earlier, we can also use a processing flow.

The processing flow **03_stack.job** sorts the shot-ordered data to CDP and creates a stack; it's configured to work with the "GNS" default file names, so you will need to edit the flow to use your own picked mutes and velocities.



The processing flow to create a stack from the shot ordered data; note how the SEISREAD module can be used to sort data from SHOT to CDP automatically.

It is worth checking this flow to see how the shot-to-CDP sorting is configured – all you do is specify CDP and CDPTRACE as the primary and secondary key in the SEISREAD module.

When the flow has completed – and you have checked you have 1870 stacked traces output according to the log file – you can go to SeisCat and display the two stacks. You may need to refresh the view by right clicking on the project name and selecting “Refresh file listing”.

The default names for these files are:

GNS_job2_CvaStack.hdf5

GNS_job2_picked.hdf5

If you used different file names then they should be the two smaller files, that were most recently created.

You can confirm the velocities and mutes used to stack the data by using the Right Mouse Button (RMB) and clicking on the desired dataset in SeisCat and selecting ‘View/edit support-files table’, which will launch the following application/display interface:-

Supportfiles Table for /cygdrive/c/Claritas_projects/V68_2DMARINE/COMMON/DATA/GNS_job2_picked.hdf5 (Total of 30.6 Kb)

	Filename	Module	Action	Last modified	Filesize	MD5 sum	File Type
1	COMMON/JOBS/03_stack.job	SEISJOB	APPLIED	02-Aug-2018 15:27	9.4 Kb	25d3ca314750caec56d0d115322d24ac	JOB
2	COMMON/JOBS/GNS_job2.job	SEISJOB	APPLIED	02-Aug-2018 15:03	14.3 Kb	c22c1d779547cf266a5b6ab3607ce17d	JOB
3	COMMON/GEOMETRY/trv-434.geom	MGEOM	STORED	13-Jun-2016 15:31	960 bytes	78972d9d2ed838905d1707a6824d637d	GEOM-REG
4	COMMON/SCALE/02_1dB_second.scl	SCALE	APPLIED	02-Aug-2018 14:16	227 bytes	63f826e56149ad12c708d9de7c4c36ac	SDE-SCL
5	COMMON/MUTES/GNS_refraction.smu	SMUTE	APPLIED	02-Aug-2018 14:16	335 bytes	a09a6874664c6c45a408864ebc9a2669	SDE-SMU
6	COMMON/VELOCITIES/GNS_brute.nmo	NMO	APPLIED	02-Aug-2018 14:16	5.2 Kb	8cbb39d6e38da741715fe60c424ef798	SDE-NMO
7	COMMON/MUTES/GNS_picked.smu	SMUTE	APPLIED	02-Aug-2018 14:16	295 bytes	f12963cf97954353ccdc9d7fc886647e	SDE-SMU

Add new

The interactive support files application, allows the user to QC/QA the velocities/mutes/geometry files etc applied/stored/removed or derived from the dataset being examined. Users can also remove or add support files into the support files table using this application.

The support files tables are only available in HDF5 format datasets, the information about the support file name, type, what's happened to it is stored in the HDF5 file itself, this table can be updated by the user without the need to rewrite the datafile, the MD5 sum information is used to sanity check and inform the user if the support files have been changed since stored in the trace header or applied to the data.

Back in SeisCat, highlight both files (GNS_job2_CvaStack.hdf5 and GNS_job2_picked.hdf5), and then right click to select SeisView. The viewer will automatically detect you are displaying stacked files, and the CDP range.

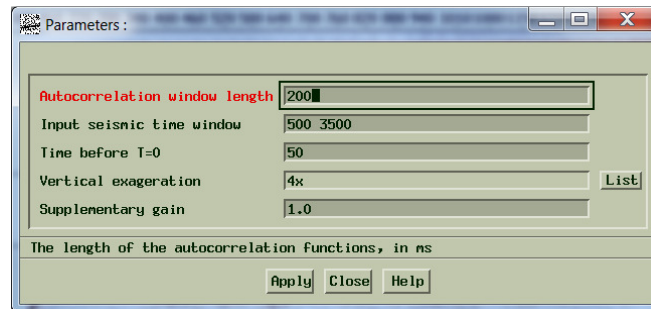
5.11 Deconvolution Before Stack

The next stage in processing is usually to apply deconvolution to the unstacked data. The goal is to reduce the long, reverberant source wavelet to a sharper pulse.

5.11.1 Looking at Autocorrelation Functions

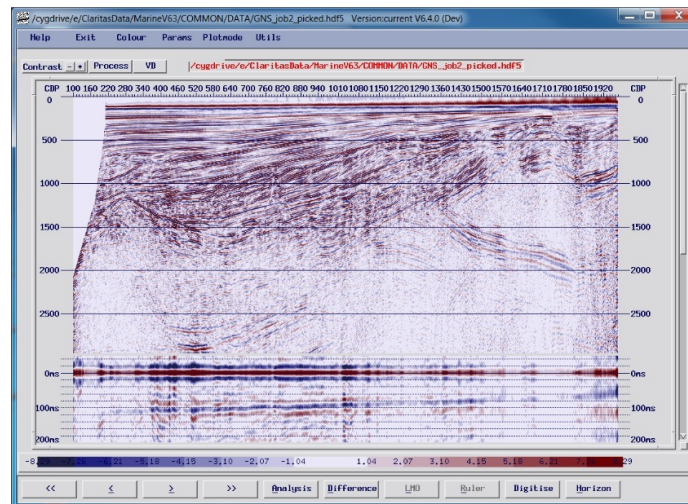
You can examine the reverberations using the stacked section we just created. Open the "picked" stack in SeisView.

- Click on the Params menu
- Select "Autocorrelation functions" in the lower section (NB : not autocorrelation zoom)
- Enter Autocorrelation window length as 200
- Enter the Input seismic time window as 500 3500
- Enter the "Time before T=0" as 50
- Make the vertical exaggeration x4
- Click Apply



The autocorrelation parameters window, configured for the stacked seismic dataset

This will append an autocorrelation function on the bottom of the stacked section which shows the “self-similarity” of the seismic trace within a 200ms window.



The stacked section with an appended autocorrelation function displayed in SeisView. There is a strong peak at zero lag (0ms) on the autocorrelation function, and then a weaker one below showing there are some reverberations in the signal.

In this dataset the main reverberations are caused by “multiples” – energy that has reflected off a rock layer in the sub-surface, but has then reflected off the sea-surface and again off the seafloor before being recorded.

This creates a “time delayed” copy (or “multiple image”) of the geology, that tracks the seafloor. In this case you can see the variation in water depth within the auto-correlation function from around 125ms on the left to around 50ms on the right.

