The GATHERing Knowledge Exchange

3D pre-stack seismic reflectivity analysis for interpreters

Practical exercises

SHARP REFLECTIONS
DISCOVER MORE

Content

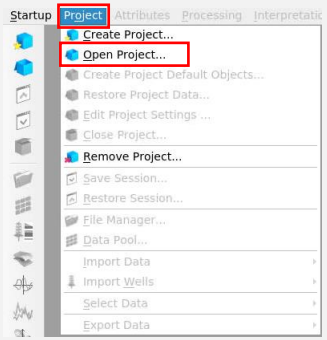
- Exercise 1 – offset gather visualization and near offset stack generation
- Exercise 2 – convert migrated offset gathers to angle gathers and create angle stacks; compare raw and final angle gathers
- Exercise 3 – observe and describe how amplitude varies with angle for a given event
- Exercise 4 – expected AVA response modelling based on log data
- Exercise 5 – AVA analysis 1
  - Generate 4 final angle stacks
  - Amplitude extraction on angle stacks & full stack
  - Create 10-fold partial pre-stack gathers
  - Compare with 1 deg angle gathers
  - Extract windowed attributes on angle stacks (+/-8 ms max neg, max pos, RMS), observe patterns
  - Arbline through feeder – view on angle stacks, flat-spot
  - Pre-stack well-tie
  - Building models from well-logs
- Exercise 6 – AVA analysis 2
  - Compute intercept & gradient from mapped amplitude; cross-plot; describe class
  - Compute Chi 25, 50 maps
  - Pre-stack spectral decomposition

Exercise 1

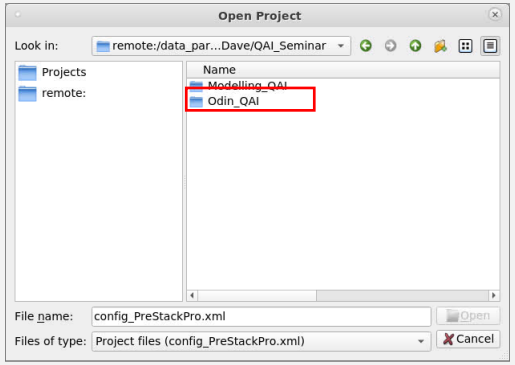
- Visualise raw migrated offset gathers and create a near offset stack
  - *What artefacts can be seen in the data?*
  - *How might these impact our amplitudes?*

Open the Odin_QAI project

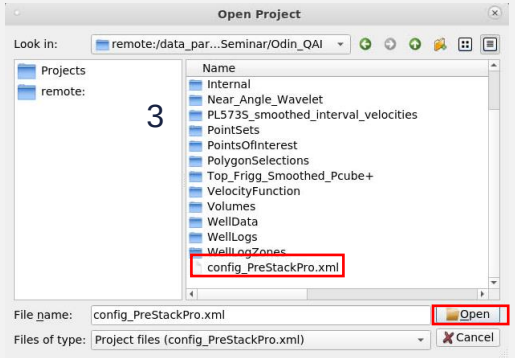
1



2



3

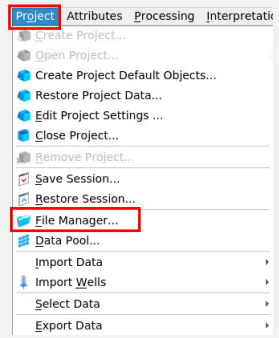


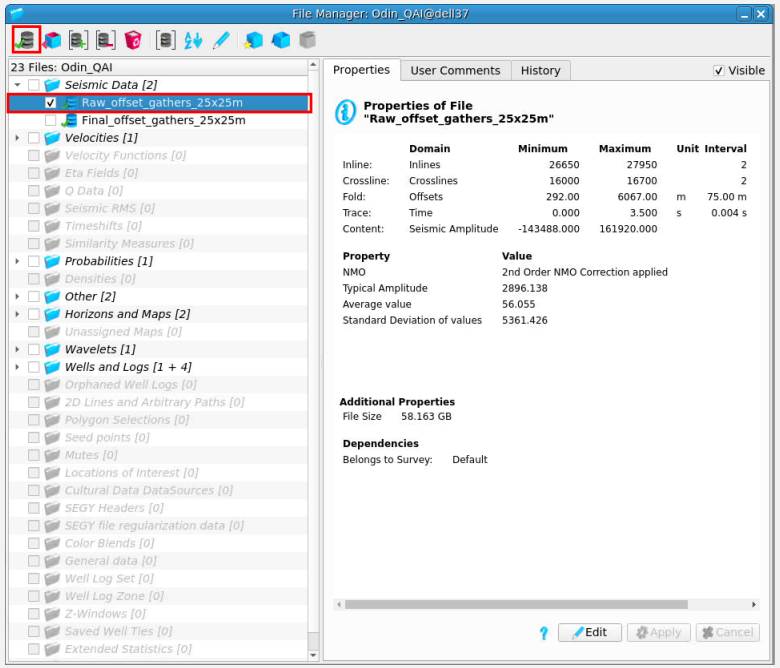
4

From the top level menu:

- Select Project
  1. > Open Project
  2. > Odin_QAI
  3. > config_PreStackPro.xml
  4. > Open

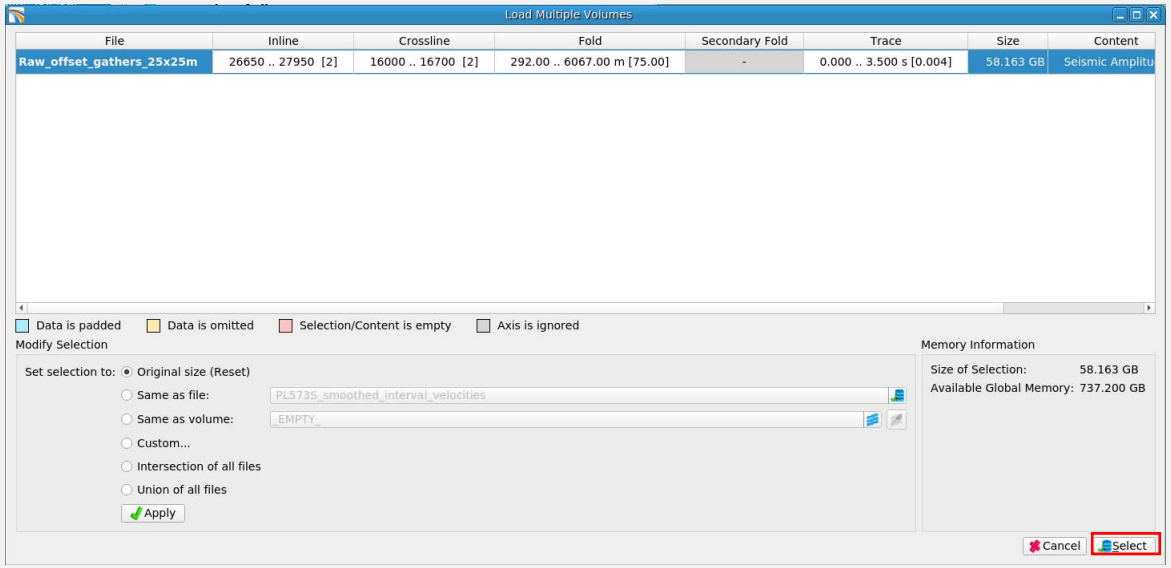
Load raw migrated offset gathers into memory



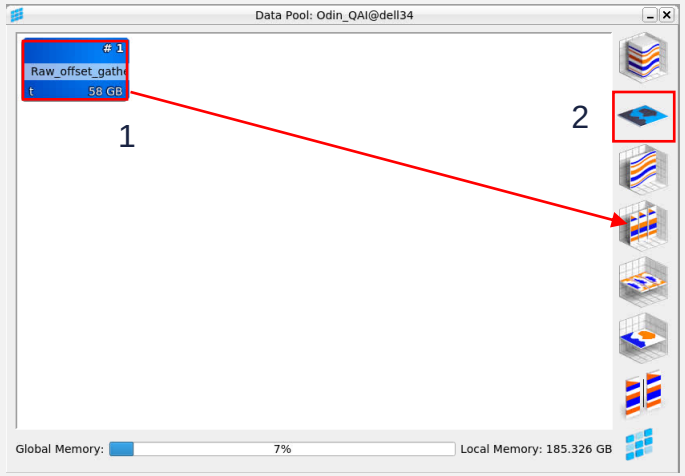


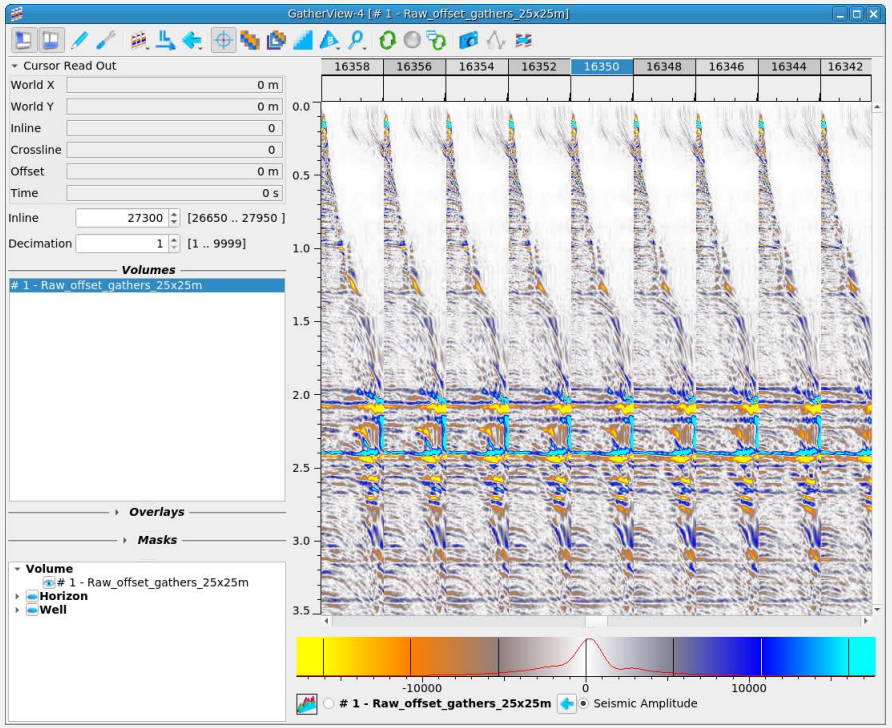
From the top level menu:

- Select Project
  1. > File Manager…
  2. Check the check box for “Raw_offset_gathers_25x25m” under Seismic Data
  3. Click the “Load selected volume(s)” icon
  4. > Select

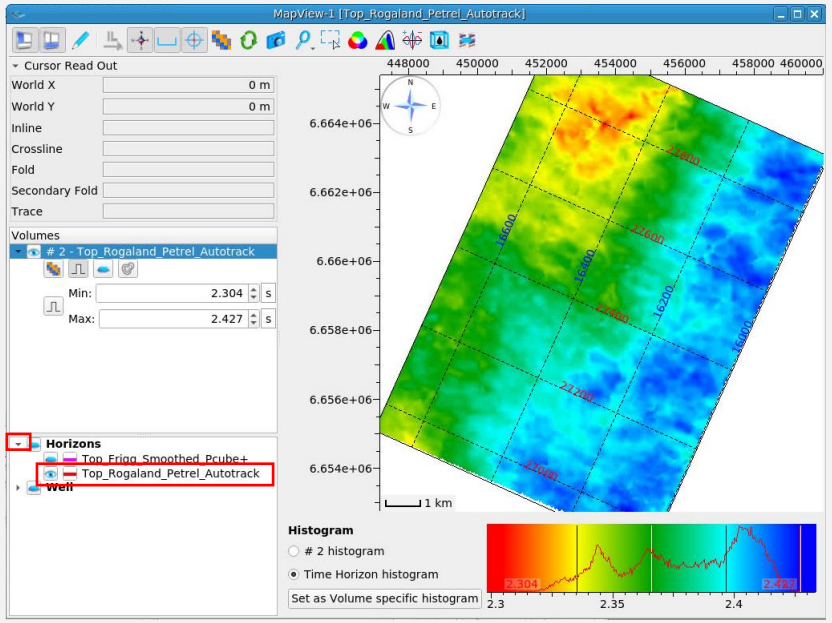


Display gathers and open a Map View





1. LMB click and drag raw gathers into a **Gather View**
2. Double click on the Map View icon
3. In the **Map View**, open the Horizon drop-down menu and toggle on the **Top Rogaland** event



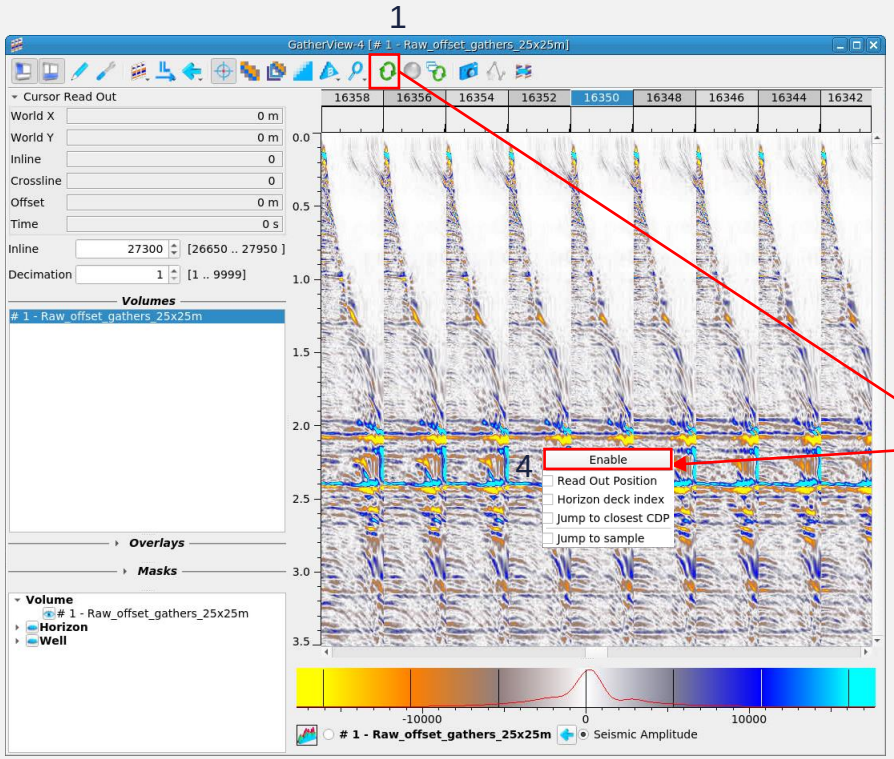
3

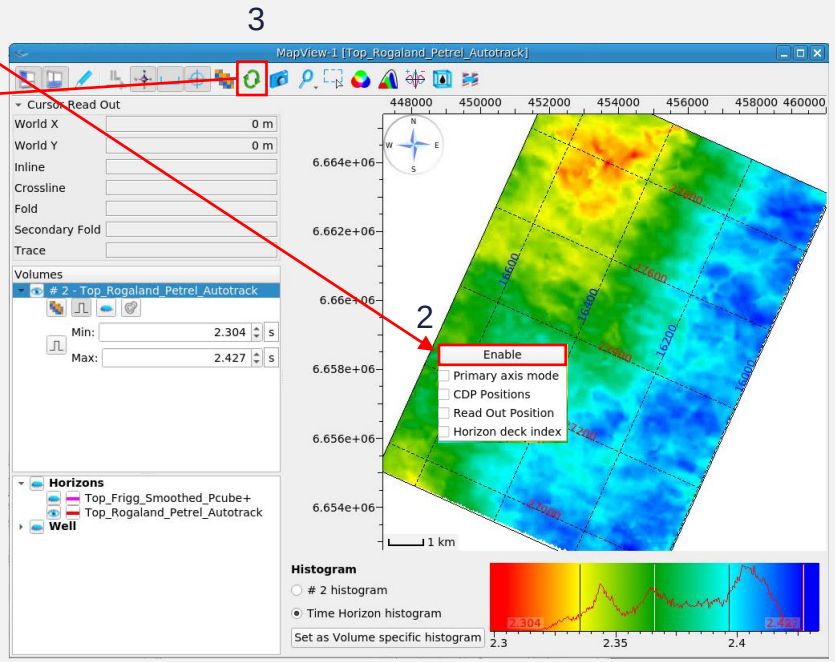
SHARP REFLECTIONS

Synchronise views

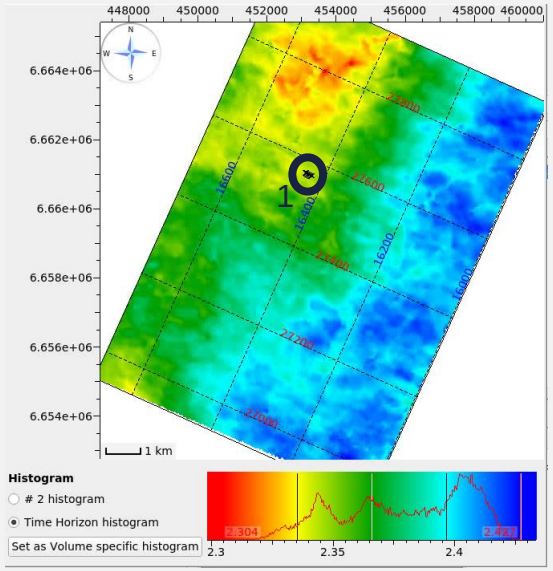
1. Click the “synchronise viewers” icon in the **Gather View**
2. LMB click in the **Map View** and toggle on “Enable”, then LMB click anywhere on the map

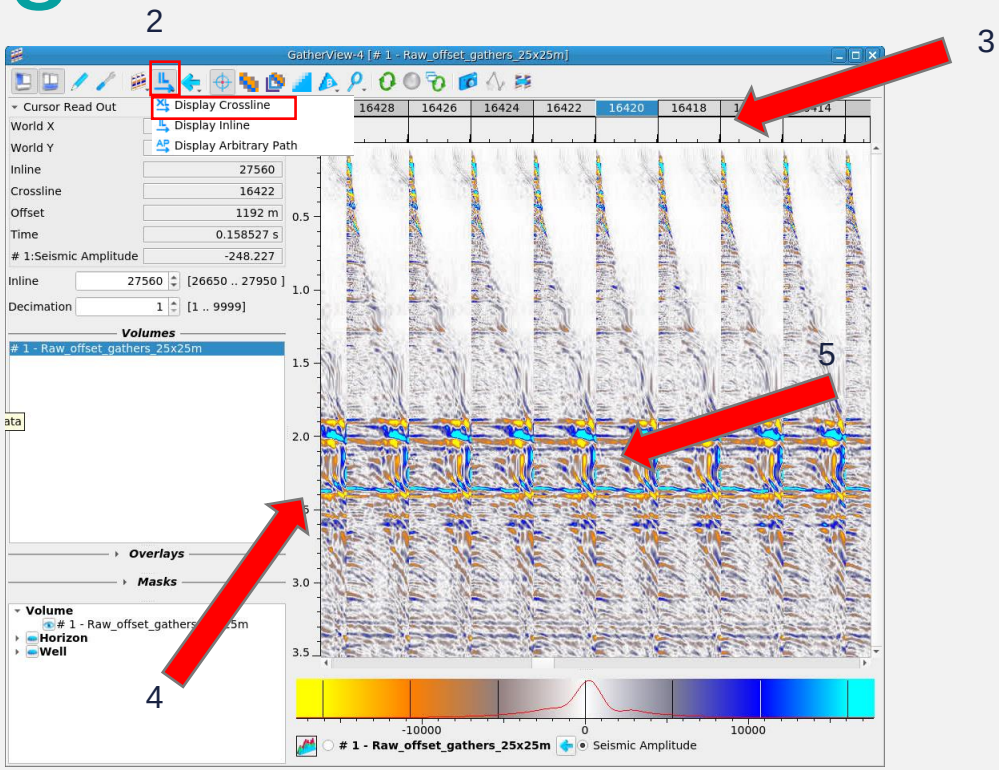
3. Click the “synchronise viewers” icon in the **Map View**
4. LMB click in the **Gather View** and toggle on “Enable”, then LMB click anywhere on the gathers





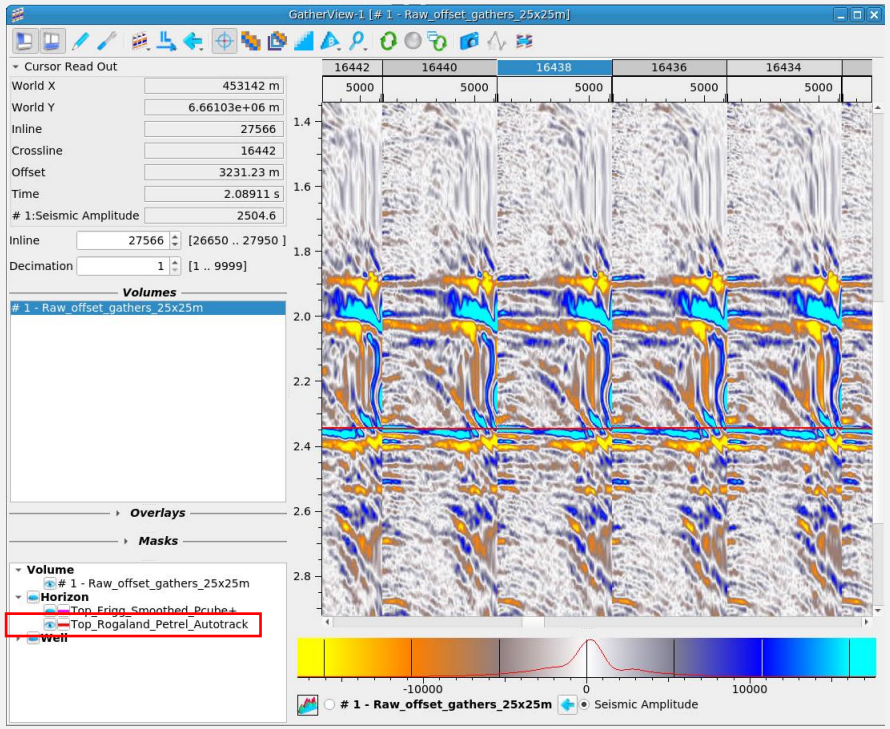
Interrogate the raw gather volume





1. Double click at any location on the map to view gathers at that location
2. Switch between IL and XL views
3. Use the mouse wheel with the cursor on the horizontal axis to zoom in and out horizontally
4. Use the mouse wheel with the cursor on the vertical axis to zoom in and out vertically
5. Use the mouse wheel with the cursor in the gather window to zoom all

What's in the data?