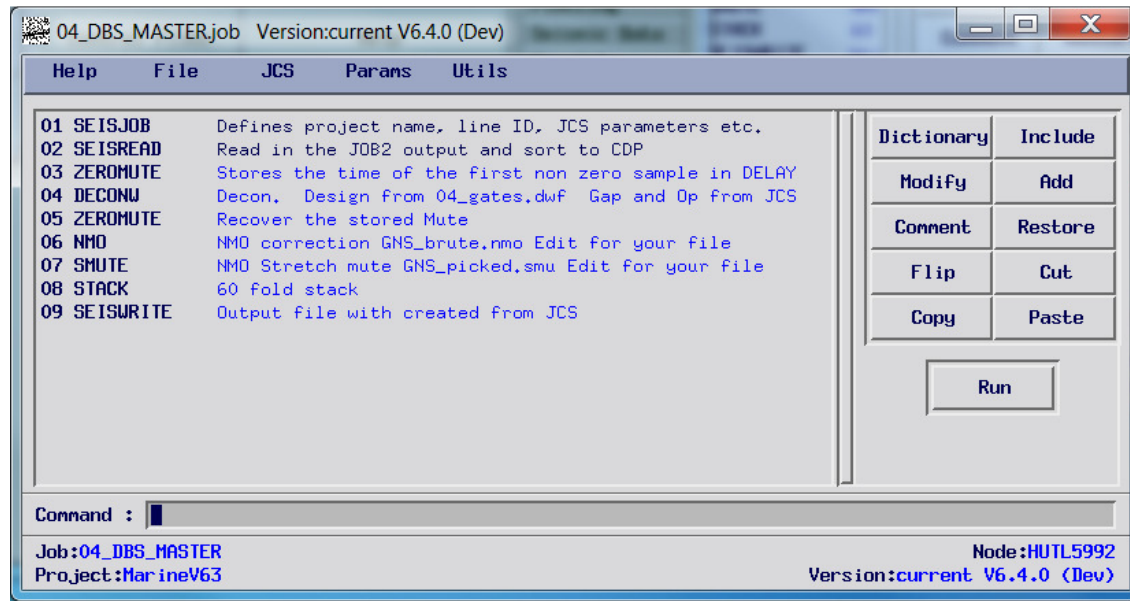
There will always be a strong peak at 0ms on the auto-correlation function; we can look at the width of this “zero-lag” peak to help guide parameter setting using the mouse. The “first zero crossing” occurs at about 8ms, and the second around 26ms.

To test the deconvolution, we’ll use the Job Control System (JCS), which allows us to make a number of similar processing flows automatically from a single master flow.

5.11.2 Using JCS for Parameter Testing

The Job Control System works using a spreadsheet, like the ones we have created for mutes or NMO velocity files. When we use it for testing, each line in the spreadsheet is a different test, and the columns contain the parameters that we want to vary as part of the test.

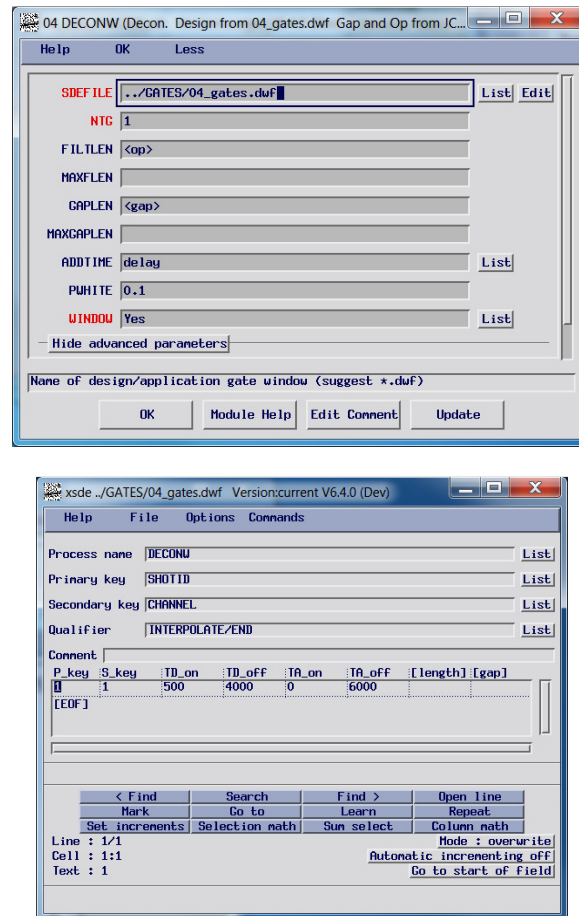
Open the processing flow 04_DBS_MASTER.job, and look at how the parameters are set up; look in particular at the DECONW and SEISWRITE modules.



The processing flow 04_DBS_MASTER.job, which is configured to work with JCS batch job creation. The DECONW and SEISWRITE modules both have parameters that have been replaced by the variable names <op> and <gap>

We could specify start and end gates based on a primary key (SHOTID) and secondary key (CHANNEL) for the deconvolution, however we can also create gates that are relative to the start of the data.

We can do this by storing the time of the first non-zero sample into a header (DELAY) using the ZEROMUTE module. Any module that uses time gates in GLOBE Claritas also has an "ADDTIME" parameter, which is used to add the time stored in a trace header (in this case DELAY) to the gates specified.



The gap deconvolution module DECONW and its associated design/apply gates definition file, 04_gates.dwf. Only one gate is defined, as the ADDTIME parameter makes these gates relative to a trace header, DELAY. We have stored the time of the first live sample in DELAY, so the deconvolution gates are relative to the start of the data. The FILTEN and GAPLEN parameters are variables, enclosed in angle brackets.

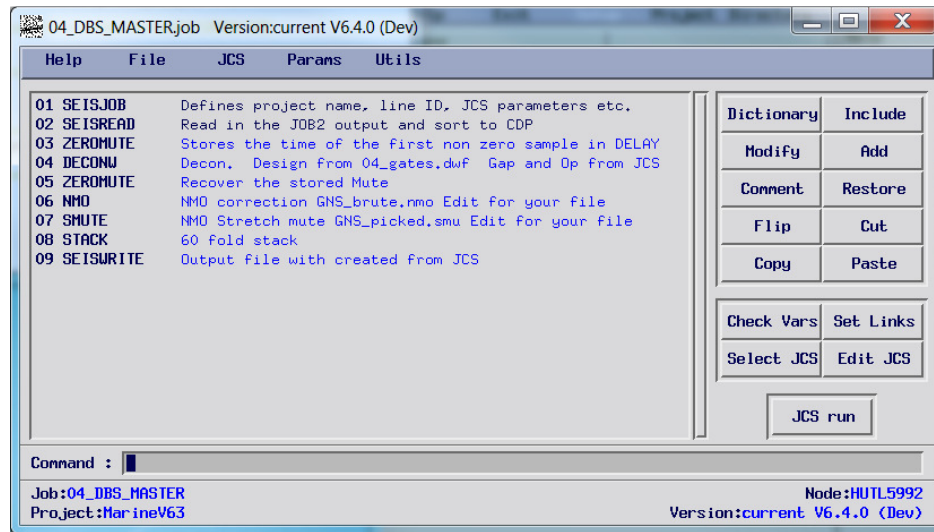
The JCS is designed to search through a processing flow looking for parameters that have been enclosed in angle brackets < >, which it then stores.

You can see a list of the variables that JCS has found in the SEISJOB module.

The system will then try to match the variable it found to names in the JCS spreadsheet; if it can't find a match then the user will be prompted to make the link.

Finally the JCS replaces each variable with the information from the appropriate column and creates a new processing flow, which it runs. It is important to include a unique combination of variables in the processing flow name and in any output files, to avoid over-writing.

To initiate JCS mode, click on JCS toolbar menu option at the top of the flow editor. This will add some new buttons to the display.



The processing flow 04_DBS_MASTER.job with the JCS mode active; there are new buttons to allow you to identify variables in the flow, link these to a JCS spreadsheet, and to create and run multiple flows based on this master job flow.

- Click on the Check vars button, to confirm that <op>, <gap>, and <SEQnum> are the only variables
- Click on the Edit JCS button, to review the parameters <op> and <gap> and how these will change
- Click on the Set Links button, to make sure the columns are linked to the variables
- Click on Select JCS, to pick which lines to run (select all of them)
- Click on JCS run, and then OK (to accept the defaults)

The JCS tools will now build and execute eight different processing flows, with each one taking around 30 seconds (or less) to run. Each flow will have different pre-stack deconvolution parameters applied to the output.