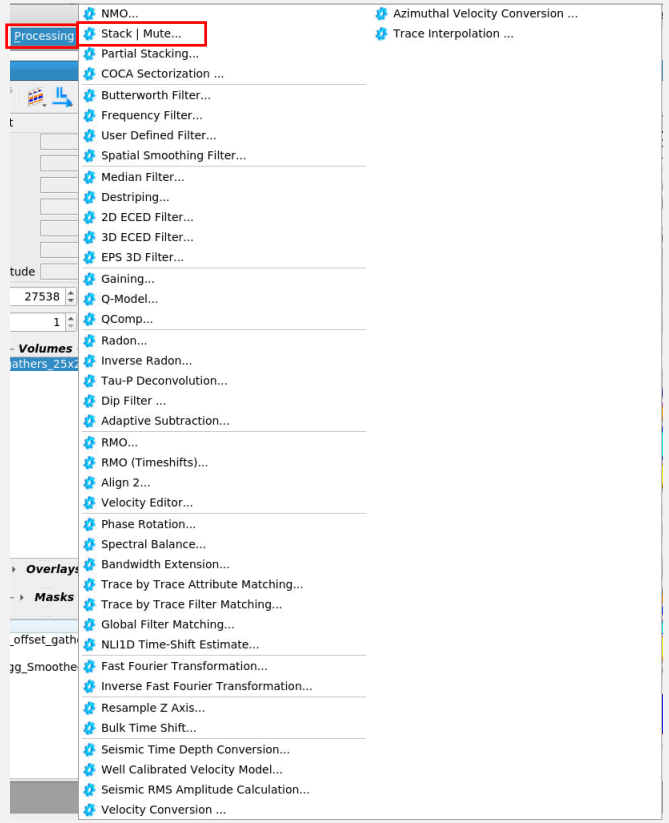


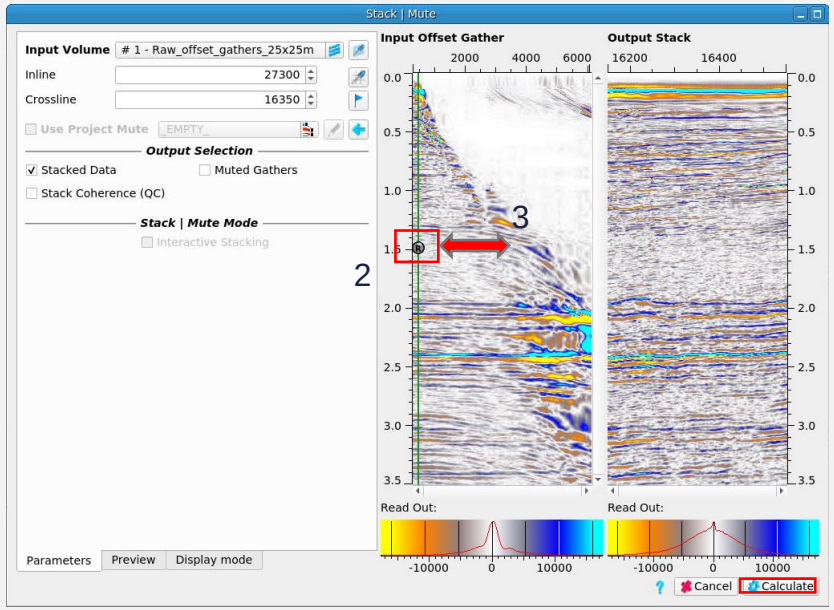
1

1. Turn on the **Top Rogaland** horizon in the gather view

What can you see in the data that might affect seismic amplitudes in he interval above and below our reference horizon?

Create a raw near offset stack





From the top level menu:

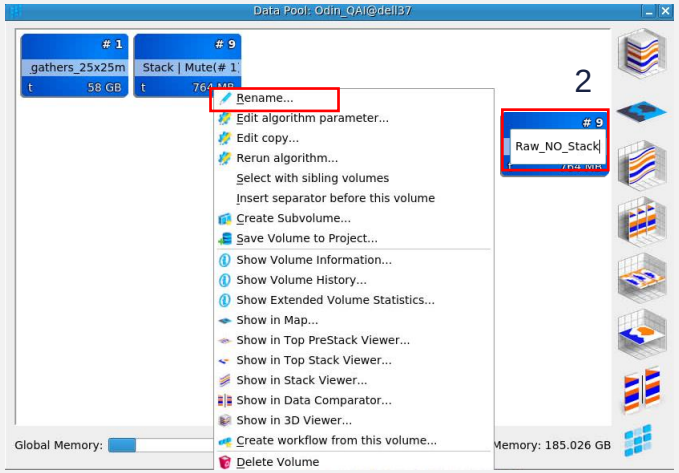
- Select Processing
  1. > Stack | Mute
  2. Ctrl LMB click in the offset gather where you would like to apply the mute (everything to the right is muted out)
  3. LMB click and drag the mute point across the gather and see the impact on the resulting stack; choose your final near offset mute
  4. > Calculate

How does the stack change as you move the mute to the right (higher offsets)?

Why do you think that is?

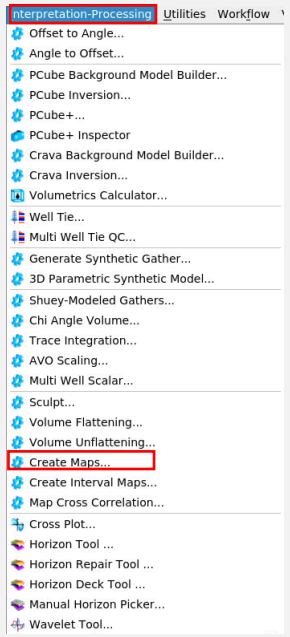
Create an amplitude map from the raw stack

1



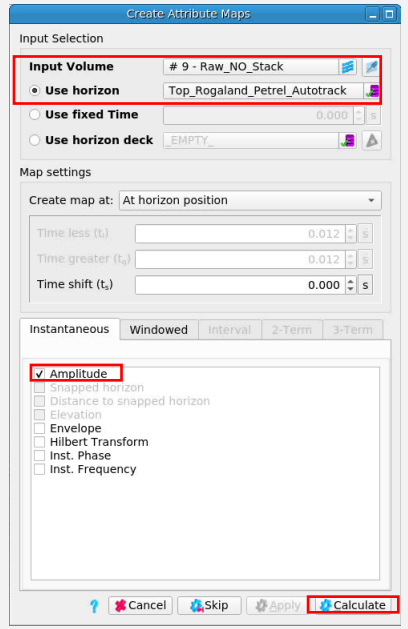
2

3



4

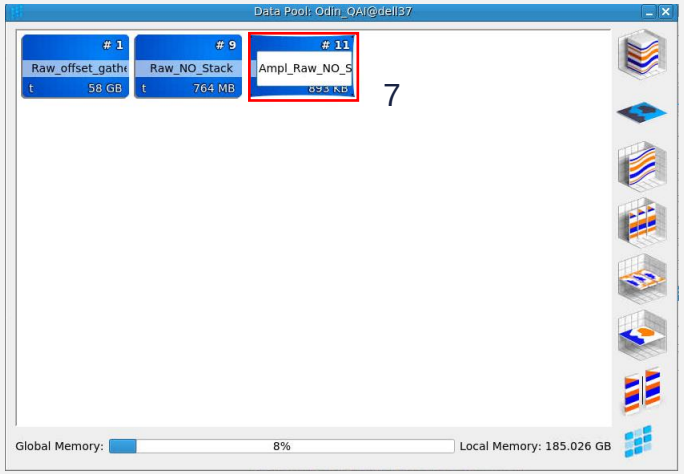
5



6

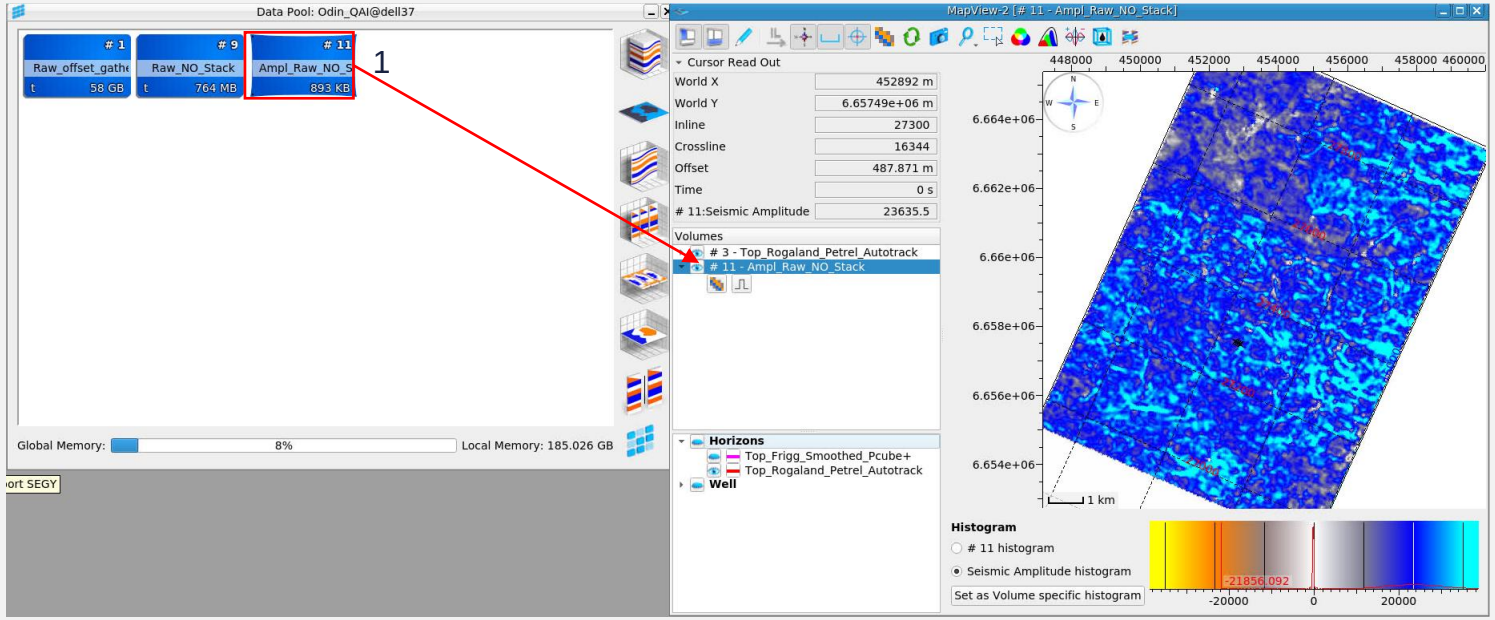
1. RMB click on the new stack volume in the Data Pool and click “Rename”
2. Type in “Raw_NO_Stack”
3. From the top level menu, select Interpretation-Processing
4. > Create Maps…

5. Ensure that Input Volume is “Raw_NO_Stack”, horizon is **Top Rogaland** and the “Amplitude” box is ticked
6. > Calculate
7. RMB click on the new map object and rename “Ampl_Raw_NO_Stack”



7

View the near offset stack amplitude map



What observations can you make from the amplitude map?

Event polarity?

Amplitude variations?

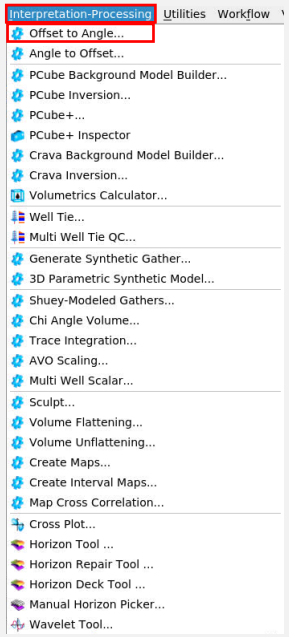
1. LMB drag and drop the amplitude map from the Data Pool into the **Map View**

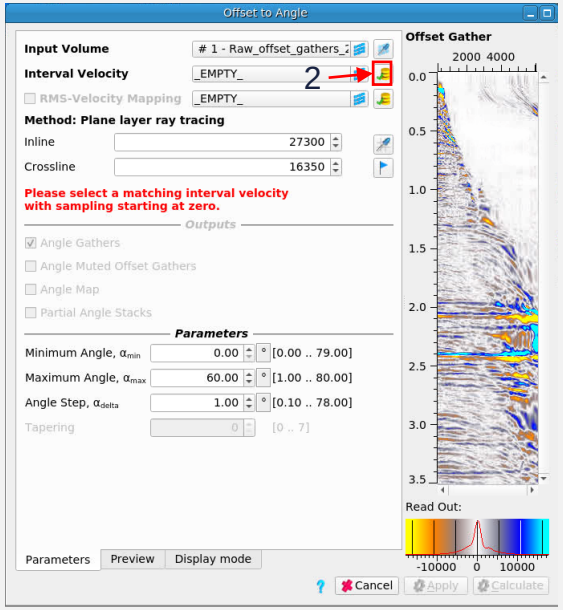
Exercise 2

- Convert raw migrated offset gathers to angle gathers & create raw angle stacks
  - *Overlay angle maps on raw offset gathers – what angle ranges are impacted by artefacts in the data?*
- Do amplitudes vary significantly with angle?
  - *Compare angle stacks in section view*
- Load final migrated offset gathers & convert from offset to angle
  - *Compare raw and final angle gathers*

Offset-to-angle conversion

1





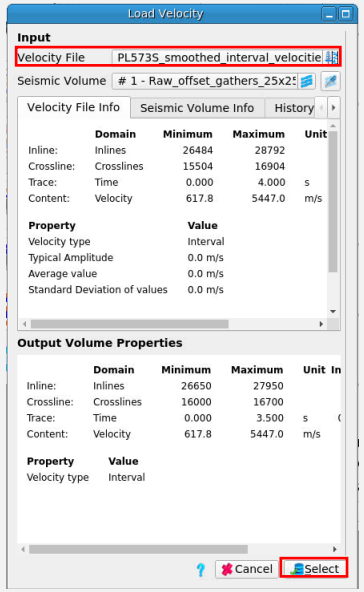
From the top level menu

Select Interpretation-Processing

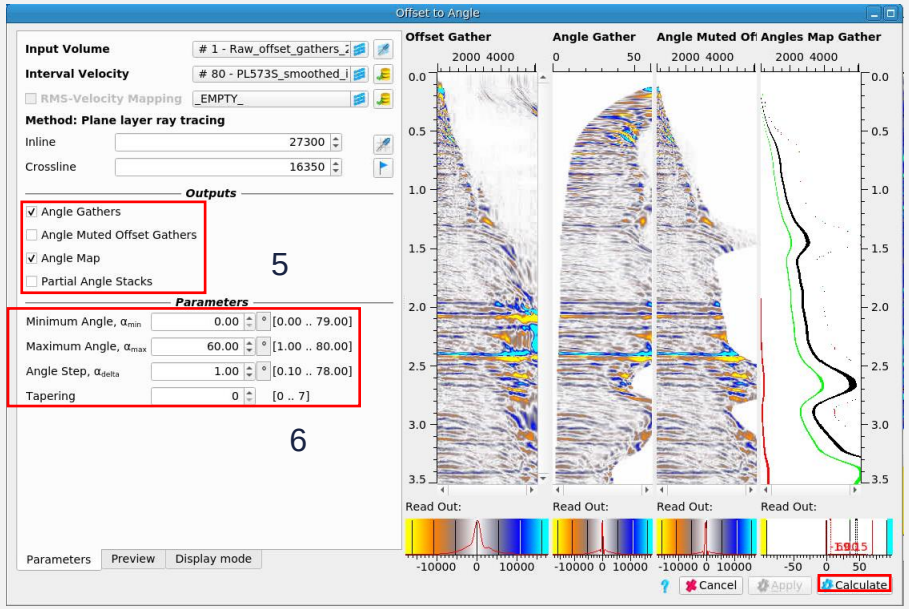
1. > Offset to Angle…
2. Click the select Interval Velocity icon

3. Select “PL5735_smoothed_interval_velocities”
4. > Select
5. Select “Angle Gathers” and “Angle Map” outputs
6. Select 0-60° angle range, 1° step
7. > Calculate

3

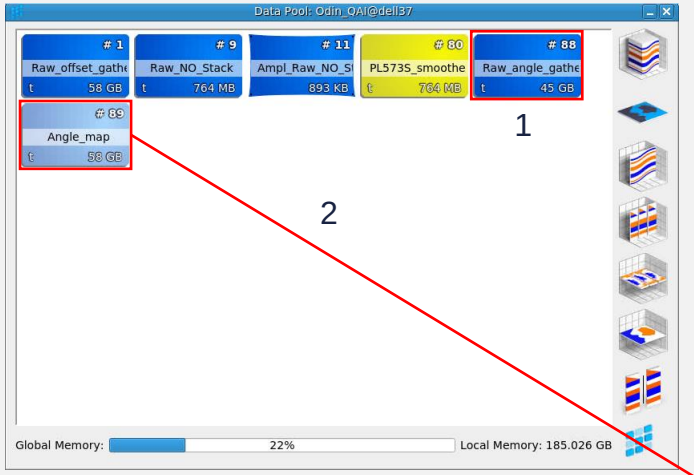


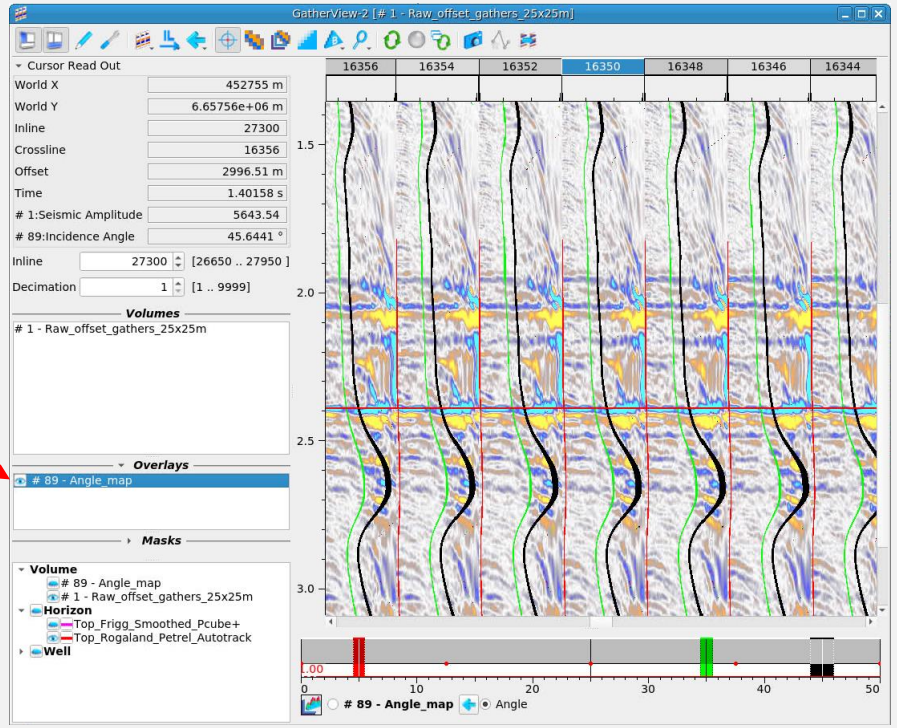
4



7

View angle map on offset gathers





1. RMB click and rename the 2 new volumes in the Data Pool to “Raw_angle_gathers” and “Angle Map”
2. LMB click and drag the Angle Map into the **Overlays** box in the **Gather View**

What data issues can be seen below 35°?

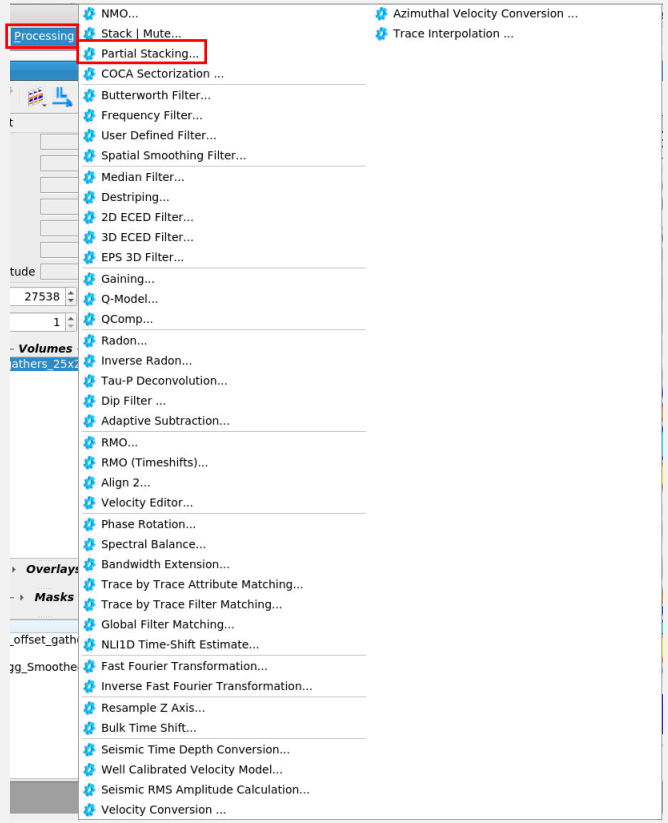
Below 45°?

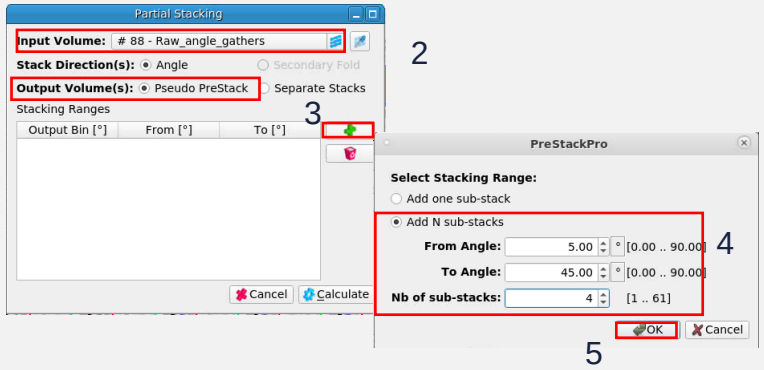
Beyond 45°?

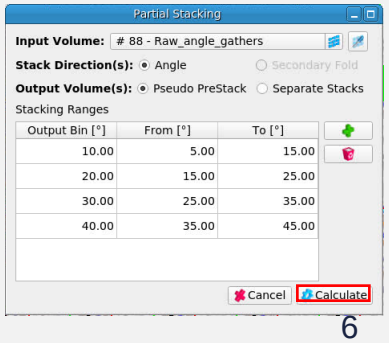
Create raw angle stacks

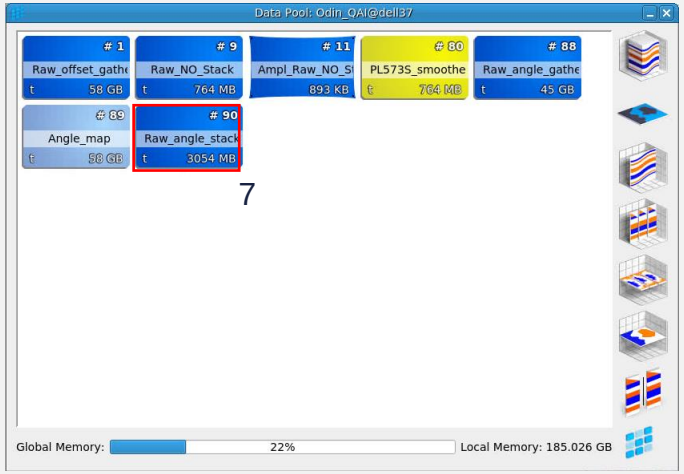
From the top level menu:

- Select Processing
  1. > Partial Stacking
  2. Select Raw_angle_gathers as input and “Pseudo PreStack” as output
  3. Click the Green + icon
  4. Toggle on “Add N sub-stacks” and add 4 sub-stacks from 5-45°
  5. Click “OK”
  6. Click “Calculate”
  7. RMB and rename new volume “Raw_angle_stacks”

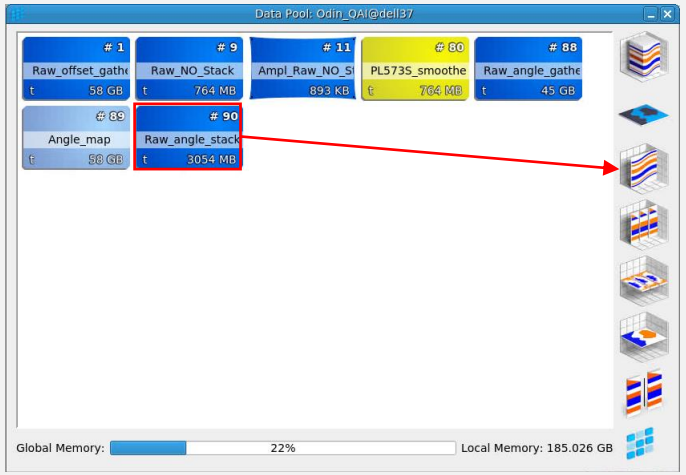


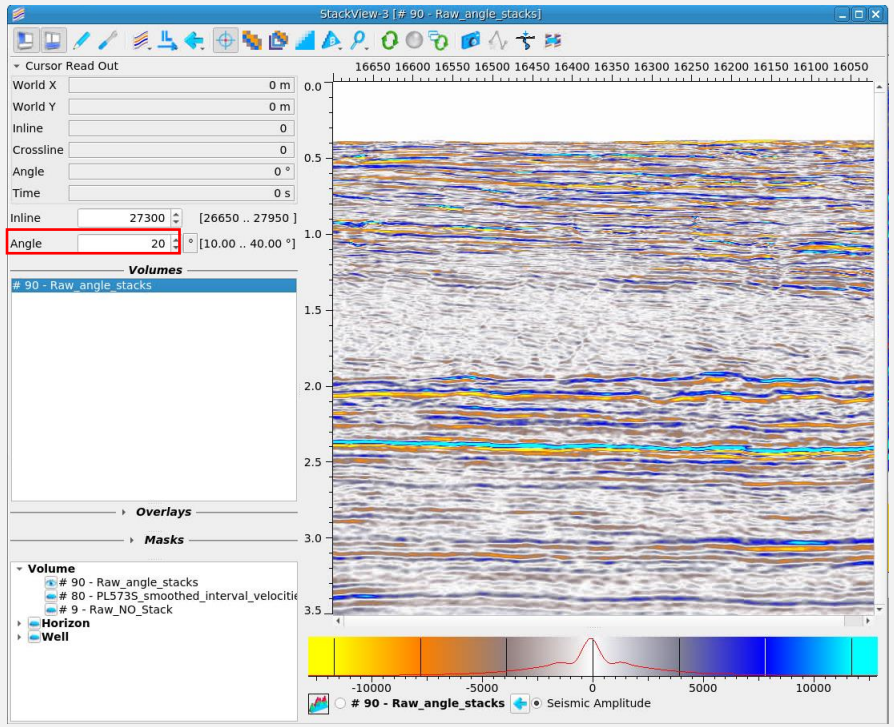






View raw angle stacks



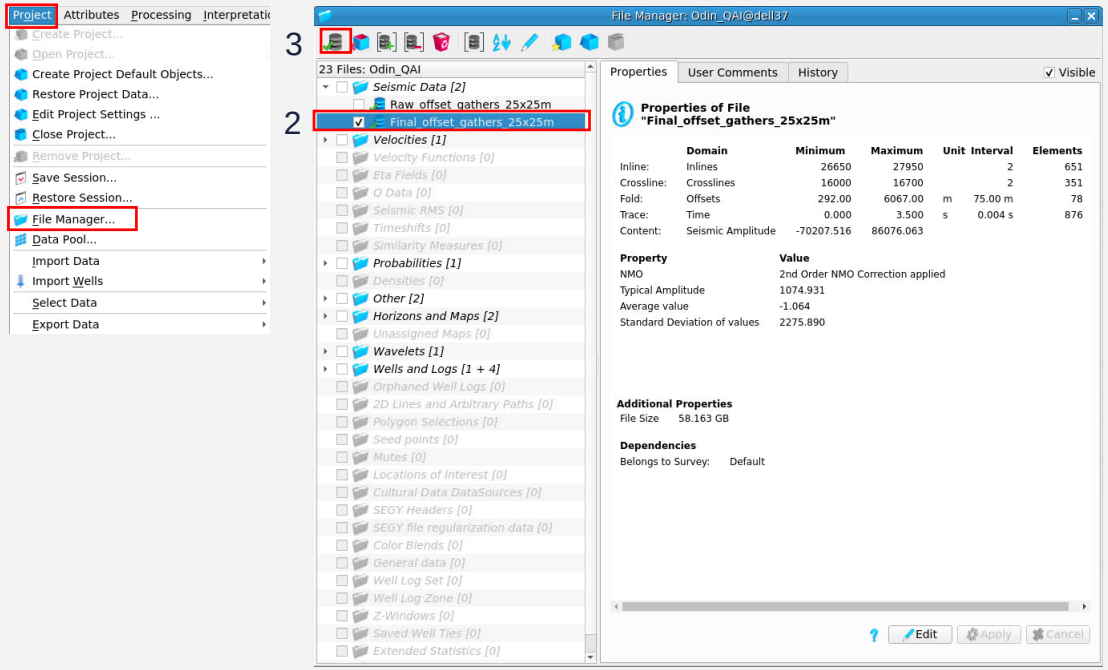


1. LMB drag & drop “Raw_angle_stacks” into a new **Stack View**
2. Scroll through the angle stacks

Do amplitudes vary from angle stack to angle stack?

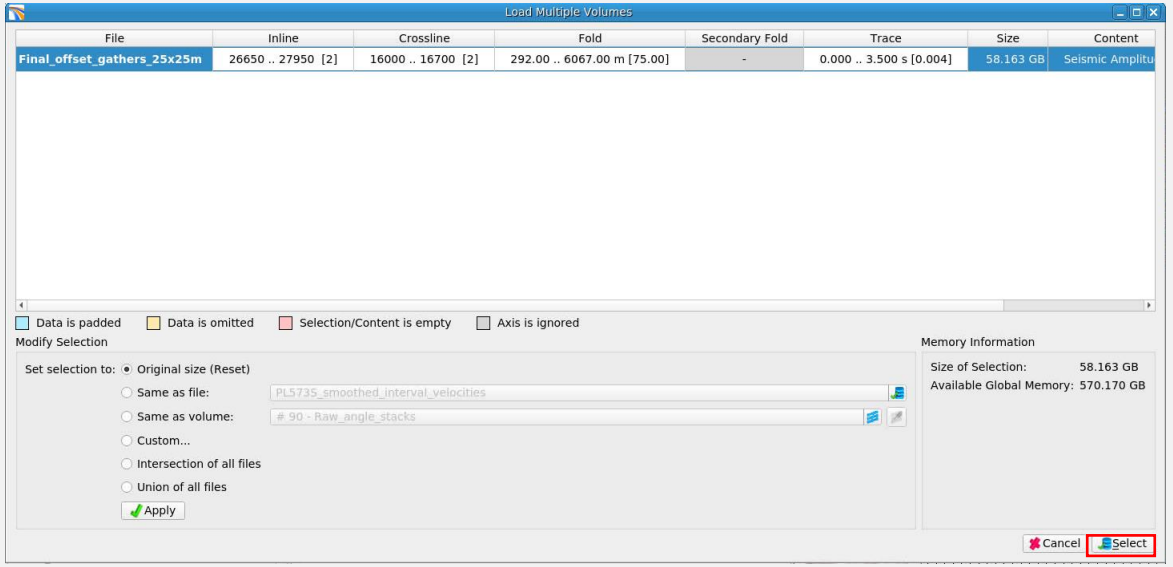
What other differences can you observe?

Load final offset gathers



From the top level menu:

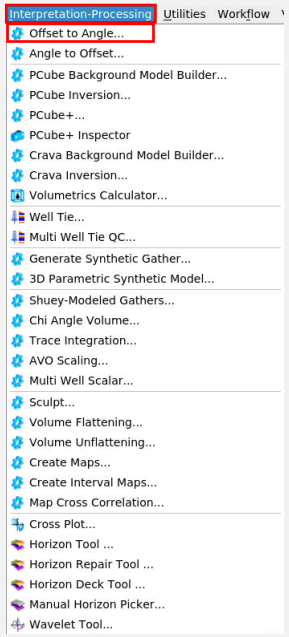
- Select Project
  1. > File Manager…
  2. Check the check box for “Final_offset_gathers_25x25m”
  3. Click the “Load selected volume(s)” icon
  4. > Select

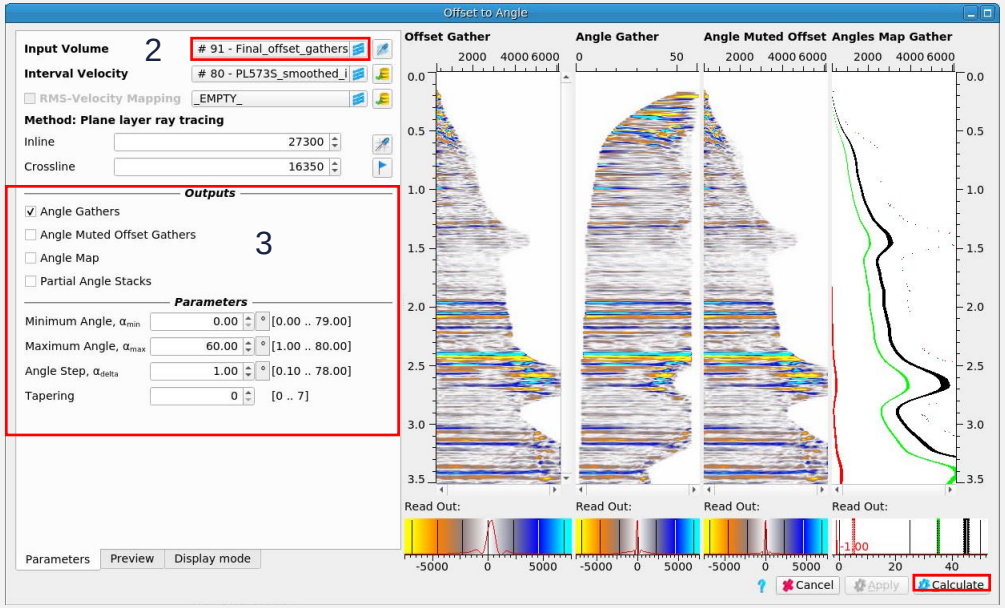


Offset-to-angle conversion

From the top level menu

1





2

3

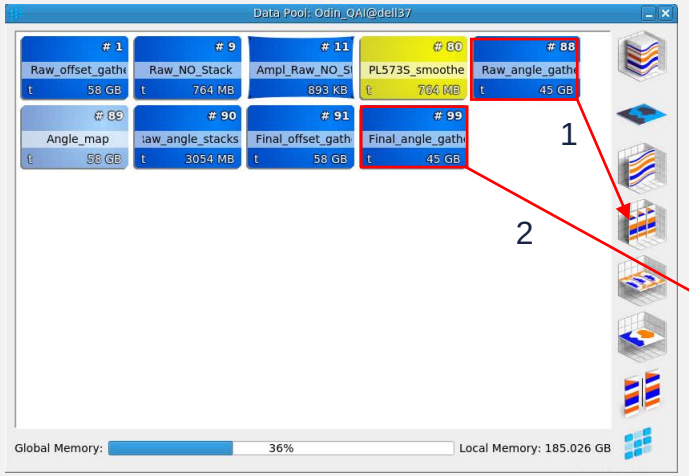
4

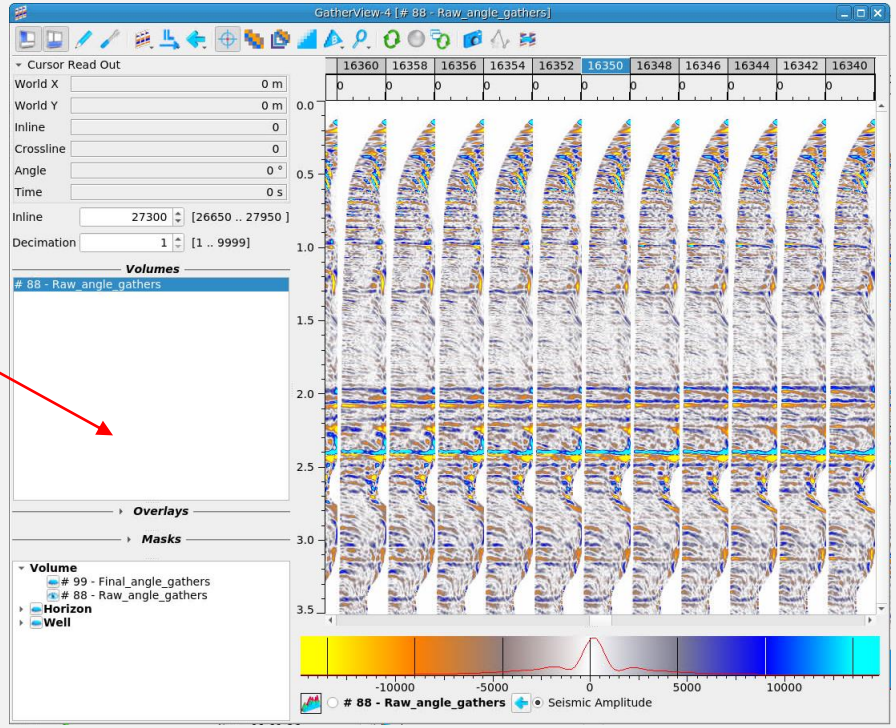
Select Interpretation-Processing

1. > Offset to Angle…
2. Set the input volume to “Final_offset_gathers_25x25m”
3. Output **Angle Gathers** from 0-60°
4. > Calculate
5. RMB & rename the new volume in the Data Pool “Final_angle_gathers”