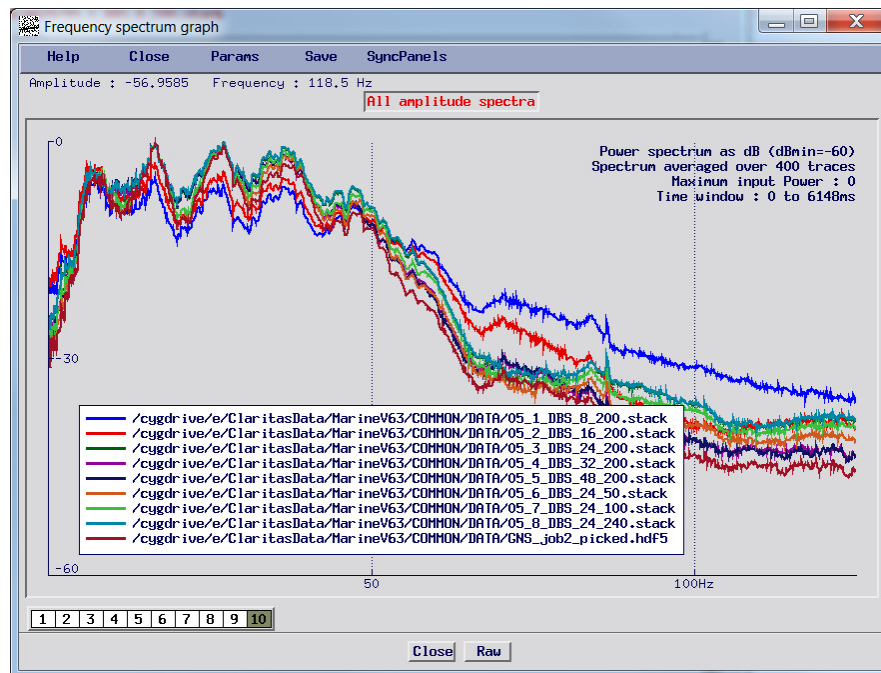
When these have completed you can then select them in SeisCat (you may need to refresh the project) and right click to display them in SeisView.

You can also add the picked stack to your viewing list – remember to set the CDP range to that of the tests (821 to 1220) if you take this option.

Add the autocorrelation function (Utils, Add Autocorrelation display) and compare the results.

The shorter operators (<200ms) don't reach the multiple, and so fail to suppress it.

If you look at the frequency content (Analysis, frequency spectrum graph) you can see how the shorter gaps (8ms and 16ms) "whiten" the signature more, adding low and high frequencies.



Overlaid frequency spectra from the deconvolution before stack testing compared on stacked sections using the SeisView viewer.

We can also use this same JCS approach to look at selected shot records with deconvolution applied, before making our final parameter choices.

The processing flow 05_DBS_shots_MASTER.job works in the same way, except this takes a subset of the shots from the line (from 100 to 900 with an increment of 100) and applies the deconvolution.

You can run this job, and compare the outputs in the same way.

Expert User Tips:

- There are two of other processing flows for deconvolution included for completeness.
- The first flow is **06_SC_decon.job**; this applies a shot-consistent deconvolution where the autocorrelation function is averaged over a whole shot record.
- The job flow **07_TauP_decon.job** demonstrates the application of Tau-P domain deconvolution within GLOBE Claritas.
- This approach is also using the OFFREG module to interpolate the shot records to a 6.25m group interval prior to the Tau-P transform, coupled with a K-filter to remove spatial aliasing effects.
- These are both techniques that can be used to obtain a superior result, however the geophysics is not detailed in this tutorial.
- Both processing flows are configured to run with selected shots; you can modify these to apply to the whole line, however the Tau-P flow can take several hours to run on all shots.

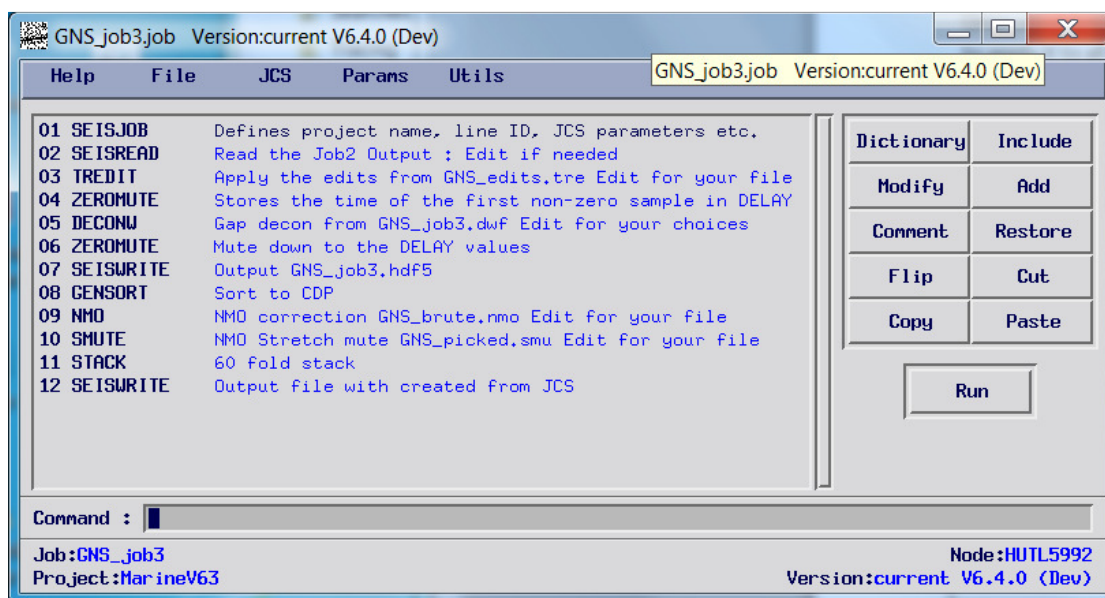
5.11.3 Applying Deconvolution Before Stack

Once you have determined which parameters you are going to use for deconvolution, you will need to apply it to all of the shots. We also need to apply the trace edits that have been made, and as part of the processing flow generate a stack that we can compare to what we have run so far.

This has all been set up in the processing flow **GNS_job3.job** with some default parameters and file names. You can use these as they are, or modify them to reflect the parameters you have chosen and the files you have created.

- The name of the input dataset from the processing flow “Job 2” in **SEISREAD**
- The name of the trace edits file you created (**GNS_edits.tre**) in **TREDIT**
- The deconvolution parameters you have used in **DECONW**
- The name of the velocity file you created (**GNS_brute.nmo**) in **NMO**
- The name of the NMO stretch mute file you created (**GNS_picked.smu**) in **SMUTE**

You can also change the names of the two output files in the **SEISWRITE** modules, if needed. Note how this job flow uses the **GENSORT** module to sort from shot-ordered data to CDP-ordered in the middle of the flow. It’s more efficient to sort-on-read using **SEISREAD**, however sometimes sorting in the middle of a flow is still useful.



The processing flow **GNS_job3.job**, which you should edit to reflect your parameter choices and meta-data files.

If you have chosen a more sophisticated deconvolution approach such as shot consistent deconvolution or Tau-P domain deconvolution, you can use the **Include** button to open up the test flow, and copy in the modules you need to the right place. You may have to use **Cut** and **Paste** to remove unwanted modules or to change the order if you get the positioning wrong.

Run the processing flow, and when it has completed you can use **SeisCat** to select and compare the stacked output (with the other stacks you have created) by selecting them and right clicking, as before, and then the shots outputs (**434_raw.hdf5** along with the outputs from the Job2 and Job3 flows).

Remember to append an autocorrelation function to both displays, so you can confirm the deconvolution has worked as expected.