5

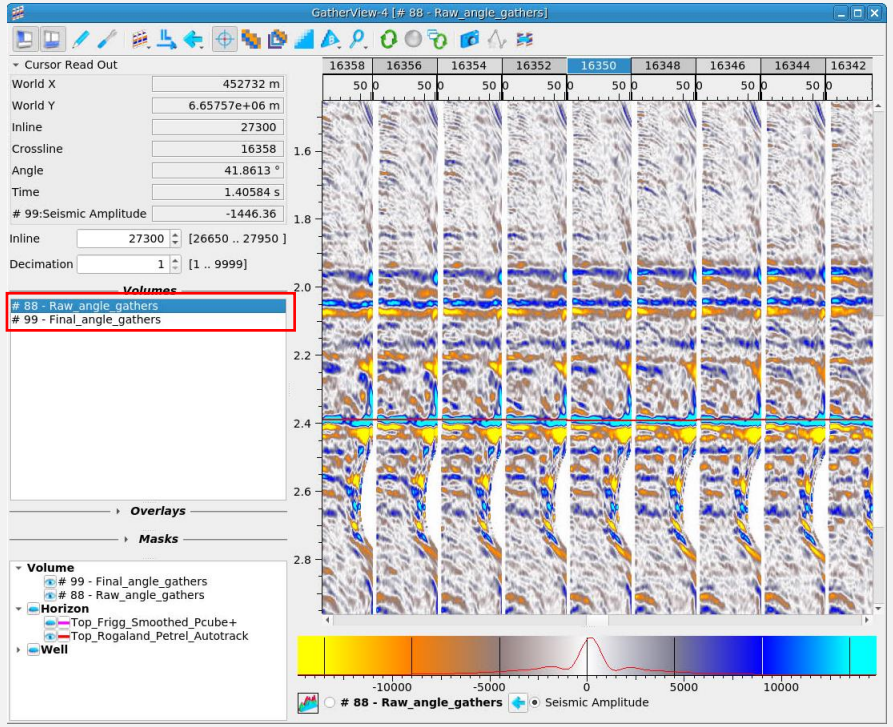
Compare raw and final angle gathers

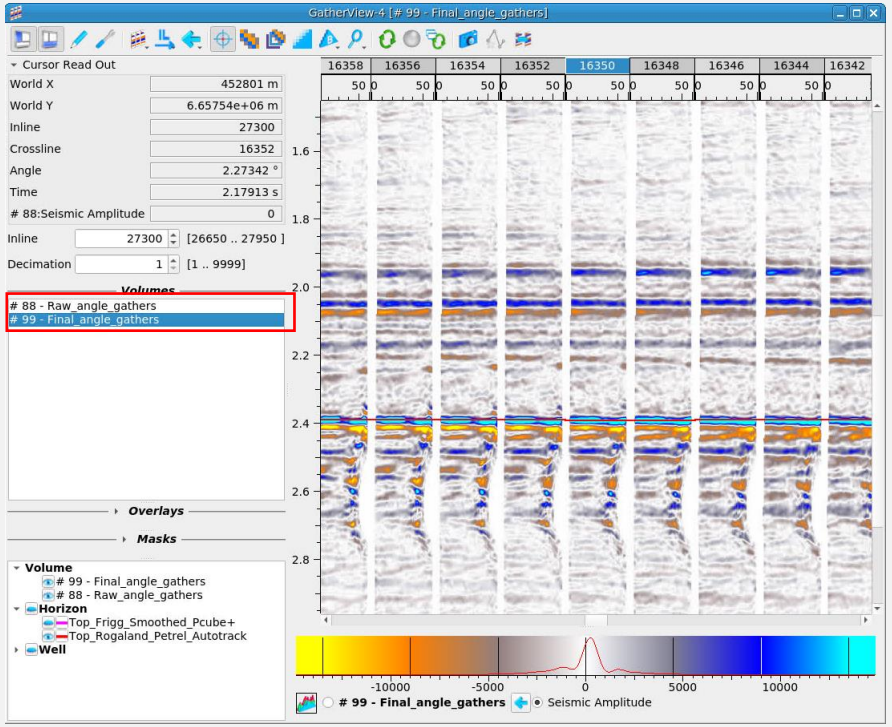




1. LMB drag & drop the “Raw_angle_gathers” into a new **Gather View**
2. LMB drag and drop the “Final_angle_gathers” into the same **Gather View**

Compare raw and final angle gathers





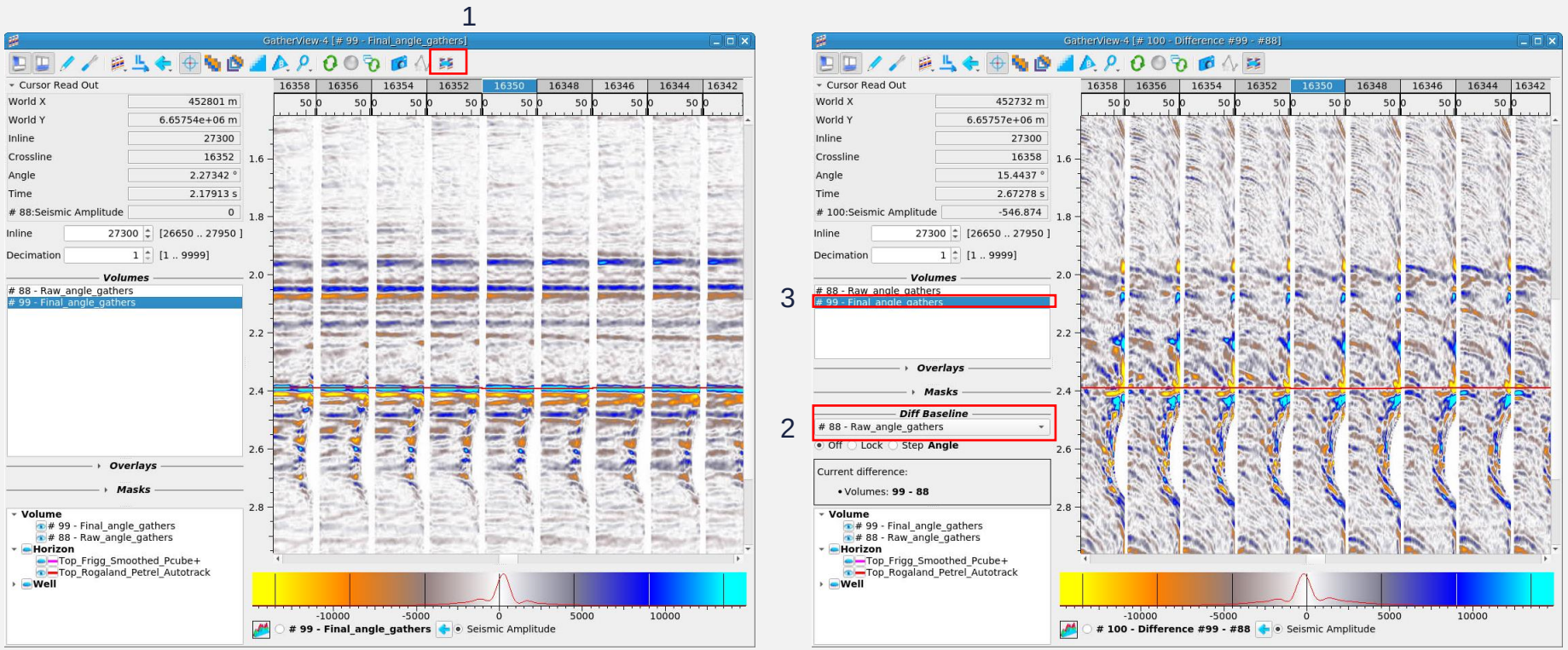
What differences do you observe between the raw and final gathers?

Which are likely to be more reliable for amplitude analysis?

Zoom into the interval of interest (turn on the Top Rogaland horizon if you need to orient yourself)

Toggle between the Raw and Final gathers in the Volumes list view

Compare raw and final angle gathers



The Difference in viewer display highlights the changes from raw to final gathers

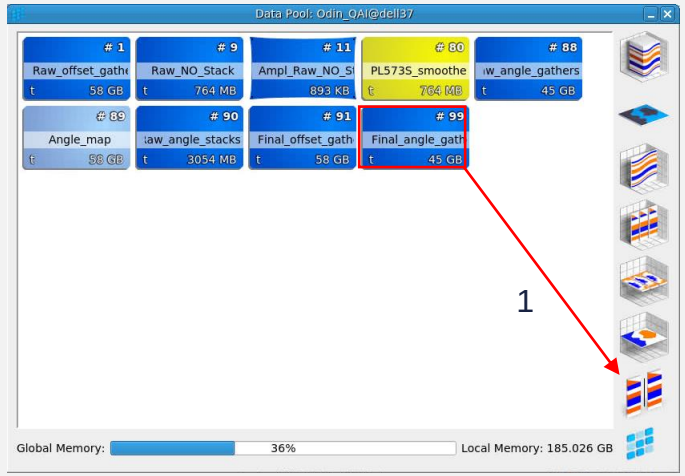
What features can you identify in the difference display?

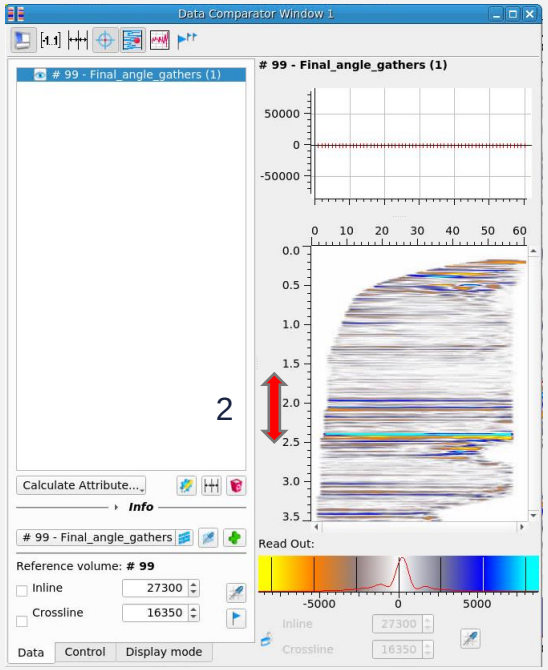
1. Click on the “Difference in viewer” icon
2. Select “Raw_angle_gathers” as the Baseline volume
3. Select “Final_angle_gathers” as the reference volume

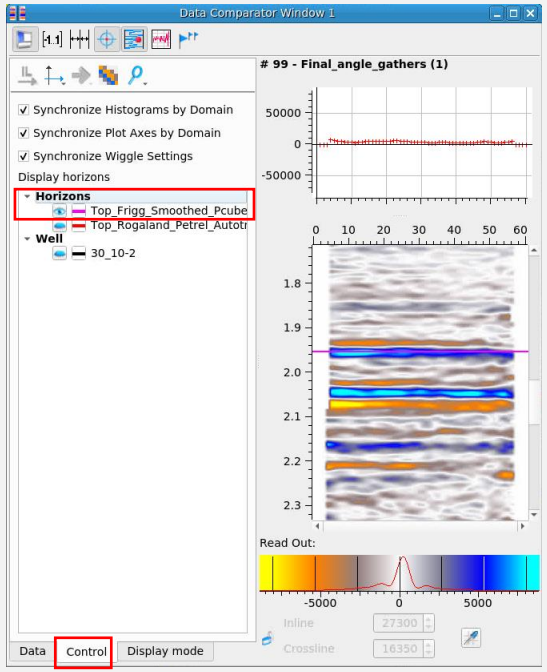
Exercise 3

- Examine and describe the amplitude variation with angle (AVA) behaviour of a top reservoir event
  - *Drag Final angle gathers into the data comparator*
  - *Post the Top Frigg event*
  - *Use the cursor to evaluate the AVA response*
  - *How would you describe the behaviour?*

Amplitude vs Angle (AVA) analysis

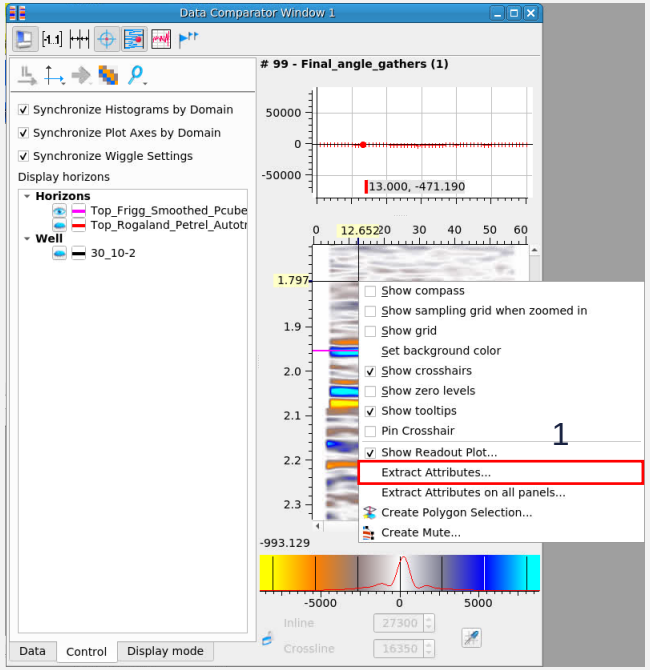


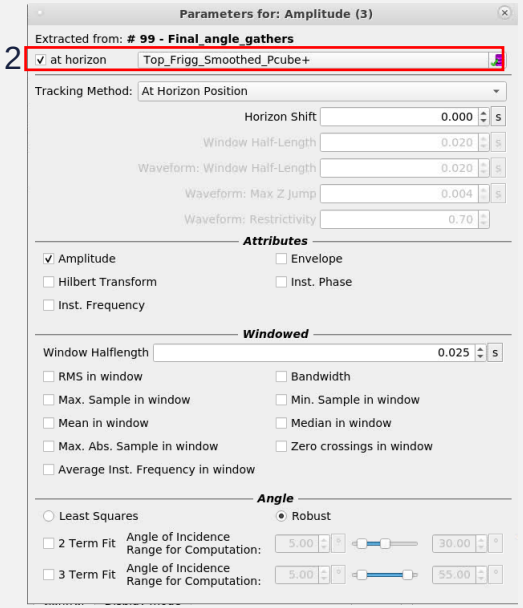


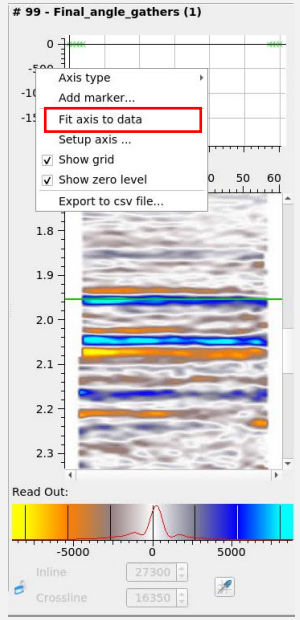


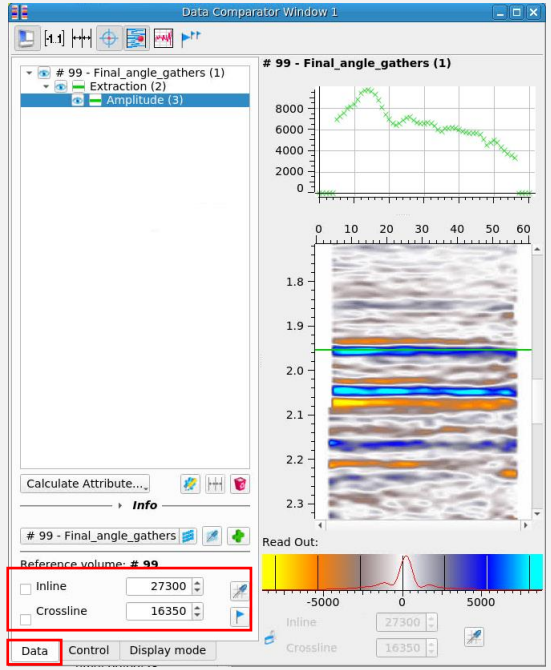
1. LMB click & drag “Final_angle_gathers” into a Data Comparator view
2. Use mouse wheel to zoom vertically around 2.0s
3. Select “Control” tab
4. Turn on **Top Frigg** horizon

Amplitude vs Angle (AVA) analysis





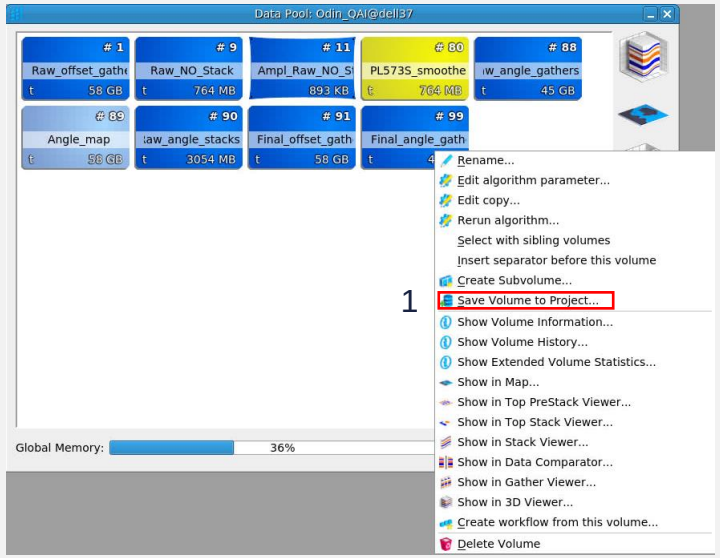




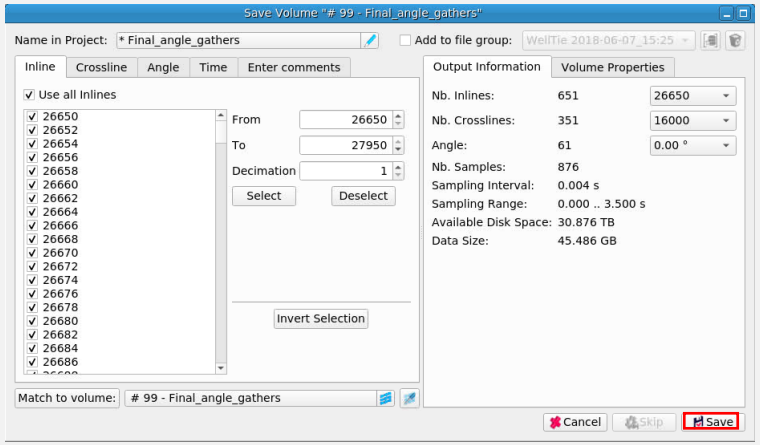
1. RMB click on the gather & select “Extract Attributes…”
2. Toggle on “at horizon” and select **Top Frigg** event
3. RMB click on amplitude axis and select “Fit axis to data”
4. Return to the “Data” tab and scroll through Inline and Crossline locations

How would you describe the AVA behaviour of the Top Frigg reflection?

Save the Final_angle_gathers



1



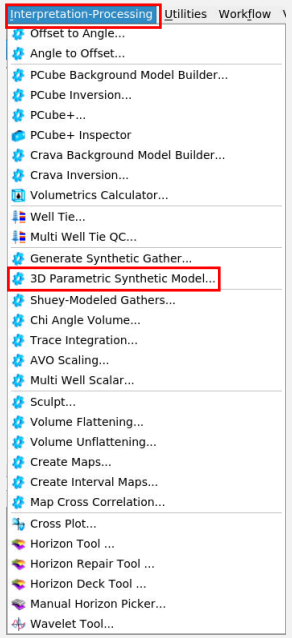
2

1. RMB click on “Final_angle_gathers” and select “Save Volume to Project…
2. > Save

Exercise 4

- Expected response modelling based on well log data
  - *Create synthetic interface models for different overburden and target interval scenarios*
  - *Compare the pre-stack response of each case in the data comparator*
  - *Which angle range would best discriminate these responses (near, mid, far, ultra-far)?*

Open the parametric model

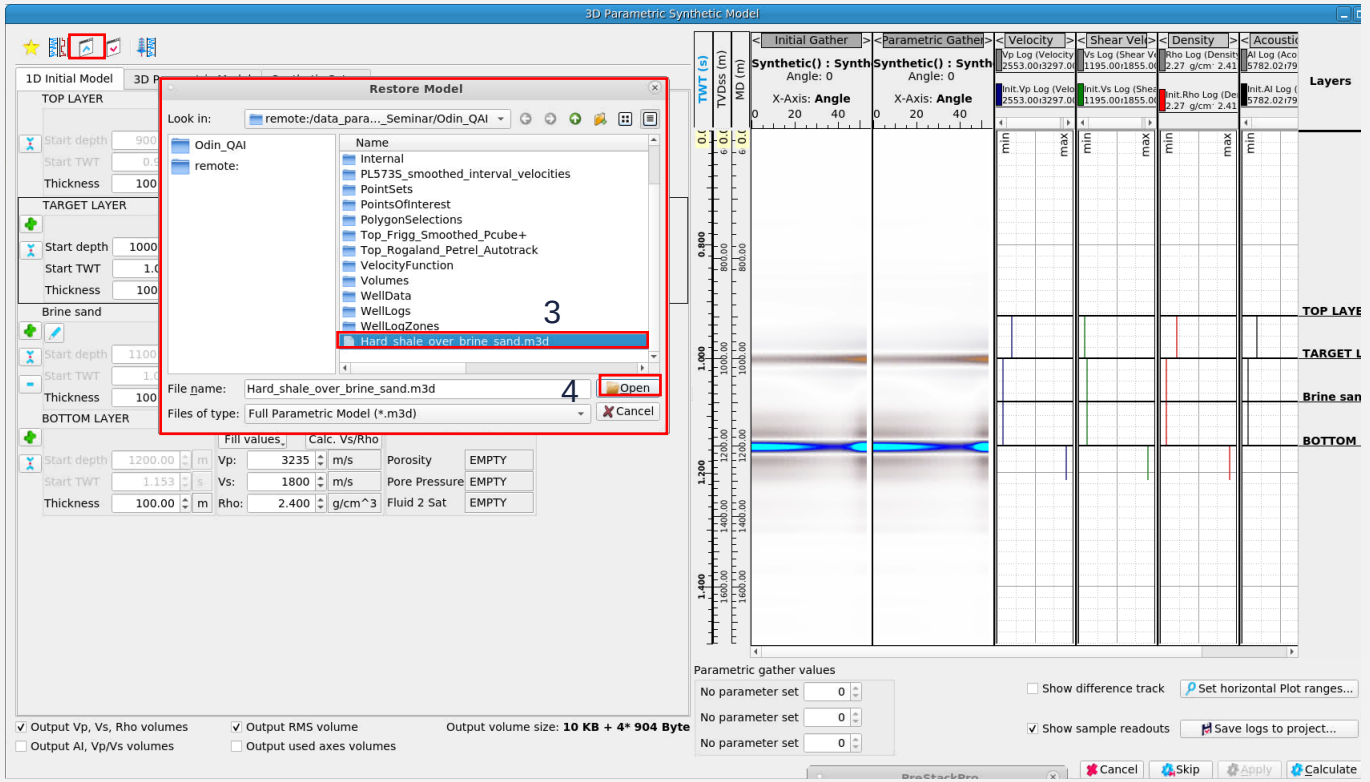


1

From the top level menu:

- Select Interpretation-Processing
  1. > 3D Parametric Synthetic Model…
  2. Click the blue “Load Model” up arrow in the top left corner of the modelling window

2



3. > Hard_shale_over_brine_sand.m3d
4. > Open

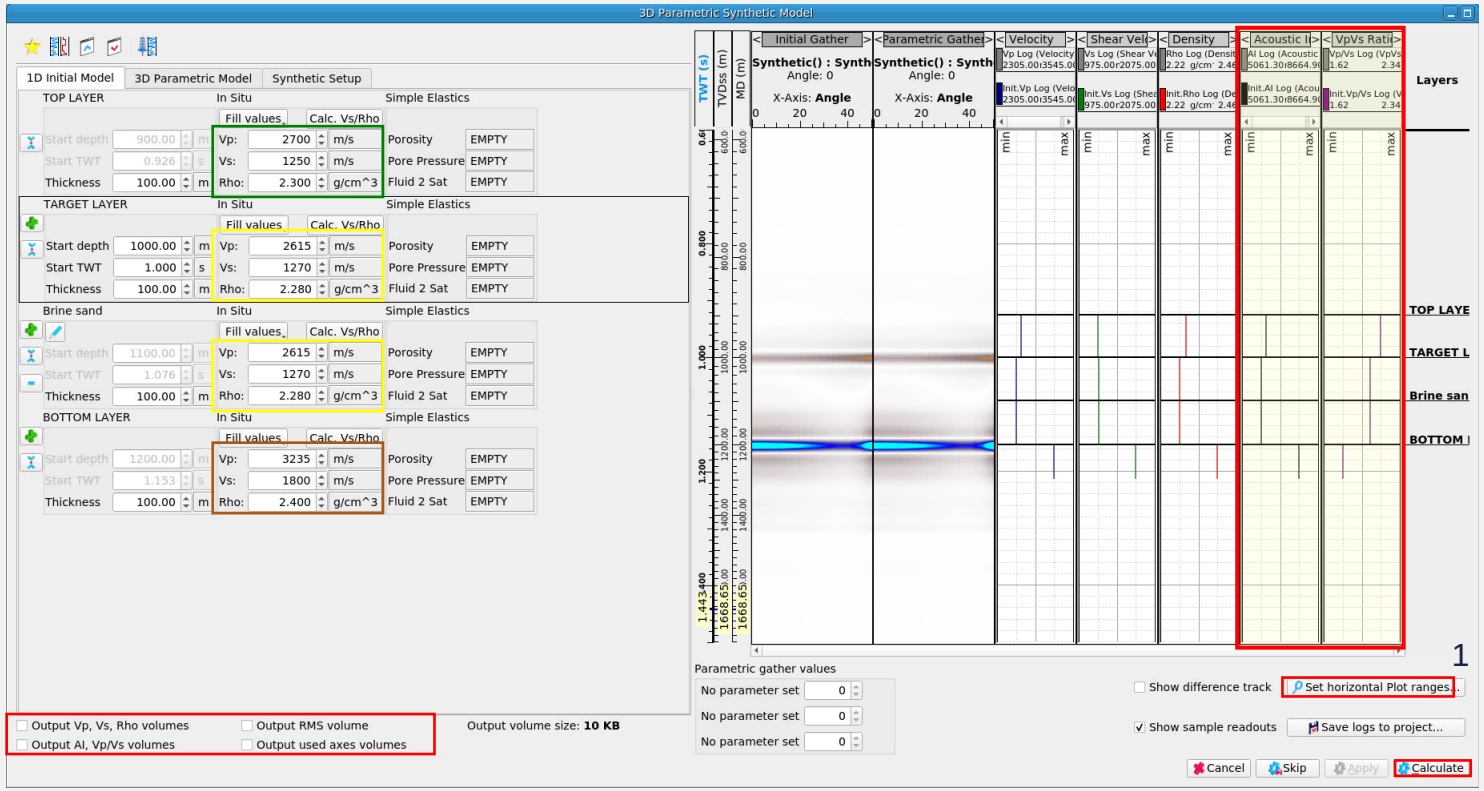
Model 1 – hard shale over brine sand

Top layer is populated with elastic property values for a **“hard” shale**

Target layer is populated with mean elastic property values for a known **Brine sand**

Brine sand layer is populated with mean elastic property values for a known Brine sand

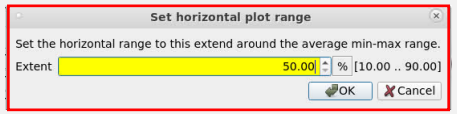
Bottom layer is populated with mean elastic property values for a known deeper shale



What are the AI and Vp/Vs ratio contrasts at the top and base brine sand?

Describe the AVA classes of the events

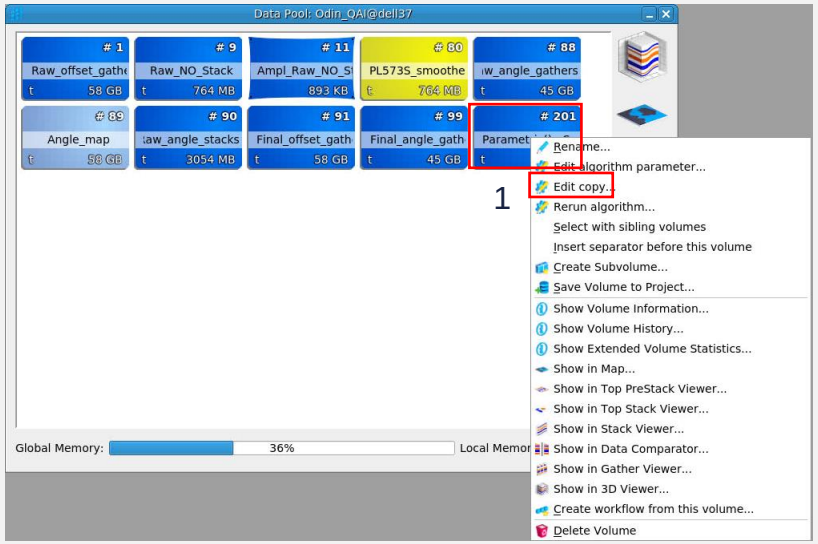
1. RMB click “Set horizontal Plot ranges…”
2. Select 50% and click OK



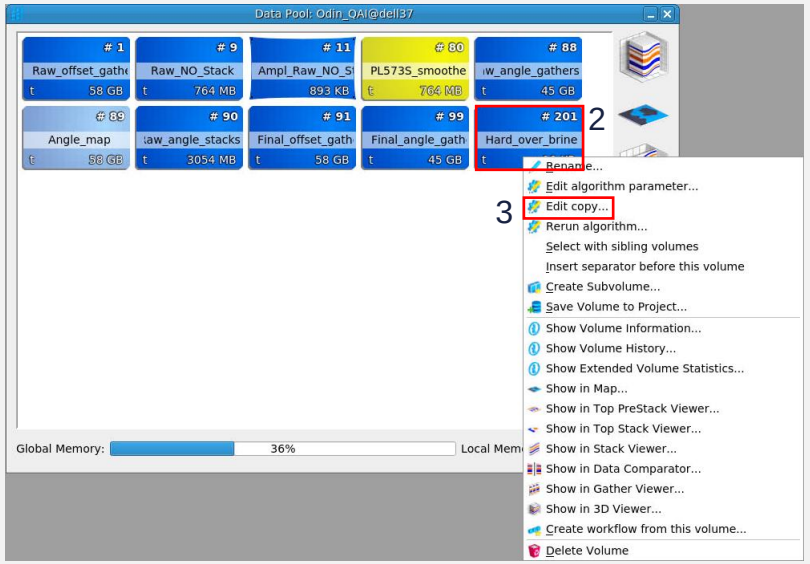
2

3. > Deselect all optional outputs
4. > Calculate to generate the model

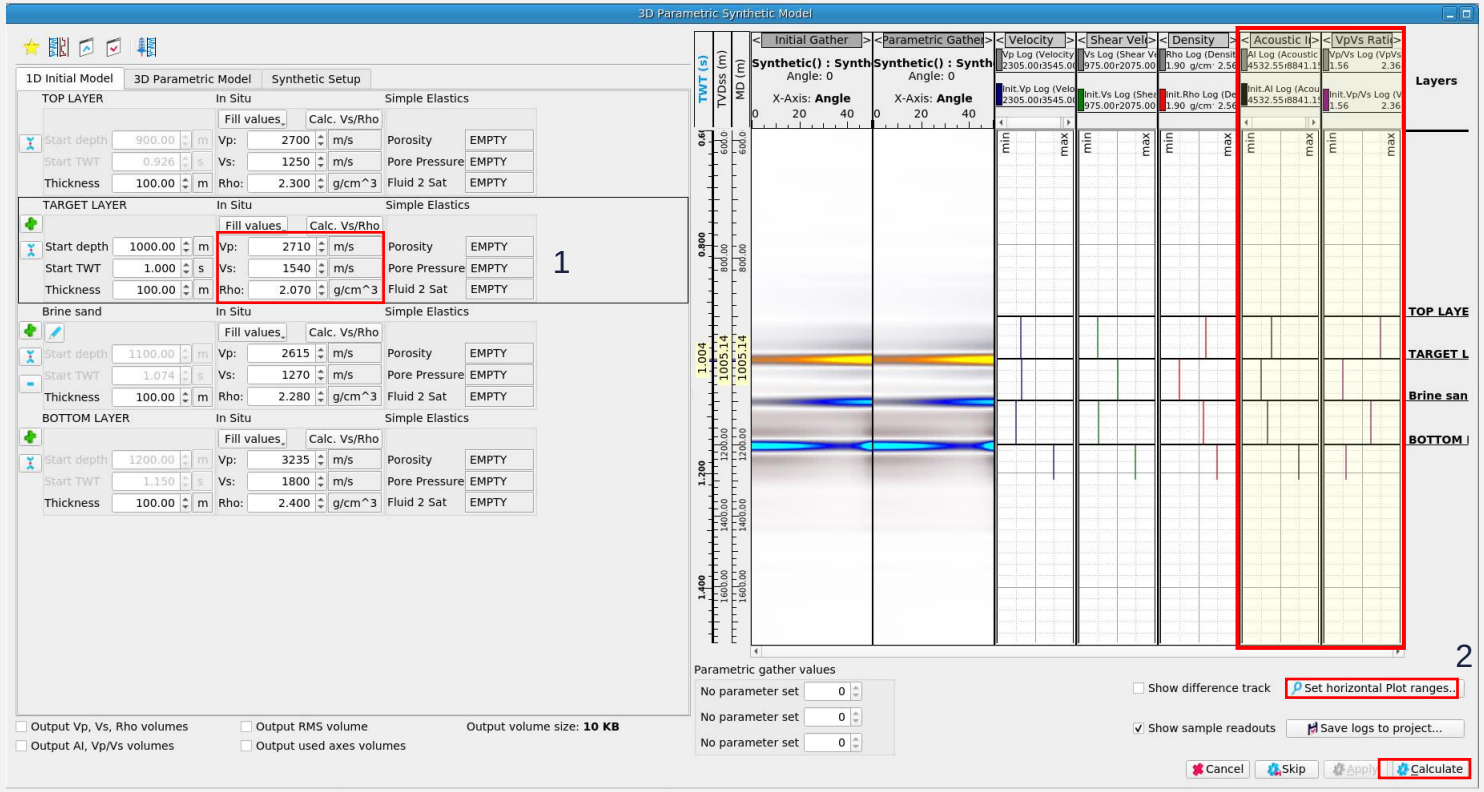
Rename model and create a copy to edit



1. RMB click the Parametric model in the Data Pool and rename “Hard_over_brine”
2. RMB click the “Hard_over_brine” icon
3. > Edit copy…



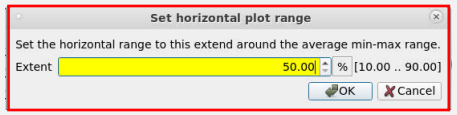
Model 2 – hard shale over gas sand



1. Change the elastic properties of the **TARGET LAYER** as follows: Vp=2710, Vs=1540, Rho=2.07
2. RMB click “Set horizontal Plot ranges…”
3. Select 50% and click OK

Describe the AI & Vp/Vs ratio contrasts at the top of the gas sand and at the gas-water contact

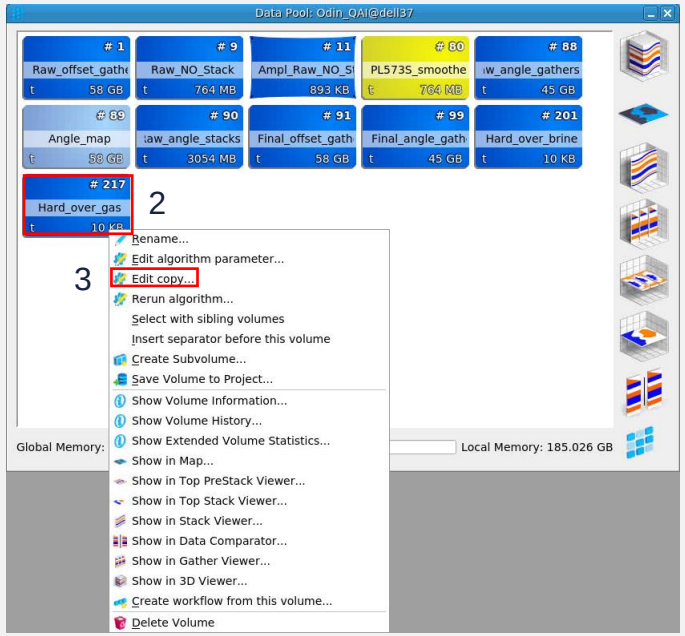
What AVA class are these events?



3

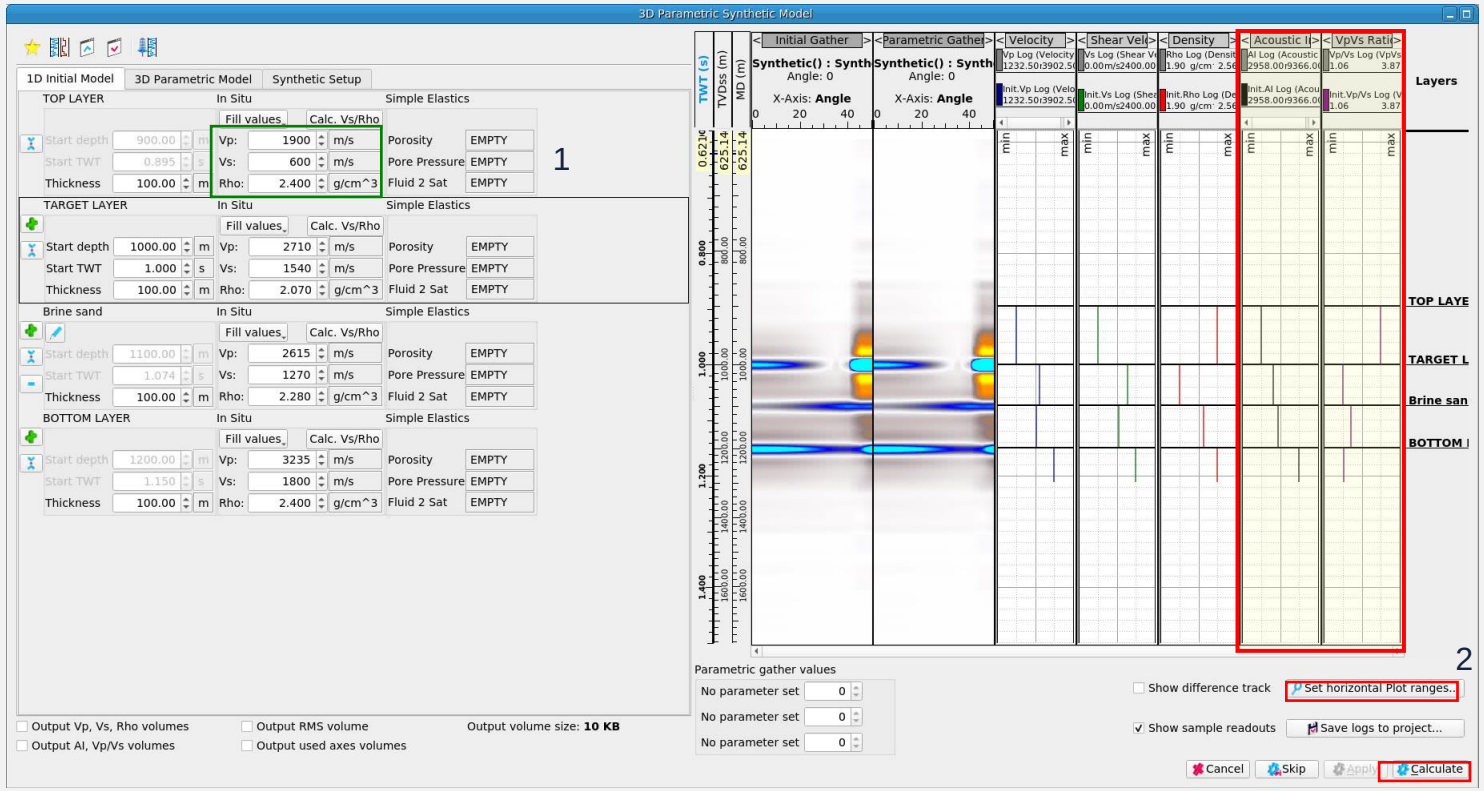
4. > Calculate to generate the model

Rename model and create a copy to edit



1. Rename the new Parametric model “Hard_over_gas”
2. RMB click the “Hard_over_gas” icon
3. > Edit copy…

Model 3 – soft shale over gas sand

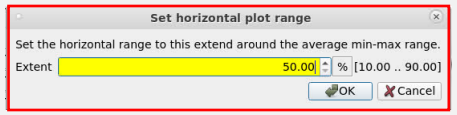


1. Change the elastic properties of the **TOP LAYER** as follows: Vp=1990, Vs=600, Rho=2.4
2. RMB click “Set horizontal Plot ranges…”
3. Select 50% and click OK

How has the top gas sand event changed?

What is its AVA class?