5.12 Removing More of the Multiple Energy

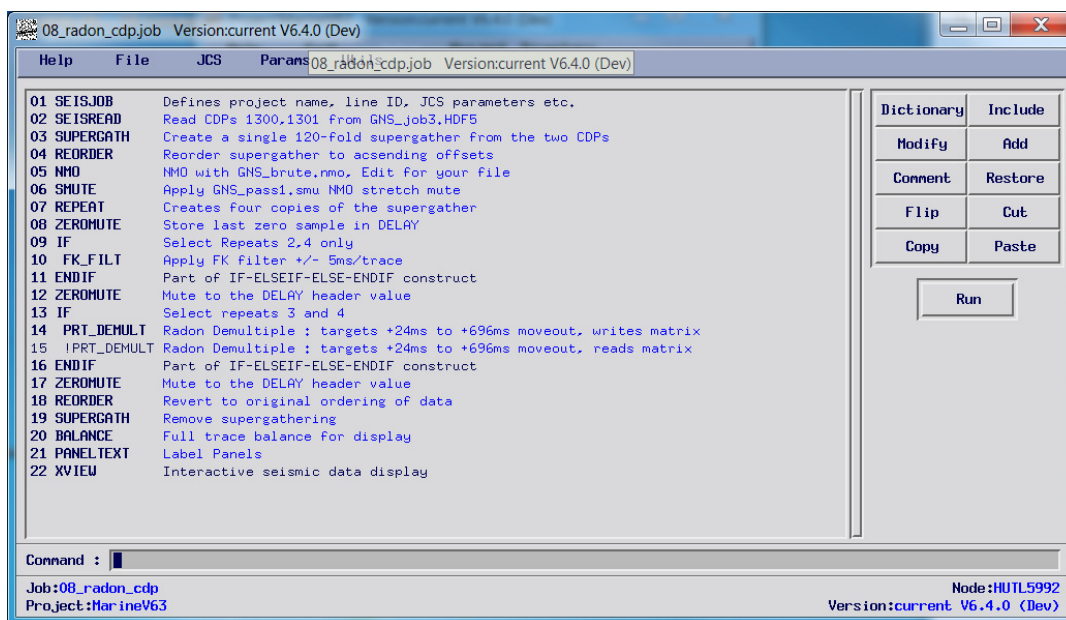
One of the challenges in picking velocities was the multiples on the deep part of the section, especially over on the right (high CDP numbered) side. Some of the multiple will have been removed by the deconvolution process, however there are other approaches we can use for multiple attenuation that are based on the NMO velocities of the “primary” and “multiple” events.

Multiples always stack up (ie are flattened) with a slower velocity than primaries. If we NMO correct the data so that the primaries are flat, we can use a dip filter to suppress the down-dipping (“slower”) multiples.

There are several different types of “dip filter”, some of which use linear dips (like FK or linear Tau-P) and some of which use parabolic or hyperbolic events (like the parabolic or hyperbolic Radon transform)

5.12.1 Testing Demultiples Approaches

Open the job flow **08_radon_cdp.job** which is designed to apply a combination of linear dip filters (FK) and parabolic dip filters (parabolic radon) to a few NMO corrected CDPs.



The processing flow **08_radon_cdp.job**, which is set up to test apply velocity-based multiple attenuation.

There's a few things in the flow you may need to edit, like the filename in **SEISREAD** and the velocity field for the **NMO** correction.

A few other things to note are:

- The processing flow creates four copies of two CDPs
- These CDPs are merged together to make a “super gather”, with data from an even numbered CDP (1300) and an odd numbered CDP (1301)
- There are two different **PRT_DEMULT** modules for the parabolic radon demultiple. The parabolic radon transform can need a large matrix which is slow to calculate. If we save the matrix the first time we run the flow (module 08), we can then read that matrix back in the next time (module 09) so the flow runs faster
- The radon demultiple is only applied from 1000ms TWT (TSTART is 1000), as above this there is too little velocity moveout difference between primary and multiple

We use supergathers because there will be improved resolution in the Radon and FK domains with 120 traces 25m apart (as we have in the shots) instead of 60 traces 50m apart (as we have in the CDPs).

The **IF/ENDIF** loops have been set up to produce four panels, so that you can compare the results of the FK and Radon demultiples separately and combined.

Run the processing flow, and compare the results on the panels.

The Radon demultiple alone is quite noisy, because of the spatially aliased linear noise still in the gather as well as the conservative choice of transform parameters; this is designed to make the flow very “tolerant” of non-optimal velocities or mutes. Applying the FK helps to create a cleaner result by addressing any residual linear noise and spatial aliasing in the data.

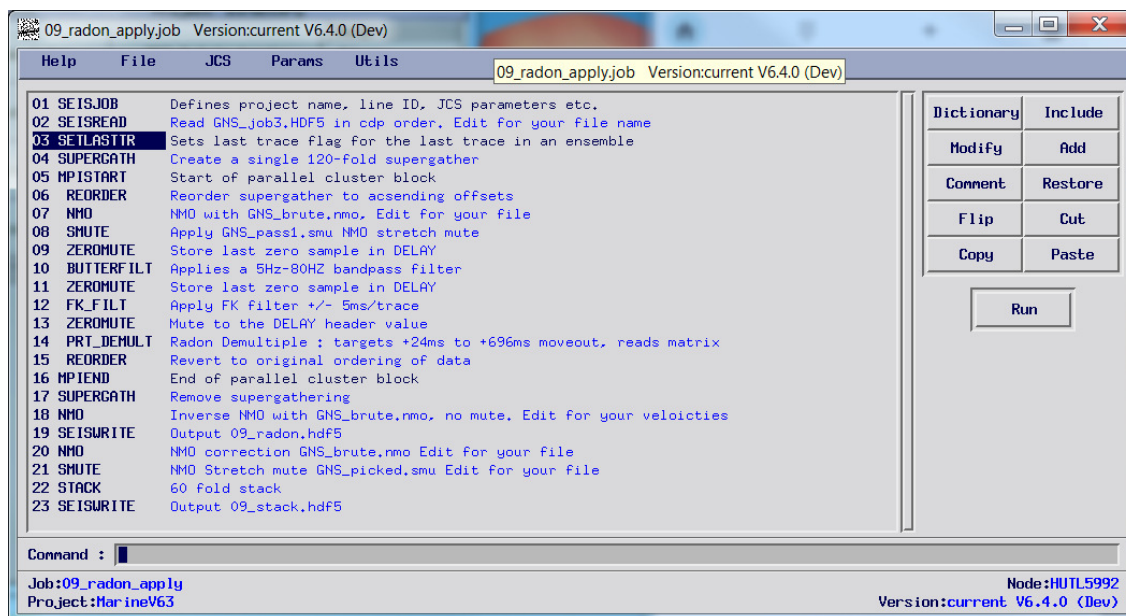
Expert User Tips:

- The radon parameters have been selected to give a reasonable result even if the velocity and mutes are not ideal. Experienced users may be able to obtain a better result by modifying the transform range.
- The linear noise components addressed by the FK filter would be better addressed by applying a mute in the Tau-P domain at the same time as Tau-P deconvolution and by better designed mutes, which would remove the need for the FK entirely and give a much cleaner Radon result.
- Usual practice would be to over correct the primaries with 90% of the NMO velocity; there is an option to scale the velocities in the **NMO** module

5.12.2 Applying Demultiple Methods in Parallel

The “production” flow to apply this to the whole line is called **09_radon_apply.job**. As before, you should edit this flow for your own input data, velocities and mutes.

As the processing flow can run quite slowly, it has been configured to make use of multiple cores or CPUs on your computer. Most processing flows can include a parallel component if required – this can be some or all of the flow, as long as the group order is not changed.



The processing flow 09_radon_apply.job, which is designed to sort from shot records to CDPs on read, processing the data in parallel, and create both CDP gathers and a QC stack outputs.

Some things to note:

- There are three different NMO modules that you may need to edit for your velocity file name (07, 18, 20)
- There are two different SMUTE modules that you will need to edit for your picked mute name (08,21)
- The part of the flow which will run in parallel is between modules 05 and 16
- You will need a licence that supports parallel processing to run in parallel; if you do not have this licence, you should use the “FLIP” button to “turn off” the MPISTART and MPIEND modules

When you click on “run” you will be asked how many nodes (computer cores) you want to run on.