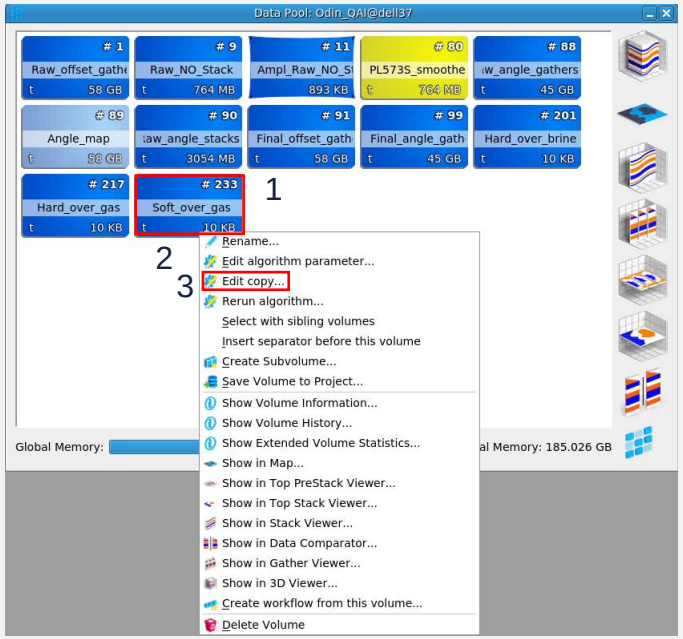
4



3

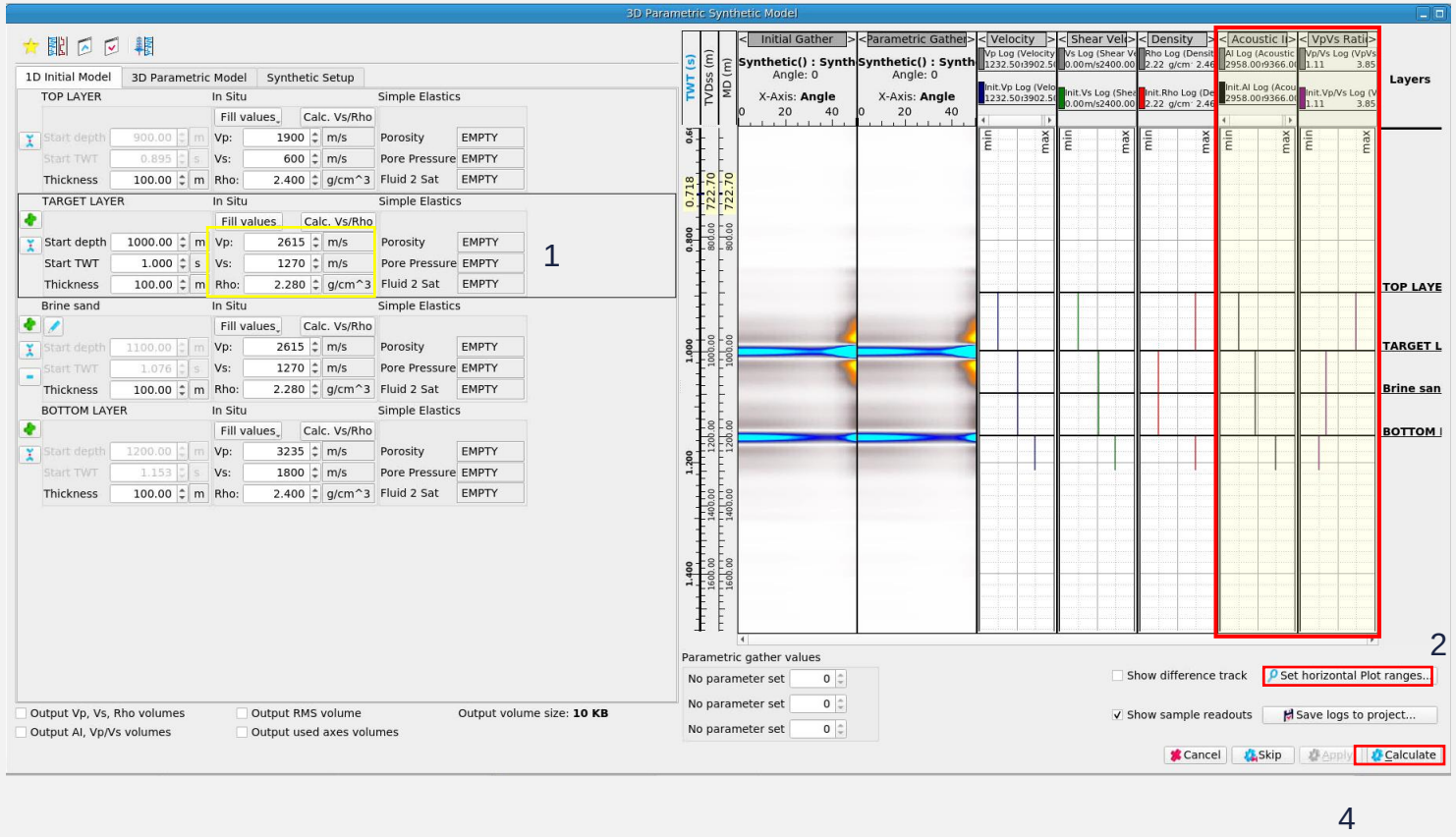
4. > Calculate to generate the model

Rename model and create a copy to edit



1. Rename the new Parametric model “Soft_over_gas”
2. RMB click the “Soft_over_gas” icon
3. > Edit copy…

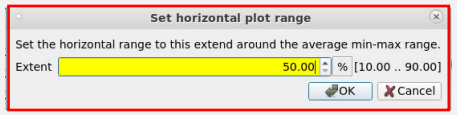
Model 4 – soft shale over brine sand



1. Change the elastic properties of the **TARGET LAYER** as follows: Vp=2615, Vs=1270, Rho=2.28
2. RMB click “Set horizontal Plot ranges…”
3. Select 50% and click OK

Describe the AI and Vp/Vs ratio contrasts at the top of the brine sand

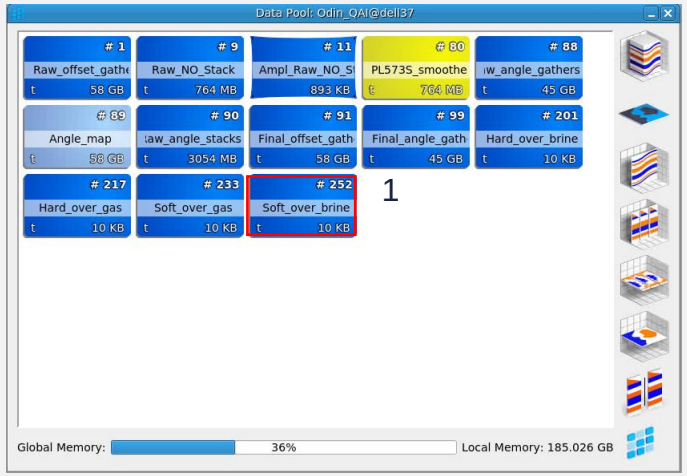
What is the AVA class of the top sand event?



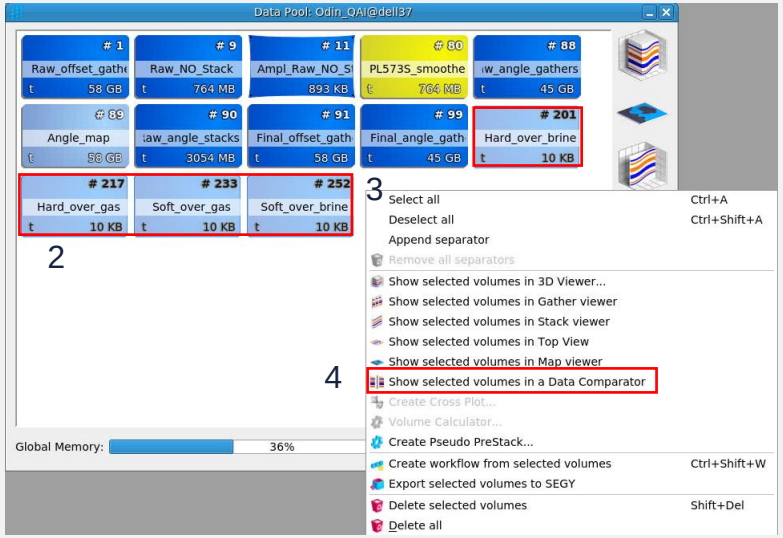
3

4. > Calculate to generate the model

Rename model and compare the 4 models



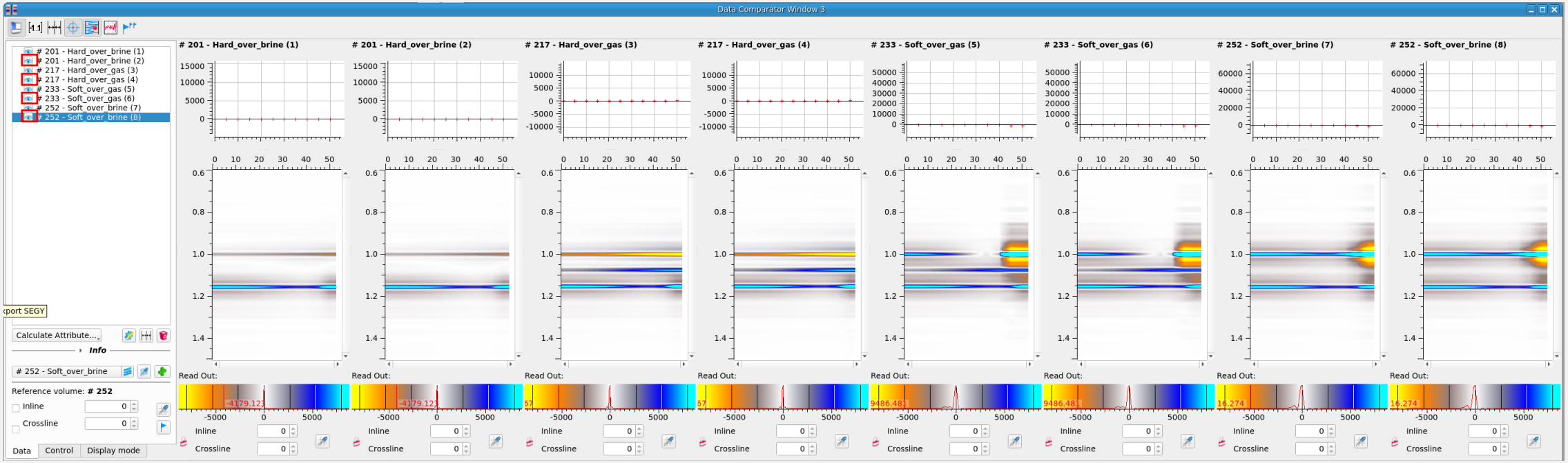
1. Rename the new Parametric model “Soft_over_brine”



2. Ctrl LMB click all 4 of the models
3. RMB click in the background of the Data Pool window
4. > Show selected volumes in a Data Comparator

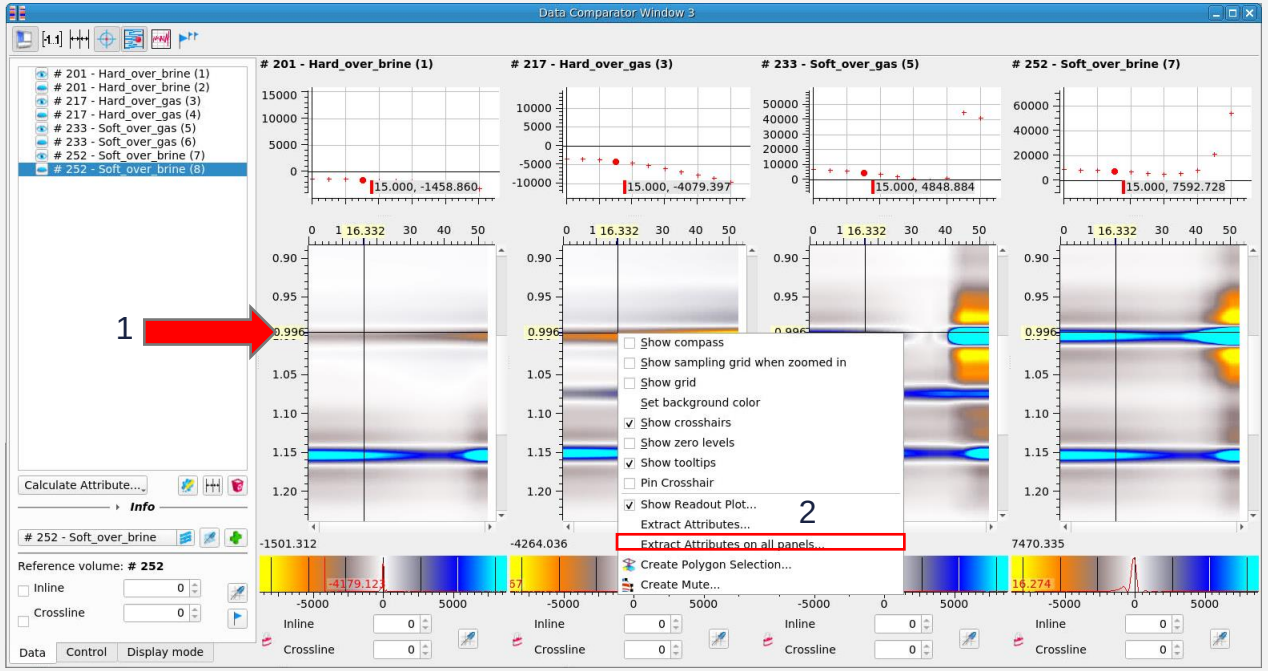
Customise display

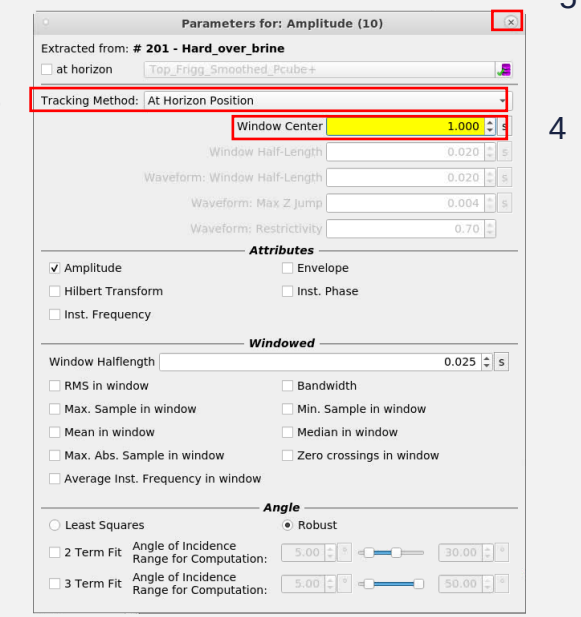
1



1. Toggle off duplicate gathers in display (Comparator automatically loads 2 gathers per model)

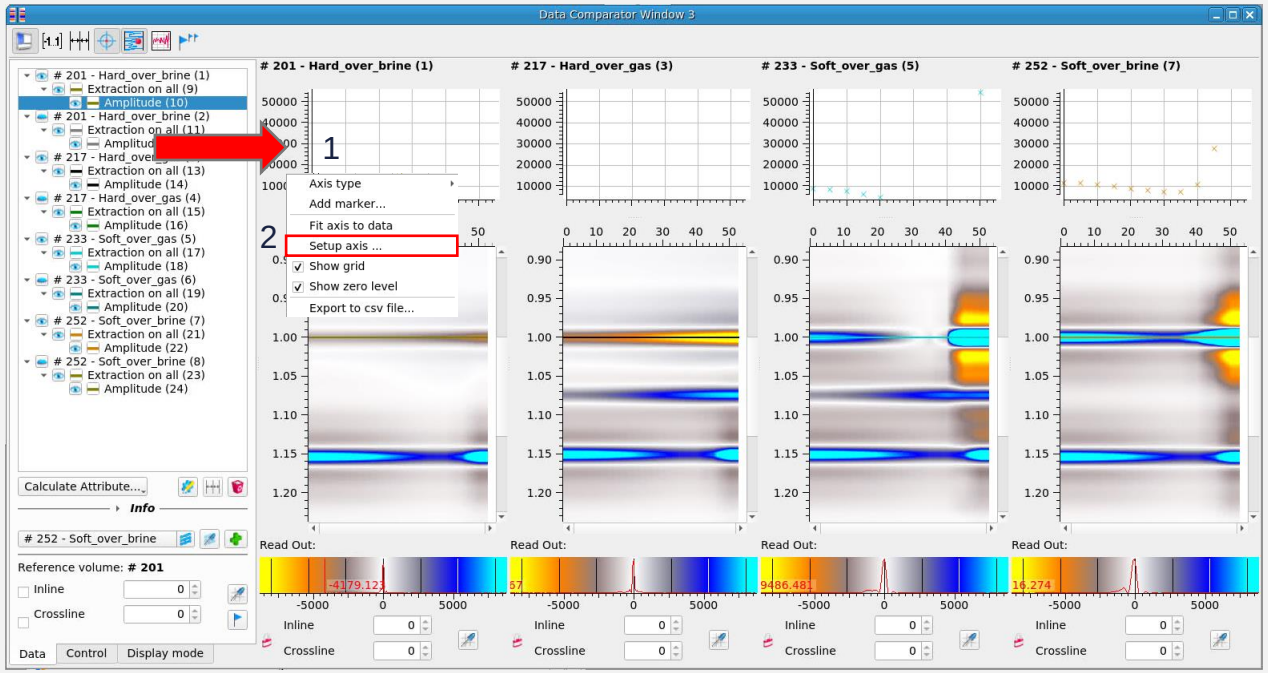
Extract AVA responses at Top Target

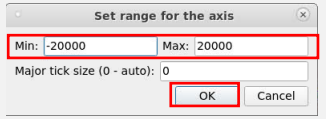




1. Use the mouse wheel with the cursor on the vertical axis to zoom in to the Top Target event at 1.0s TWT
2. RMB click in any gather window and select “Extract Attributes on all panels…”
3. Select “At Horizon Position” as Tracking Method
4. Set window center to 1.0s (Top Target event)
5. Close the parameters window

Set display range



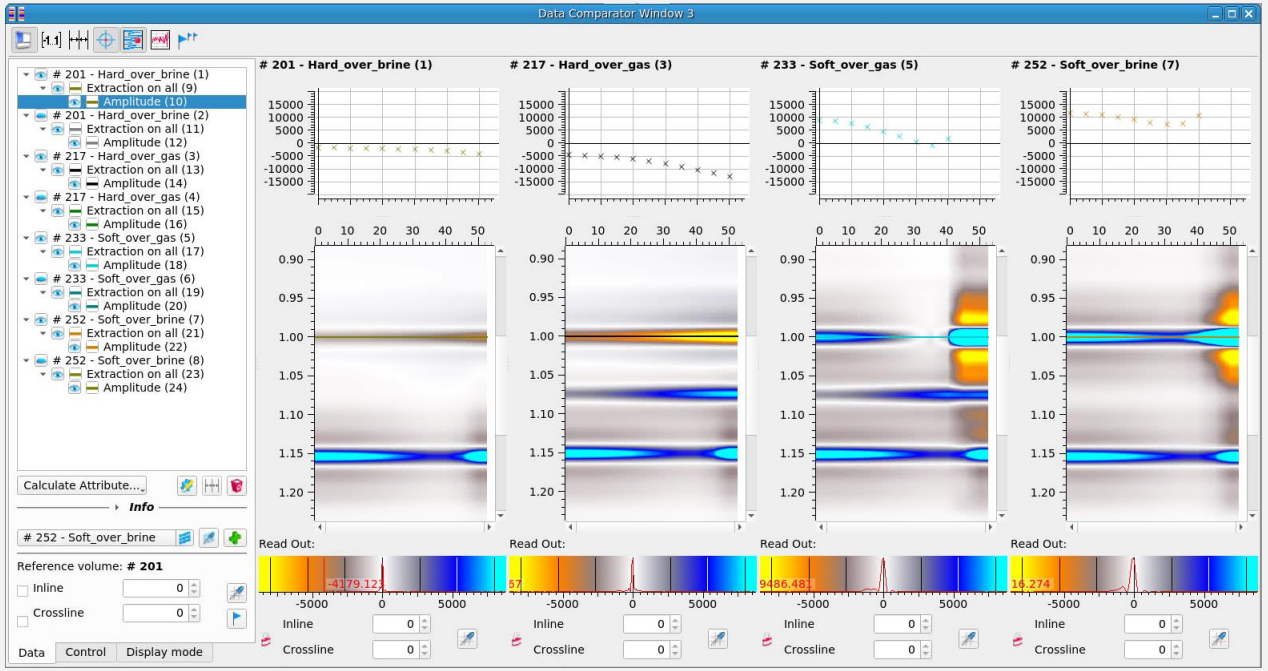


3

4

1. RMB click on the vertical axis of one of the AVA displays
2. > Setup axis…
3. Set range from -20000 to 20000
4. > OK

Compare AVA responses



What are the AVA classes for each of the different target scenarios?

Is the top gas sand always the same AVA class?

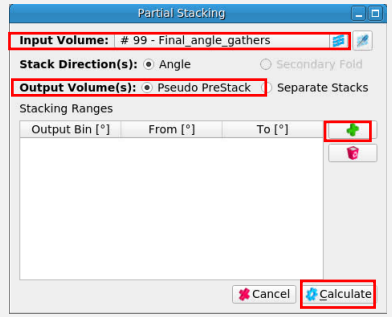
Is the top brine sand always the same AVA class?

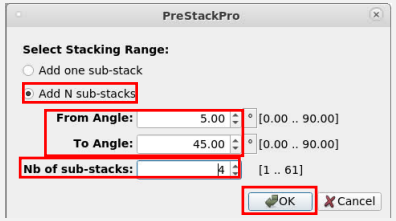
What would be the best angle range at which to tell these responses apart? Is there a single best angle?