It’s a good idea to not run the process on all available cores – this will tend to “redline” the computer, making it slow and unresponsive; you may also find that leaving several cores “idle” gives improved performance, especially if the computer you are using employs multi-threading to create “virtual cores”.

Expert User Tips:

- GLOBE Claritas “scales” very well in parallel, up to thousands of cores
- You need to have at least 2Gbytes of RAM available for each core you want to use; in many cases, more cores are better
- Some processes like SRME demultiple or preSTM have separate parallel modules

5.12.3 Checking The Results

Using the SeisCat application, select the files **09_stack.hdf5** and your output from JOB3, which will be called **GNS_job3.stack** if you didn't change the file name, and then right click to display them with Seisview.

You should also review the output gathers **09_radon.hdf5** using Seisview; display 5 ensembles at a time, with an increment of 50.

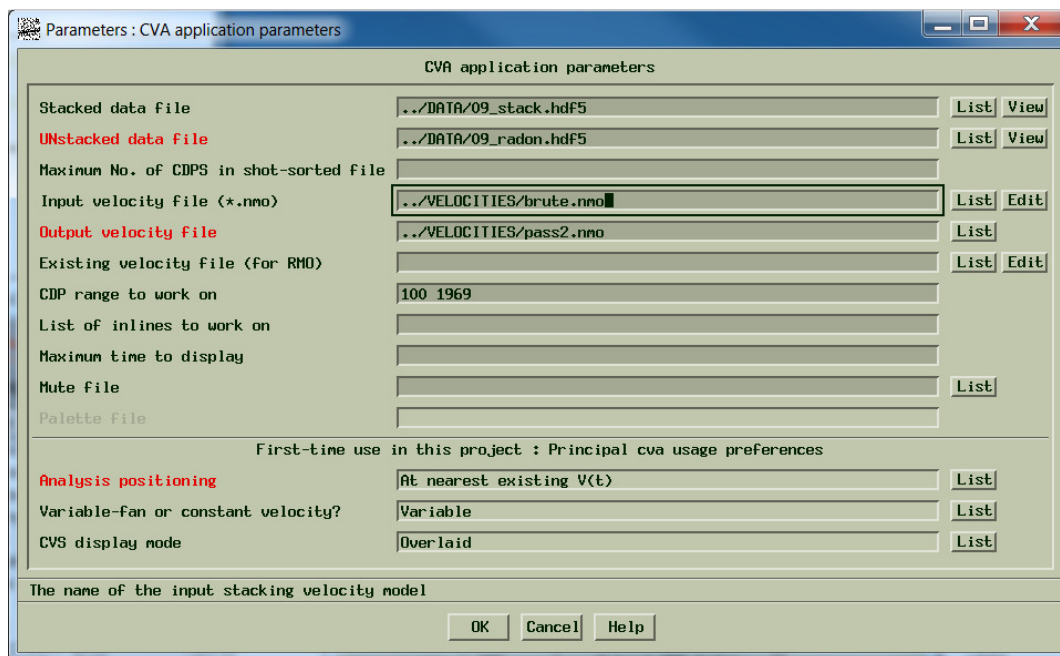
- Use the arrow buttons <<, <, >, >> to step through the data
- To review with an NMO applied, click on the Process button, type "NMO" for the processing sequence and click OK. You can then select the NMO velocity file to apply

With the multiple removed, we should be able to pick a better velocity field.

5.13 Second Pass Velocities

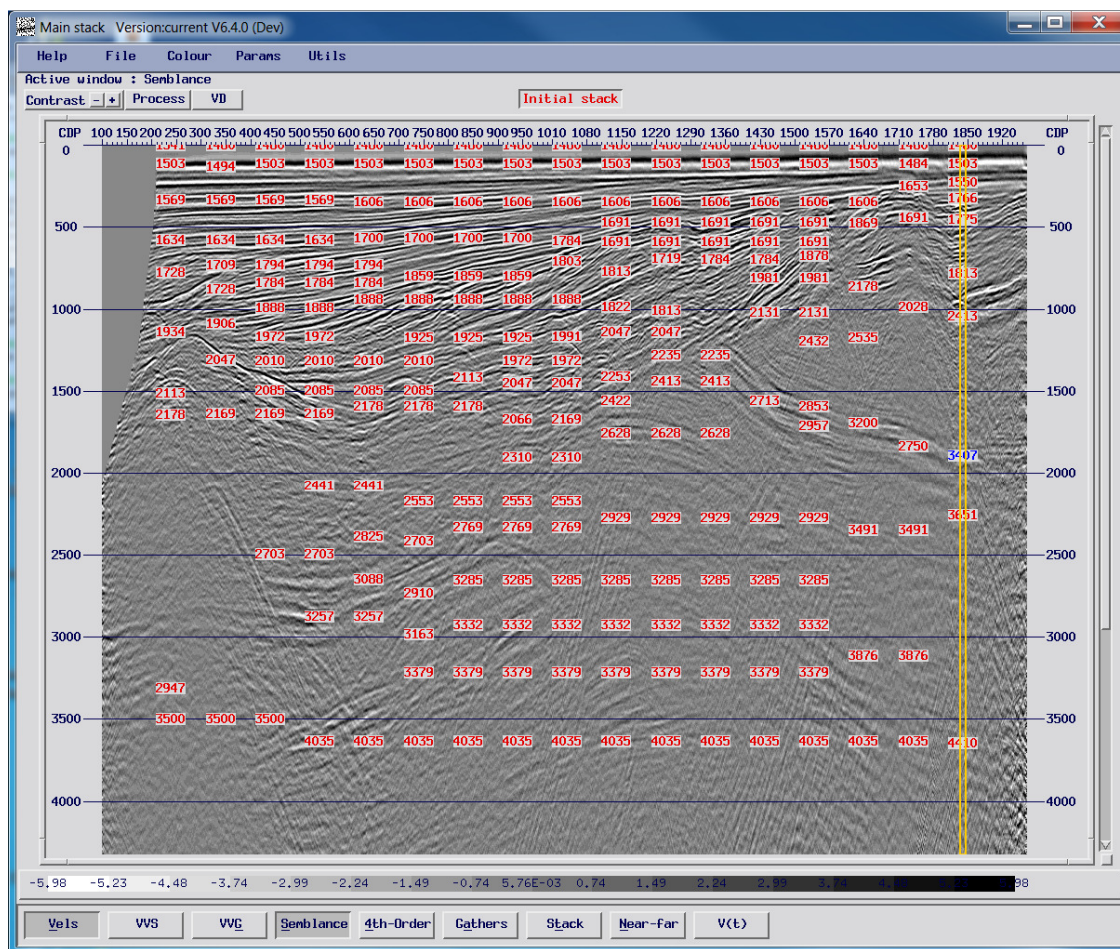
Now that we have addressed the reverberation and multiples in the dataset it should be a lot easier to pick velocities, especially at depth.

We have already got a stacked dataset, so we can go straight into CVA to pick velocities again, although in practice we will be modifying the velocity field we picked before, as this is a lot faster to do.



The initial CVA parameter form set up for repacking velocities after the radon demultiple processing flow; you should adjust the input and output file names to match your own choices. The files **GNS_brute.nmo** and **GNS_pass2.nmo** should also be available to compare with.

This time when you start CVA, the stack will display with the input velocities overlaid in red.



The input stack and velocity field for the second pass velocity analysis; picks that have not been modified are colour red, and those that have been adjusted are coloured blue.

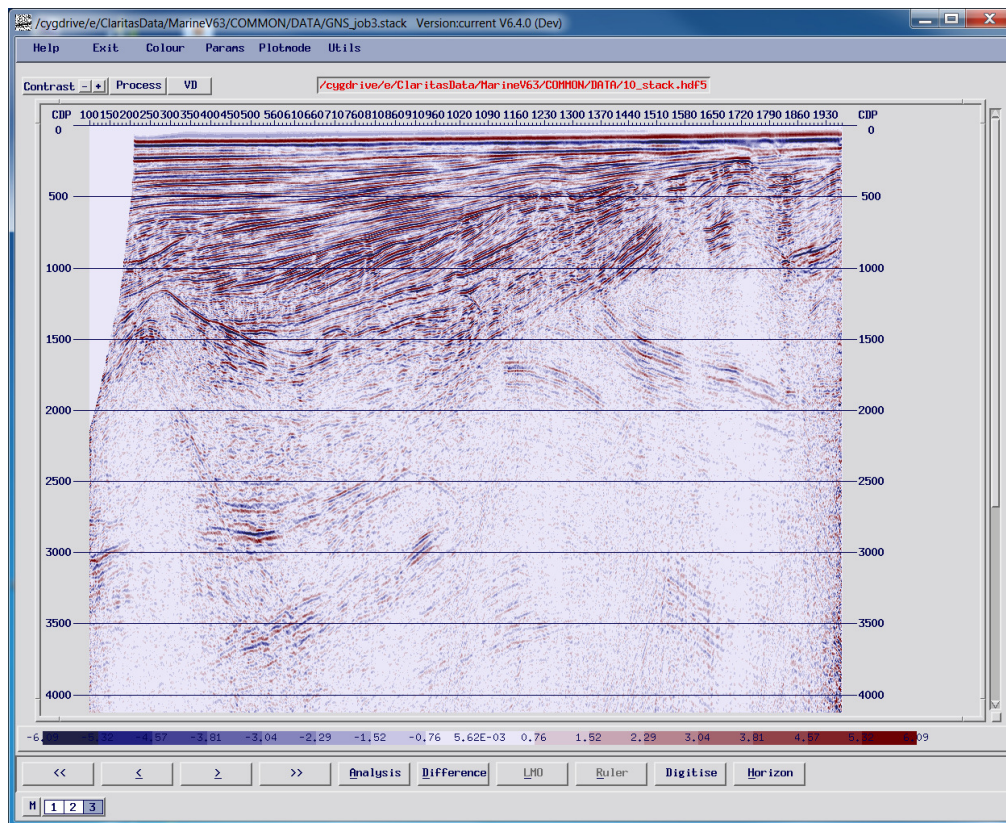
As you repick the velocities using the left mouse button to move (hold down) or delete/re-pick the velocity values on the stack will change from red to blue, so you can easily see where changes have been made.

When you are satisfied with the velocities, save and exit (under the “File” menu)

5.13.1 Restacking the Data

The processing flow **10_restack.job** is set up to restack the data with the new velocity field; you will need to modify this for your velocities, and your mutes.

As before, you can compare the output from this flow **10_stack.hdf5** with **09_stack.hdf5** and the output from Job 3 (**GNS_job3.stack** is the default name) by selecting the files in **SeisCat** and picking the ‘View with seisview’ option.



The radon demultiple gathers output from 09_radon_apply.job, after restacking with the velocity field GNS_pass2.nmo in the processing flow 10_restack.job.

5.14 Pre-Stack Time Migration

The next stage in processing is an imaging step called pre-stack time migration.

Geophysics Comments:

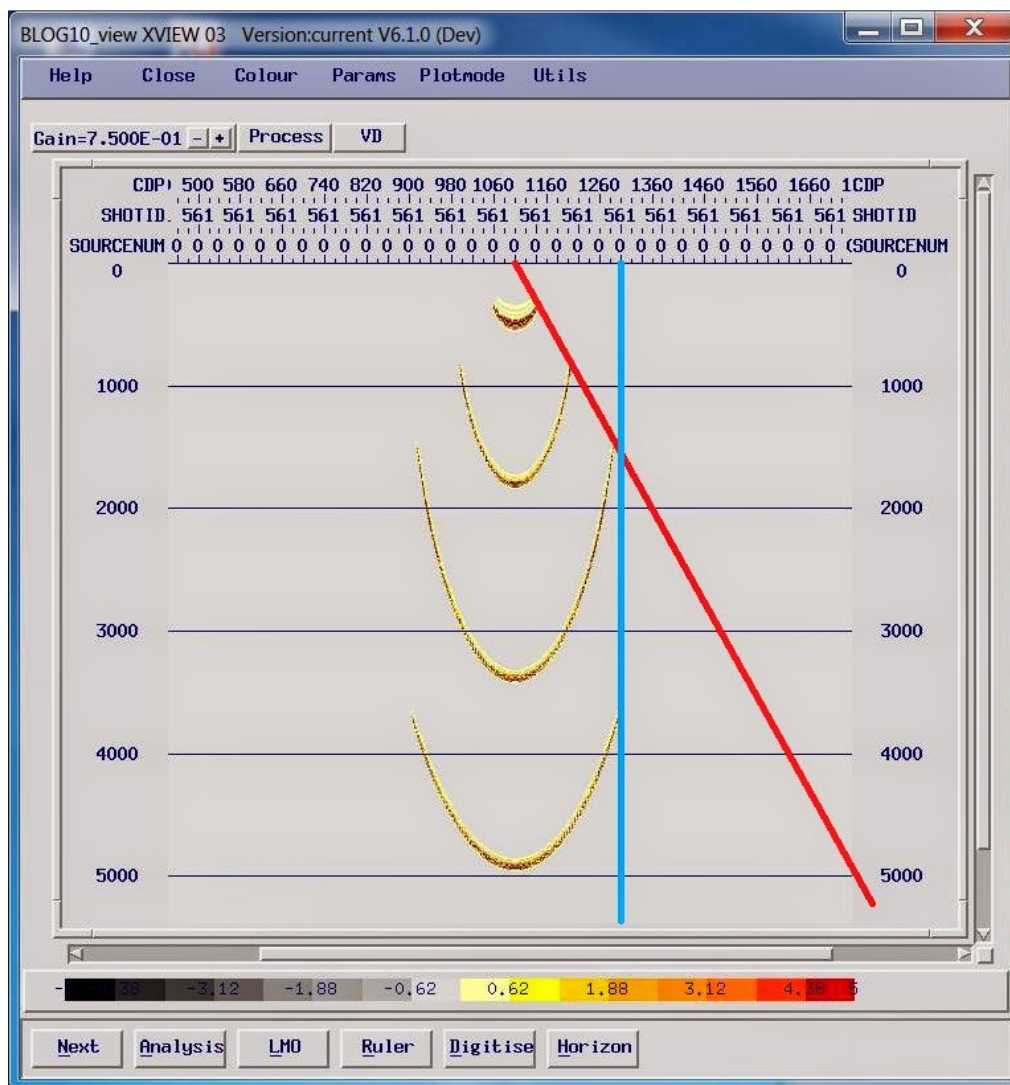
- A stacked section is a “normal ray” zero-offset section. It is the result we would see from a co-incident shot and receiver (zero offset) with the seismic energy reflecting off the sub-surface with a normal incidence raypath
- While flat structural events are positioned correctly, dipping events are distorted and laterally miss-positioned. We also have diffractions in the data
- Migration will collapse the diffractions and correct for dip to produce an improved structural image
- Time migration produces an image ray section, where the ray paths are still influenced by refraction at layer boundaries or within rock layers; where the velocities vary rapidly either laterally or vertically, dipping events will be miss-positioned
- A depth migration would produce a “vertical ray section” with no miss-positioning, but requires a complex velocity model and is out of scope for this tutorial

5.14.1 Preparing the data for PreSTM

Pre-stack time migration is a kinematic process with a wide operator shape. As a result, it will partially correct for spherical divergence – so we need to remove this from the data before we run PreSTM. The processing flow **11_migprep.job** removes the spherical divergence that we first applied – if you modified the spherical divergence parameters for JOB2, you will need to edit the processing flow.