Exercise 5

- AVA analysis 1
  - *Generate 4 final angle stacks*
  - *Generate a full-stack*
  - *Amplitude extraction on angle stacks & full stack*
  - *Create 10-fold partial pre-stack gathers*
  - *Compare with 1 deg angle gathers*
  - *Extract windowed attributes on angle stacks (+/-8 ms max neg, max pos, RMS), observe patterns*
  - *Arbline through feeder – view on angle stacks, flat-spot*
  - *Pre-stack well-tie*
  - *Building models from well-logs*

Create 4 Final Partial Angle Stacks

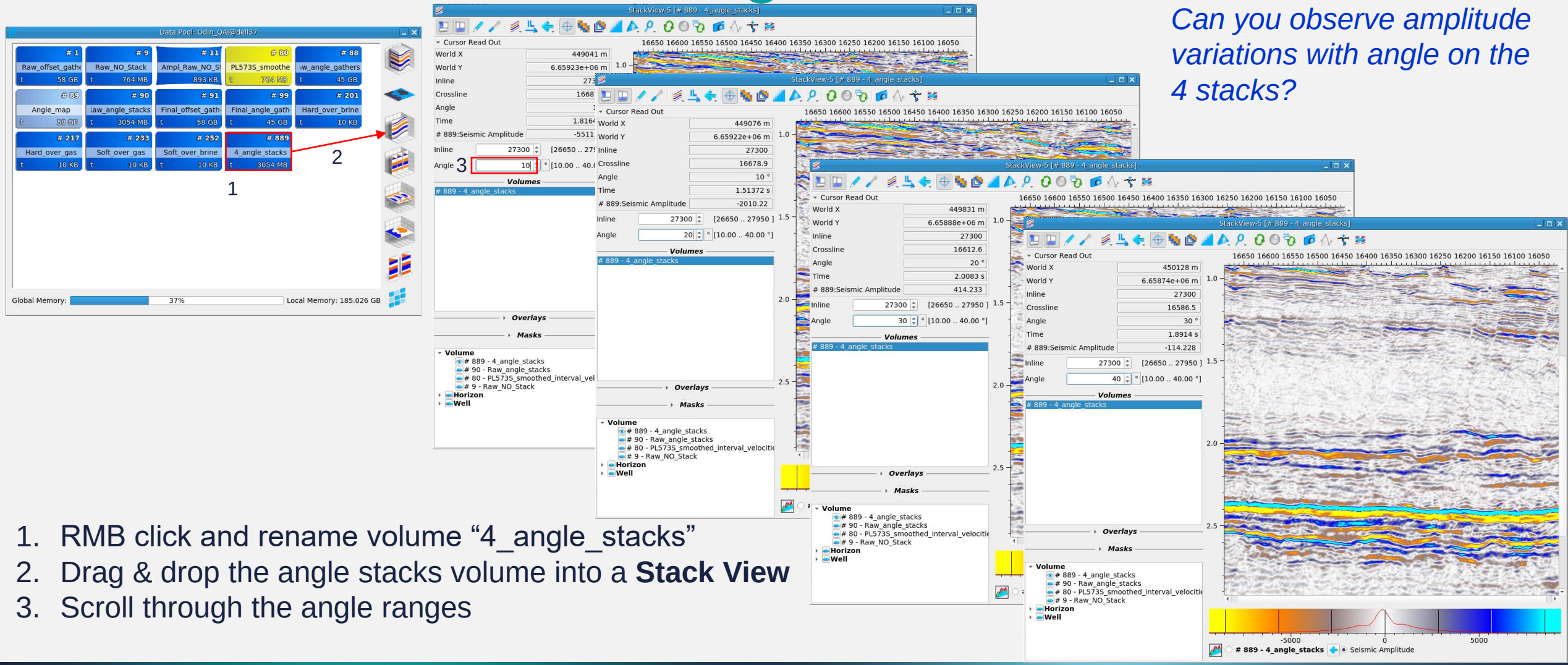




From the top level menu:

- Select Processing
  1. > Partial Stacking…
  2. Select “Final_angle_gathers” as Input
  3. Toggle on “Pseudo PreStack” output
  4. Click the green “plus” icon
  5. Add 4 sub-stacks between angles of 5° and 45°
  6. > OK
  7. > Calculate

Rename and view angle stacks



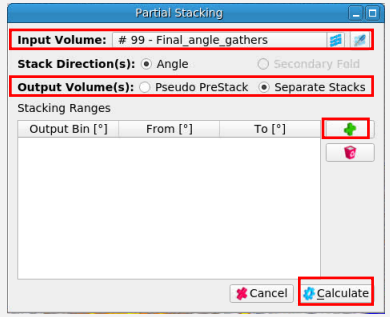
Can you observe amplitude variations with angle on the 4 stacks?

1. RMB click and rename volume “4_angle_stacks”
2. Drag & drop the angle stacks volume into a **Stack View**
3. Scroll through the angle ranges

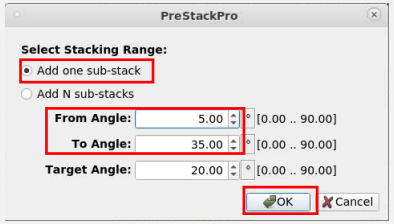
Create a Full Stack

1

2 3 4 7



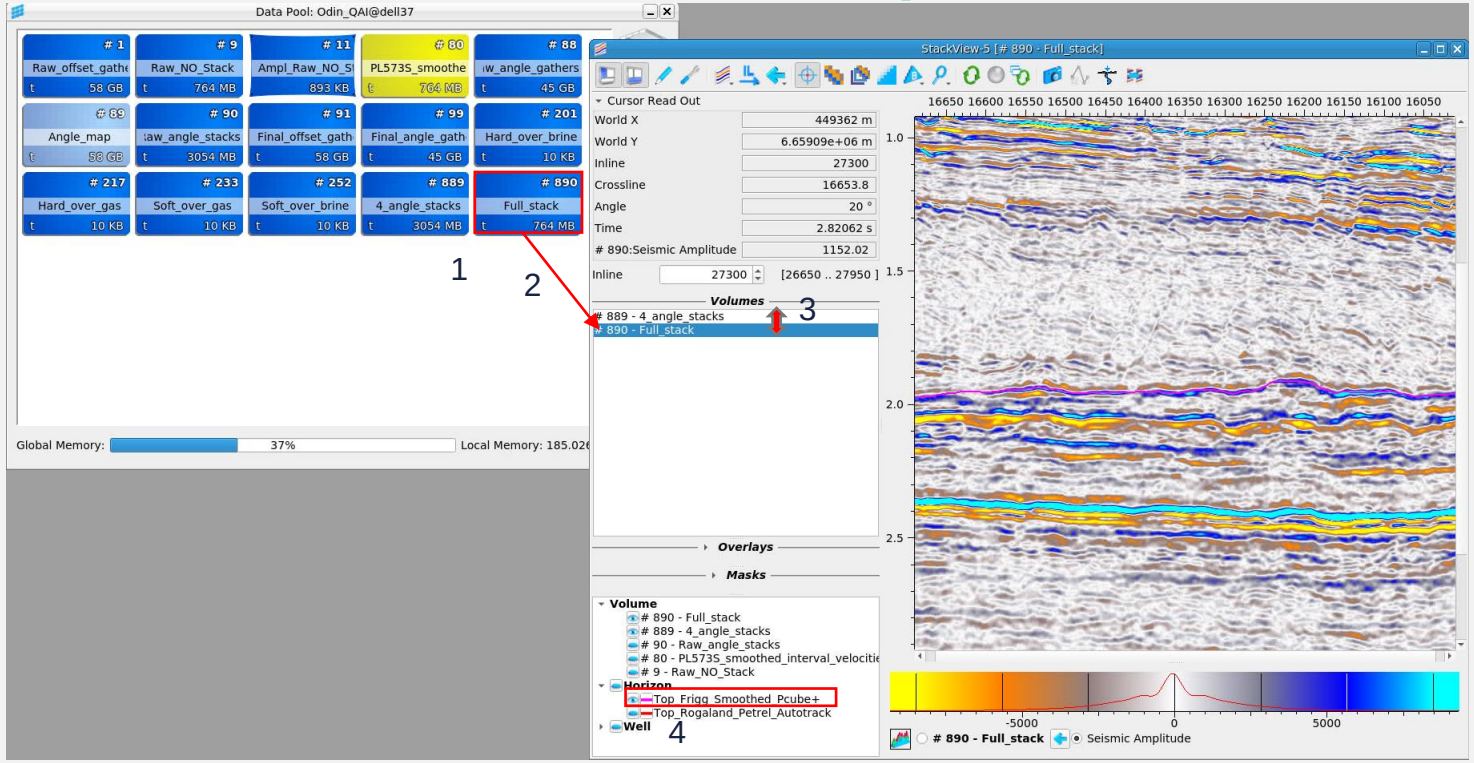
5 6



From the top level menu:

- Select Processing
  1. > Partial Stacking…
  2. Select “Final_angle_gathers” as Input
  3. Toggle on “Separate Stacks” output
  4. Click the green “plus” icon
  5. Add 1 sub-stack between angles of 5° and 35°
  6. > OK
  7. > Calculate

Rename and compare full stack with angle stacks

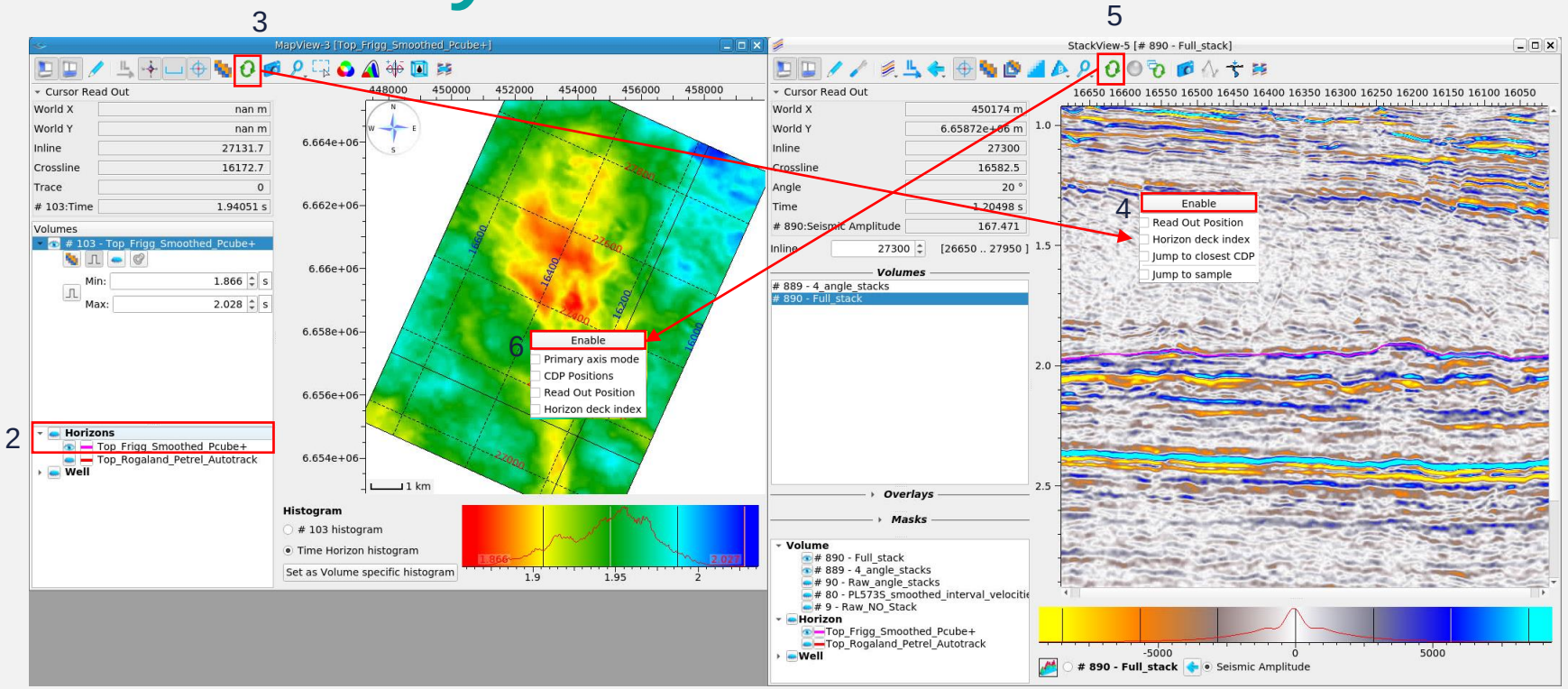


Which Angle stack looks most similar to the Full stack?

1. RMB click and rename volume “Full_stack”
2. Drag & drop the “Full_stack” into the existing **Stack View**
3. Toggle between “Full_stack” and “4_angle_stacks” volumes, rotating through angles
4. Turn on the **Top Frigg** horizon

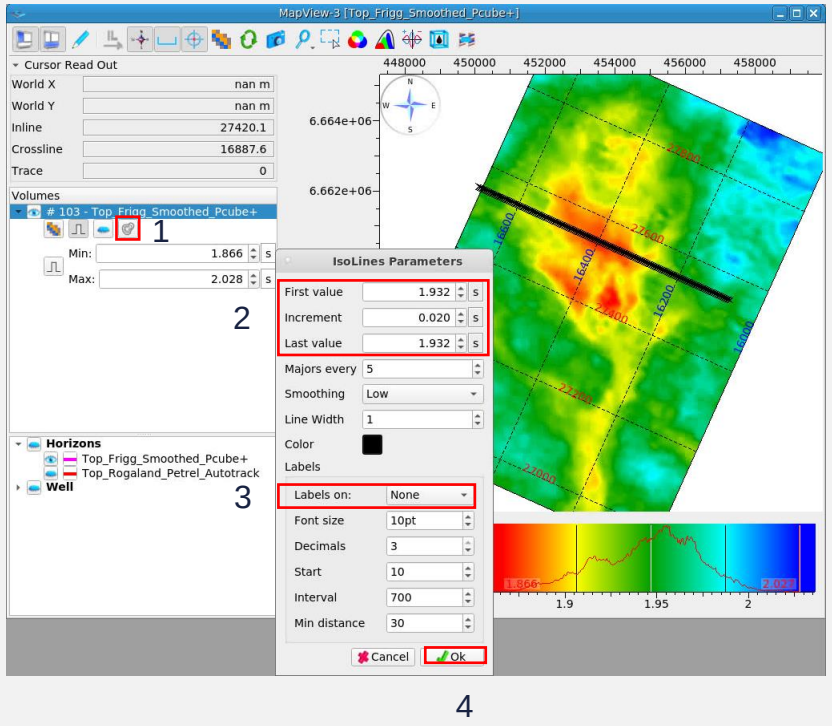
Open a Map View & synchronise views

1. Double click the Map View icon in the Data Pool
2. Turn on the **Top Frigg** horizon
3. Click the “synchronise viewers” icon in the **Map View**



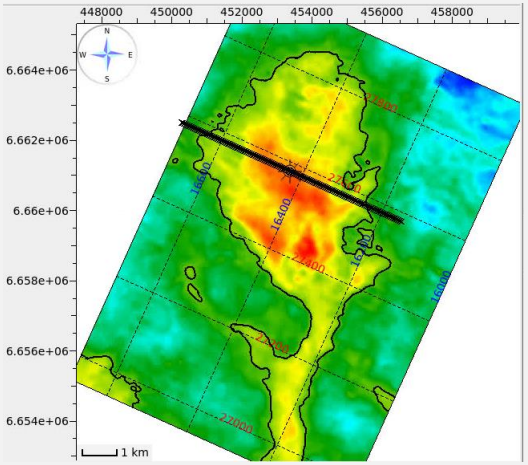
4. LMB click in the **Stack View** and toggle on “Enable”, then LMB click anywhere on the gathers
5. Click the “synchronise viewers” icon in the **Stack View**
6. LMB click in the **Map View** and toggle on “Enable”, then LMB click anywhere on the map

Turn on a structural contour for reference

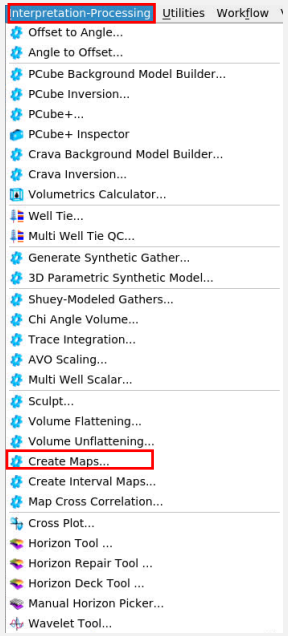


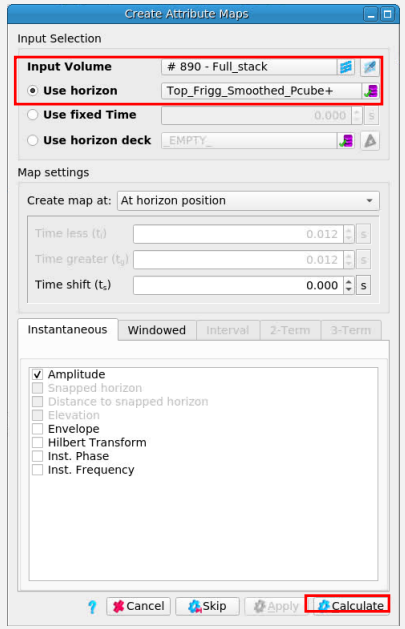
1. Click on the “Modify Contours” icon for the **Top Frigg** event in Map View
2. Set the First and Last contour values to 1.932s
3. Set “Labels on” to “None”
4. > OK

Double click anywhere on the map to change IL location

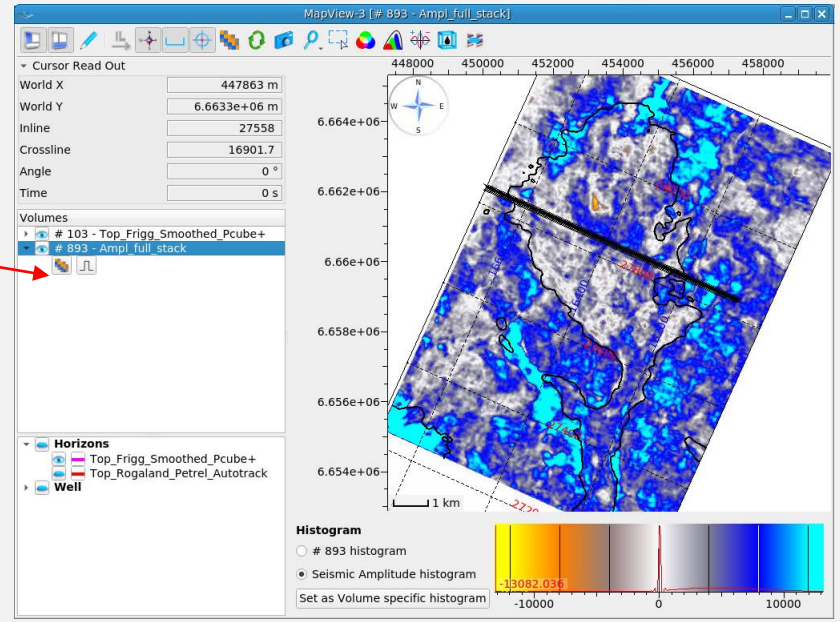


Create a full stack amplitude map





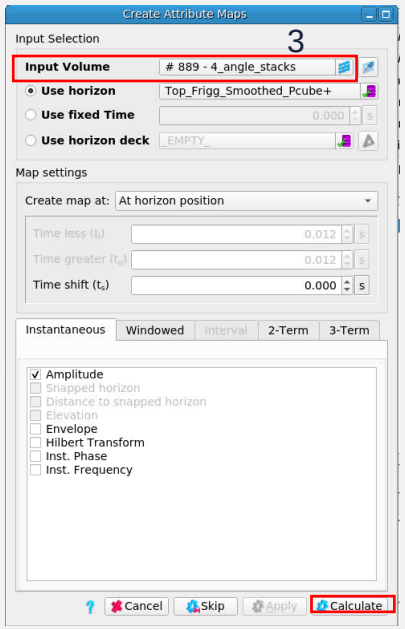
What observations can you make from the full stack amplitude map?