5.14.2 Pre-Stack Time Migration

The Kirchhoff pre-stack time migration is a “stand alone” module, which needs to be the only module in the processing flow. The data is formed into “common offset planes” and migrated using a Kirchhoff operator; there are a series of key parameters that control the quality of the migration by placing limits on the operator.



A series of spikes migrated with the Kirchhoff operator. The red line is the “angle” limit, where the blue line is the “range”; in the near surface you can “protect” the near offsets so these are not affected by the “angle” limit. There are also controls for how far the wavelet becomes stretched, as well as anti-alias filters for steeper dips.

The key parameters are the range (migration aperture) and dip limits; there are also anti-alias and stretch controls for situations where you have very large angles, and a parameter to “protect” the near surface image by limiting the impact of the “angle” based muting.

02 IMAGE_K2T

Help OK

INPUT FILE ../DATA/11_prep.hdf5 List View

OUTPUT FILE ../DATA/12_preSTM.hdf5 List

V5_OUTPUT No List

NMO FILE ../VELOCITIES/GNS_pass2.nmo List View

ETA FILE List View

GEOM FILE List View

MARINE Yes List

Output cdp/offset

CDPSTART 100

CDPINC 1

CDPEND 1969

STARTOFFSET

ENDOFFSET

OFFSETS -3220:-270/50

CDP_DIST 12.5

Migration specific parameters

RANGE 6000

PROTECT 150

ANGLE 35

STRETCH 120

STRETCHMODE List

ANTI_ALIAS 4

PSEUDO_3D No List

TAPER 20.0

MPI configuration

MPI_COMMAND

TOTAL_PROCS 5

Input seismic data file (Claritas SEGY or HDF5)

OK Module Help Edit Comment Update

The parameter form for Pre-stack Time Migration, configured to run on 5 cores (TOTAL_PROCS) in parallel. This is the processing flow 12_preSTM.job – you will need to modify the NMO file to match your chosen file name.

The processing flow 12_preSTM.job runs the pre-stack time migration; it is currently configured to run on 5 cores in parallel. If you have sufficient time, you can test the imaging parameters and compare

results. Relaxing the angle produces steeper dips, but gives a noisier output requiring harsher anti-alias filtering.

The output from the preSTM is ordered in offset planes; the processing flow **13_image_stack.job** creates a stack from these data that can be compared to the un-migrated stack **10_stack.hdf5**

The pre-stack time migration has built in edge effects scaling at the start and end of the line, to mute/scale traces that prior to migration were empty where the migration operator would “swing” energy into these traces and create noise.

The processing flow **13_image_stack.job** produces a stack of the PreSTM output for input into the CVA application for RMO velocity analysis.

5.14.3 Residual Moveout (RMO)

The velocities used for pre-stack time migration are influenced by the dip of the events, so that the resulting preSTM gathers might not be perfectly flattened.

The velocity analysis tool CVA has an RMO (residual moveout) mode that can be used to tune the velocities and optimise the stack without re-running the migration.

To pick an RMO field, use CVA with the following parameters:

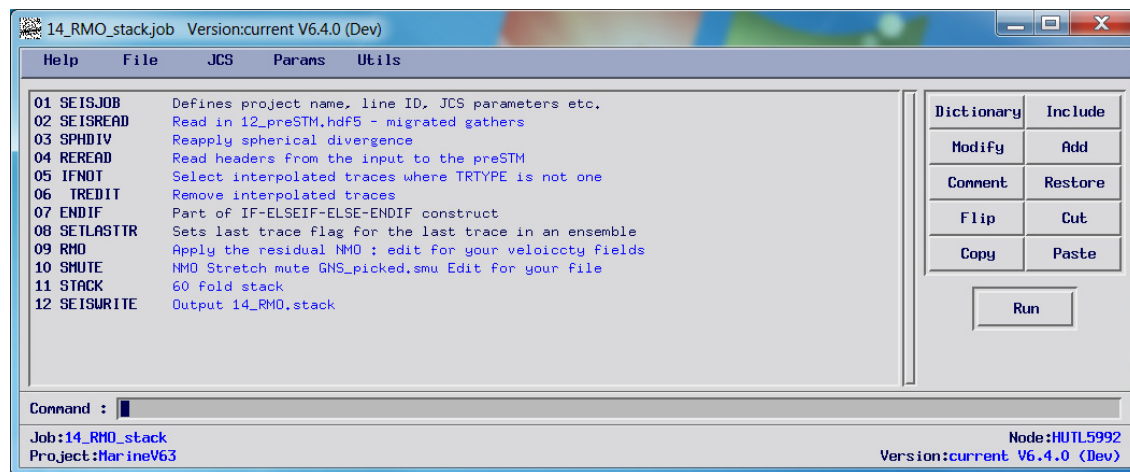
CVA parameter form set up for RMO analysis; you will need to modify the velocity field names to match your choices, including the output field; they key thing is that the Input Velocity file is the same as the Existing Velocity file which was used for the migration.

Residual Moveout analysis is, for the user, identical to repicking the velocity field. The “existing field” and input flattened gathers are automatically taken into account, so that you are simply adjusting the current picks to produce a flat gather. The output velocity field is a normal “nmo” velocity.

While you could remove the “old” velocity field using an inverse NMO and apply a new forward NMO correction with the picked residual moveout field, this is computationally expensive and does degrade the quality of the result slightly.

Instead, there is a specific processing module, **RMO**, which applies the differential moveout between the original input field (used for migration) and the newly picked RMO field.

The processing flow **14_RMO_stack.job** creates a new stack with the residual moveout applied.



The processing flow **14_RMO_stack.job** with the residual moveout (RMO) module; this applies the differential moveout between the migration velocity field and the picked RMO field.

When you have run this job you can compare the stacked results from the radon demultiple (**09**), the pre-stack time migration (**13**) and the RMO (**14**) phases, by selecting the stacks on the **SeisCat** display and using **SeisView**.

6 Post Stack Processing

Once we have our final images stack, there's a limited number of things we can do to further improve the quality of the result.

6.1 Post-Migration Deconvolution

If you display the stacked result (**14_RMO.stack**) using **SeisView**, and then append an auto-correlation function (**Utils – Add Autocorellation Display**) then you can see there is still some level of reverberation in the dataset, which we can try to address using a post-migration deconvolution.

The processing flow **15_DAM.job** is configured to test four different post-migration deconvolution operators, and display the results. You should compare these with an auto-correlation function appended, as well as looking at how the deconvolution has varied the frequency content - much as you did for the deconvolution before stack.

6.2 Random Noise Attenuation

There are a number of different random noise attenuation routines you can apply; in general they use frequency and/or dip in some way to identify or enhance coherent signals.

The processing flow **16_random.job** is configured to apply a selected post-migration deconvolution (32ms gap, 400ms operator) followed by three different random noise attenuation methods.

It can be difficult to see differences between panels; you can use the “difference” panel option (**Utils – Plot difference**) to create a new panel that is the difference between two existing panels.

6.3 Filtering

When you have selected the noise attenuation you prefer, you can also explore using post-stack filtering to further remove noise. In general, we'd expect higher frequencies to attenuate with depth, and in this dataset the deep (13m) cable tow depth also restricts the frequency content.

You can create filter panel displays (**Utils-Create a Filter Panel**); these are initially band-pass filters, however if you right-click on the button labelled “Band Pass” on the filter display and select “Low Cut” you can explore which frequencies contain useful energy.

6.4 Scaling

The processing flow **17_scale.job** uses the same **REPEAT** and **IF/ELSEIF/ENDIF** approach to look at different ways to apply a final scaling to the seismic section. As noted earlier, it may be preferable to allow the scaling to be applied in an interpretation workstation.

You can examine the impact of the scaling using the same amplitude decay analysis window we used when looking at pre-stack amplitude recovery.

7 Final SEGY Output

In general, the last thing we do in processing is to create a SEGY format dataset. This is the Society of Exploration Geophysicists “exchange” format, which can be universally read by all seismic interpretation software.

7.1 Setting up the Geometry, Statics and Reel Header

While we have applied a simple 2D geometry to the data, one of the things we will need to do is to update the headers with the actual Easting and Northing locations for the ship track.

The processing flow **18_SEGY.job** is set up to run all of the post-stack processing we have tested, as well as merging the navigation data and creating a final SEGY file.

The SEGY file has a 3200-byte text header, arranged over 40 lines. Ideally this should include all of the acquisition and processing information, as well as the location of the key seismic trace headers in the SEGY file.


```

001 PROJECT: TUTORIAL CLIENT: GNS SCIENCE AREA: TARANAKI NEW ZEALAND
002 =====
003 LINE: TRV-434 CDPs:100-1969 ORIGINAL SHOTPOINTS: 100-970
004 CDP FOLD : 60 TRACE LENGTH : 6000MS / 1501 SAMPLES 4MS SR
005 =====
006 DATASET: FINAL PRE-STACK MIGRATED IMAGE
007 PROCESSED BY <NAME>, GNS SCIENCE , LOWER HUTT, NEW ZEALAND JUNE 2016
008 =====
009 ACQUISITION PARAMETERS:
010 VESSEL : CREW # 503 CONTRACTOR : GRANT NORPAC
011 SOURCE : AIRGUNS SOURCE ENERGY : UNKNOWN PRESSURE : UNKNOWN
012 SOURCE TOW DEPTH : 6 METRES SHOTPOINT SPACING : 25 METRES
013 CABLE : 120 CHANNEL STREAMER, 20 HYDROPHONES AND 25 METRES PER GROUP
014 NEAR OFFSET : 258 METRES FAR OFFSET : 3233 METRES TOW DEPTH : 13 METRES
015 NAVIGATION : UNKNOWN GUN-ANTENNA SPACING : UNKNOWN
016 RECORDING SYSTEM : DVS V RECORDING FORMAT : SEG2 RECORD LENGTH : 6000MS
017 RECORDING SAMPLE RATE : 2 MS FIELD FILTER : 128HZ HIGH CUT
018 =====
019 PROCESSING SEQUENCE
020 REFORMAT AND RESAMPLE TO 4MS SAMPLE RATE WITH ANTI-ALIAS FILTER
021 SPH. DIV V**2 FUNCTION PLUS 1 DB/SECOND GAIN / REFRACTION MUTE
022 SWELL NOISE ATTENUATION / TRACE EDITS / DECON : 32ms GAP 240ms OP
023 VELOCITIES / FILTER : 5-6-80-90 / SUPERCATHER / NMO / FK FILTER
024 RADON DEMULTIPLE FROM 23ms to 600ms / 2ND PASS VELOCITIES /
025 KIRCHHOFF PRESTACK TIME MIGRATION, 60 OFFSETS / RMO / 60 FOLD STACK
026 DECON : 32ms GAP 400ms OP / FX DECONVOLUTION / FILTER : 7-15-60-70 HZ
027 SCALE / NAV-SEIS MERGE / SOURCE, STREAMER STATIC 12.6ms / OUTPUT SEG.Y
028 =====
029
030 CDP NUMBER : BYTES 21-24 SP NUMBER : BYTES 17-20
031 EASTING : BYTES 73-76, 81-84 (METRES) NEW ZEALAND MAP GRID GD 1949
032 NORTHING : BYTES 77-80, 85-88 (METRES) NEW ZEALAND MAP GRID GD 1949
033 NAVIGATION POSITION HAS BEEN ASSUMED TO BE SOURCE LOCATION CORRECTED
034 NO CORRECTION FOR SOURCE-ANTENNA OFFSET APPLIED
035
036
037
038
039
040
[EOF]

```

Line : 1/40
Column : 1
Margins : undefined
Text wrapping off

< Find Search Find >
Mark Go to Replace
Join Learn Repeat
Spell Sum diffs

Mode : insert
Select : by line
Search : case-insensitive

The 3200 byte (40 lines x 80 columns) text file that will be read into the reel header in the SEG.Y file.

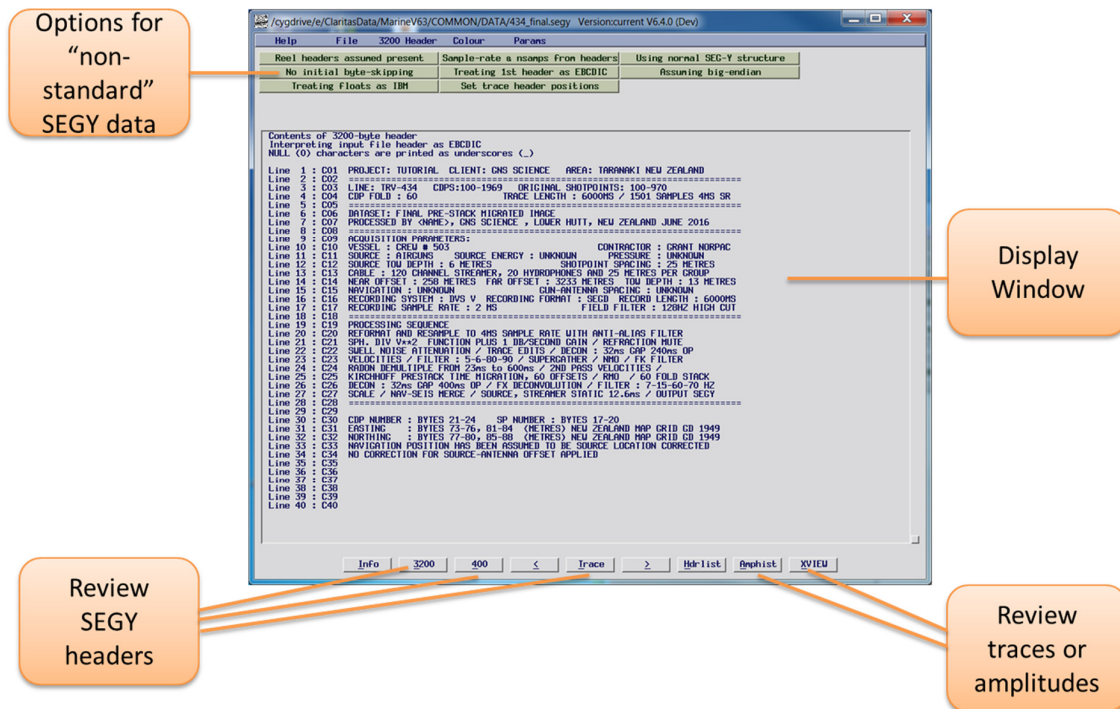
The navigation data is matched to the **SPARE4** header, which is calculated automatically when we apply the simple marine geometry. This is the equivalent shot-point location for each CDP, and is automatically extrapolated for the start of the line.

We also need to adjust the data for the tow-depth of the source and the streamer. The shift can be calculated from the source and receiver tow depth, coupled with the speed of sound through seawater (approximately 1.5 metres/millisecond)

- Edit the processing flow **18_SEG.Y.job** to reflect your choices of parameters, including the text file header
- Run the processing flow

7.2 Checking the SEGY Results – SEGY Analyser

You can check that the SEGY has been correctly written out using the SEGY analyser tool, which is started using the ‘Analyser’ button on the ‘Seismic Data’ tab of the launcher.



The SEGY Analyser showing the 3200-byte EBCDIC text header from the final SEGY output. You can also review the binary header, or trace headers, as well as displaying sample amplitudes as a histogram or an XVIEW display of the data. Options allow “non-standard” SEG-Y data to be analysed, and either rewritten or a flow created that will read them in.