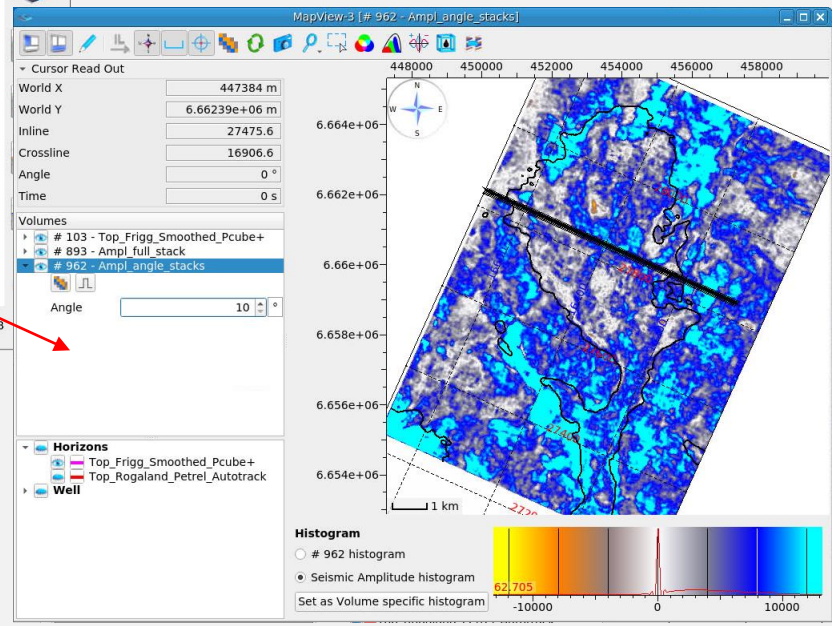


From the top level menu, select Interpretation-Processing

1. > Create Maps…
2. Ensure that Input Volume is “Full_stack”, horizon is **Top Frigg** and the “Amplitude” box is ticked
3. > Calculate
4. RMB click on the new map object and rename “Ampl_Full_stack”
5. Drag and drop the “Ampl_Full_stack” map into the existing **Map View**

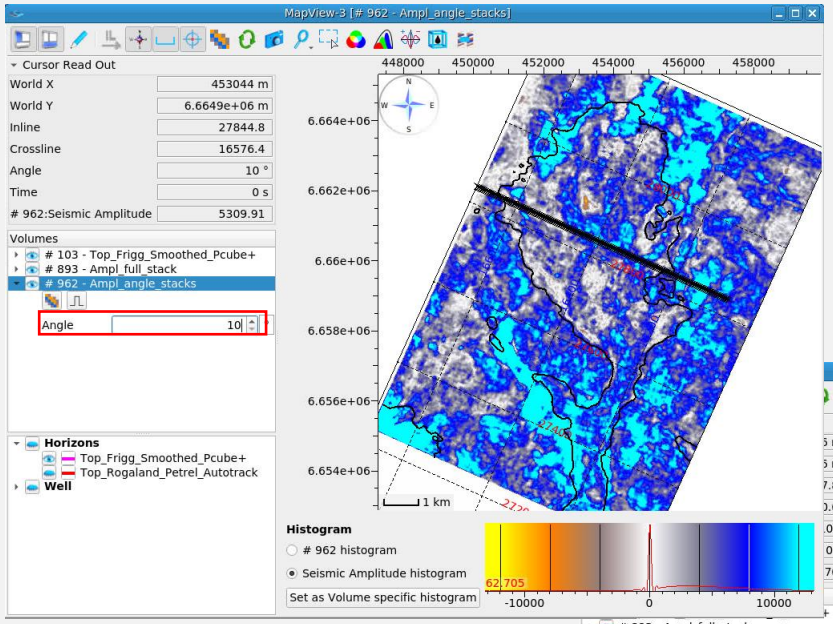
Create angle stack amplitude maps

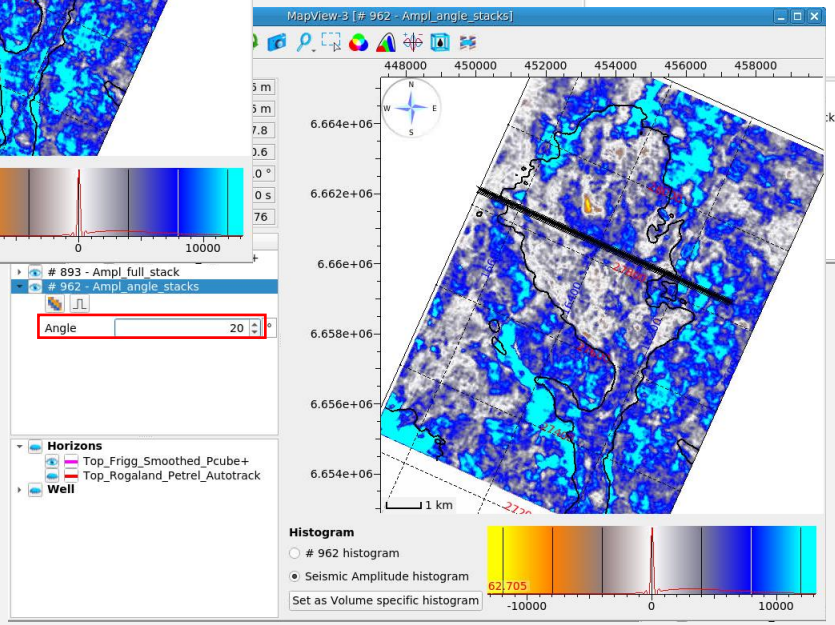


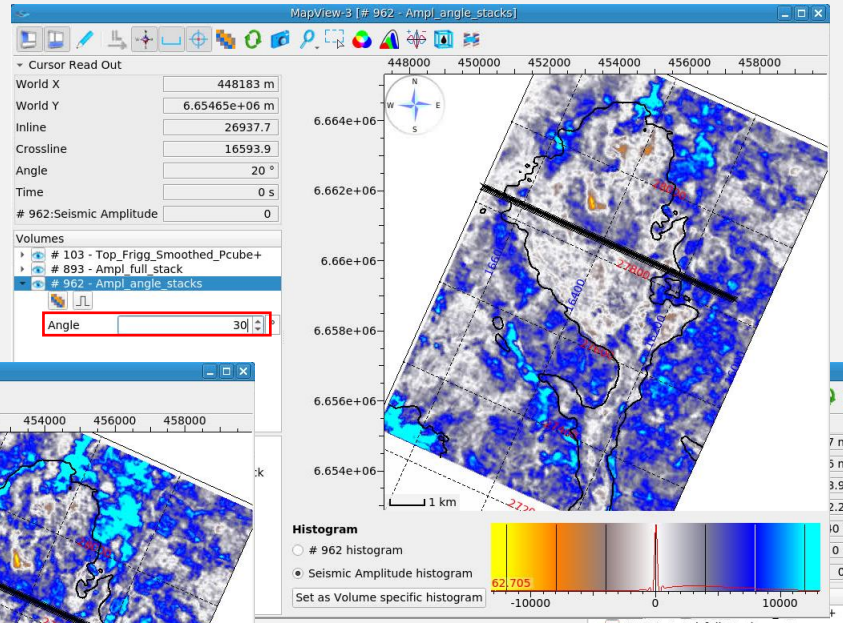


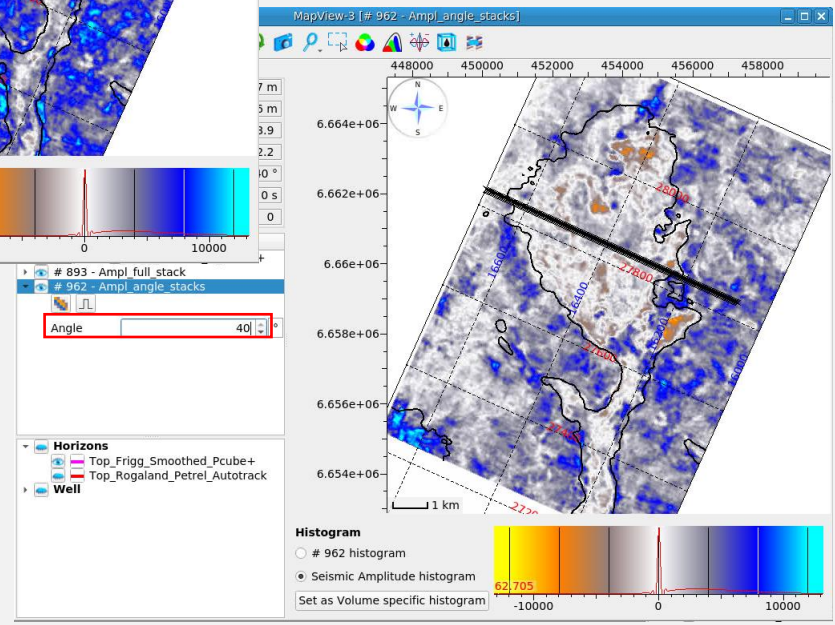
1. In the Data Pool, RMB click on the “Ampl_Full_stack” map
2. > Edit copy…
3. Change the “Input Volume” to “4_angle_stacks”
4. > Calculate
5. RMB click on the new map object and rename “Ampl_angle_stacks”
6. Drag and drop the new Amplitude map into the existing **Map View**

Compare amplitude maps by angle





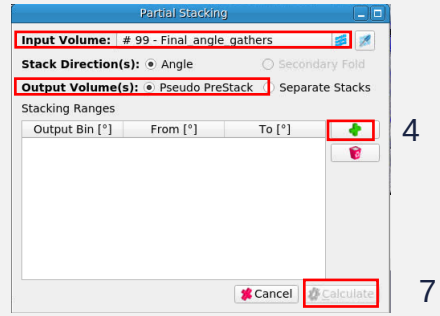


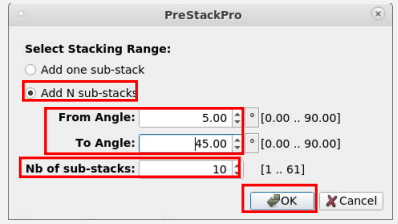


What observations can you make from the angle stack amplitude maps?

Scroll through the amplitude maps by angle

Create a 10-fold Pseudo pre-stack volume



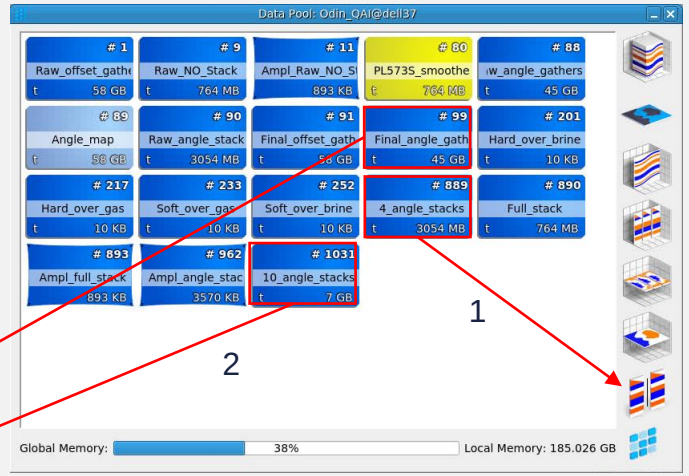


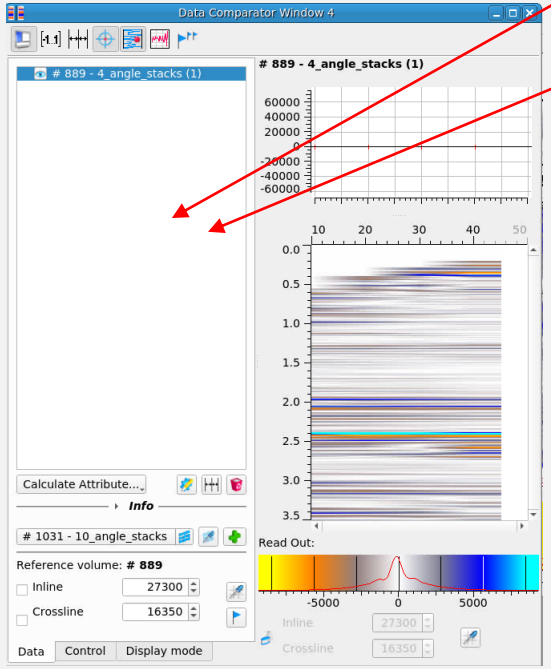
From the top level menu:

- Select Processing
  1. > Partial Stacking…
  2. Select “Final_angle_gathers” as Input
  3. Toggle on “Pseudo PreStack” output
  4. Click the green “plus” icon
  5. Toggle on “Add N sub-stacks” and add **10** sub-stacks between angles of 5° and 45°
  6. > OK
  7. > Calculate

7. In the Data Pool, RMB click and rename the new volume “10_angle_stacks”

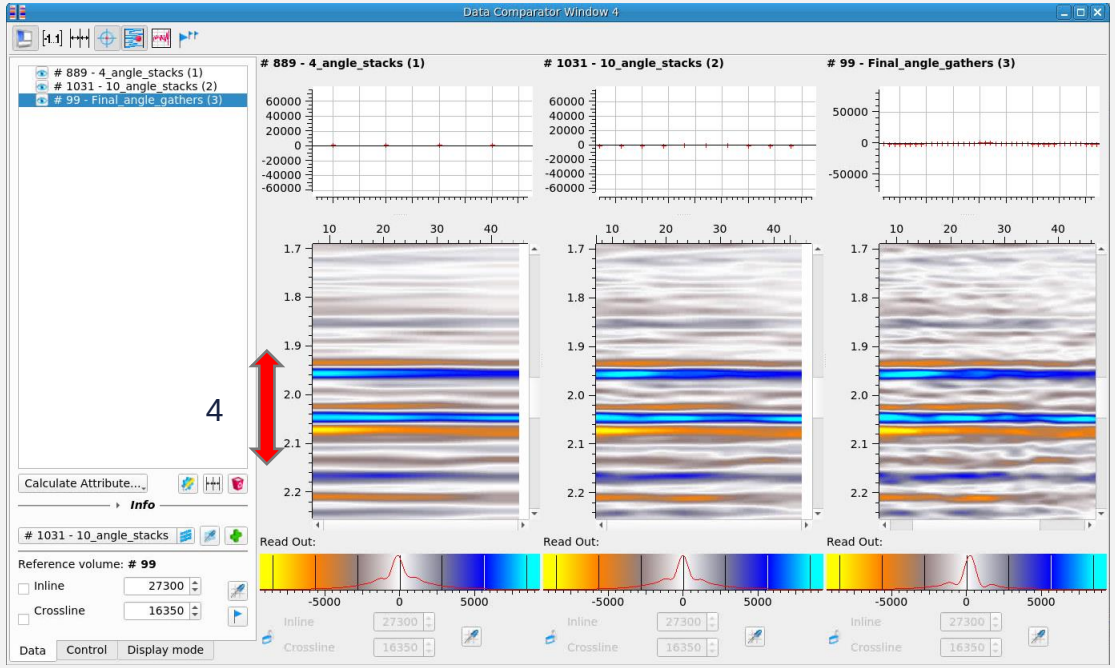
Compare pre-stack fold



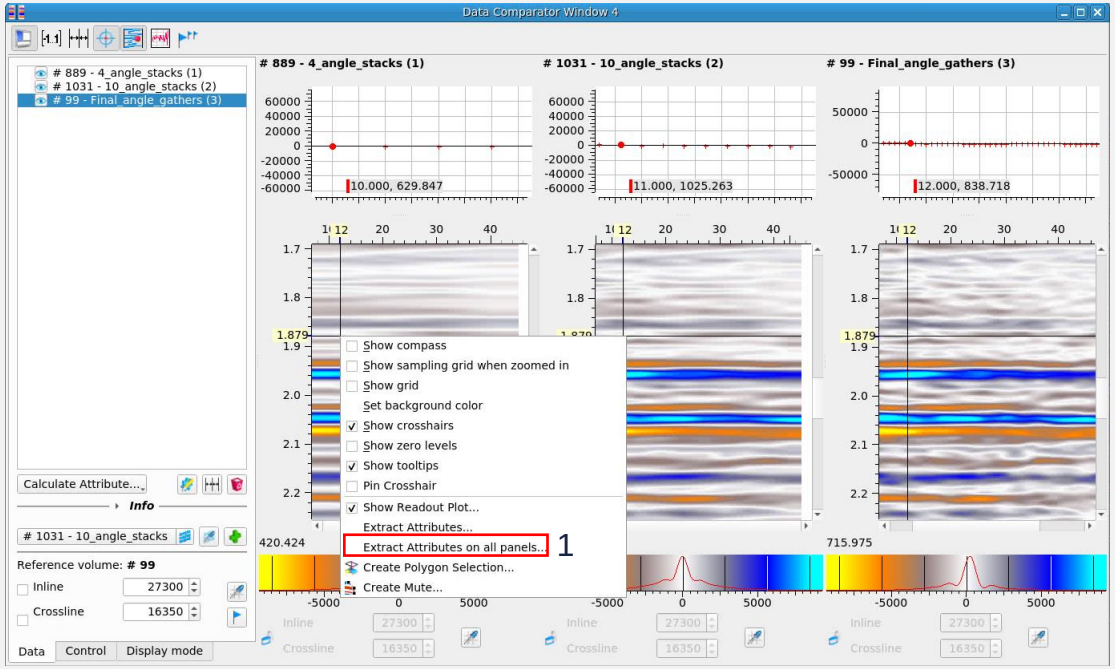


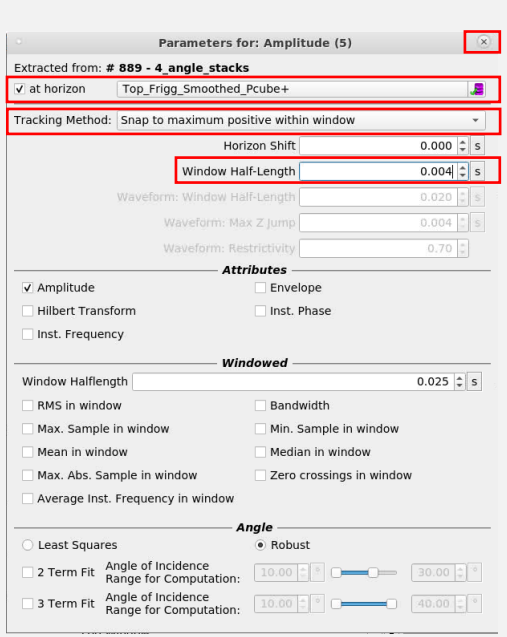
1. Drag & drop “4_angle_stacks” volume into a new Data Comparator
2. Drag & drop the “10_angle_stacks” volume into the Comparator
3. Drag and drop the “Final_angle_gathers” into the Comparator

4. Place the cursor on the TWT axis and use the mouse wheel to zoom in to the target at around 2.0s TWT



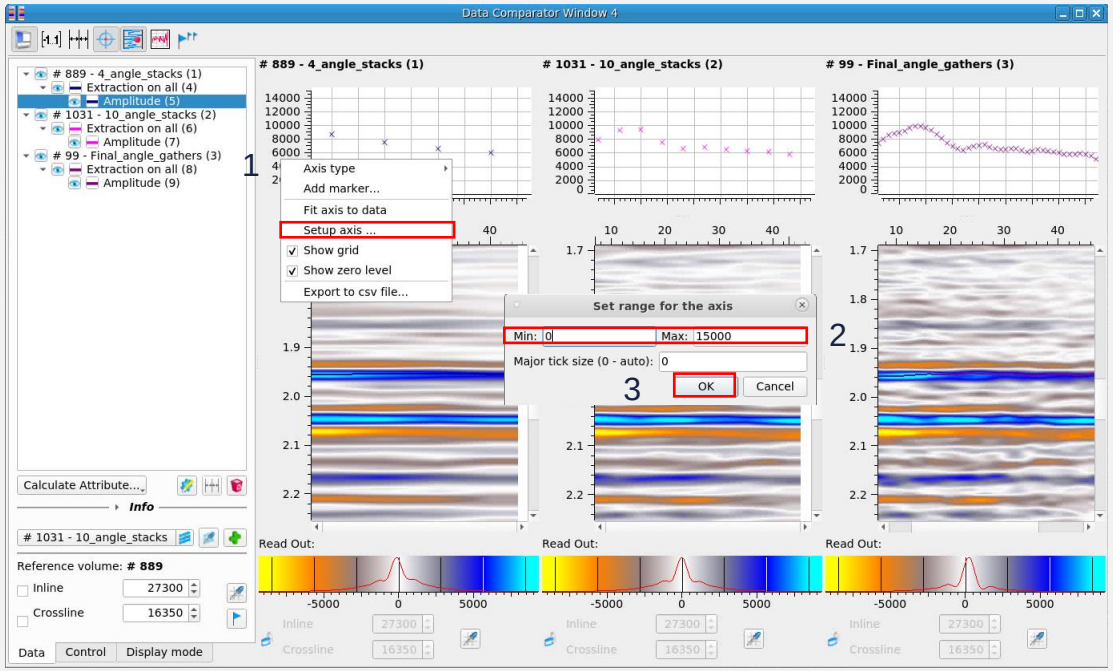
Extract amplitudes from each pre-stack data set





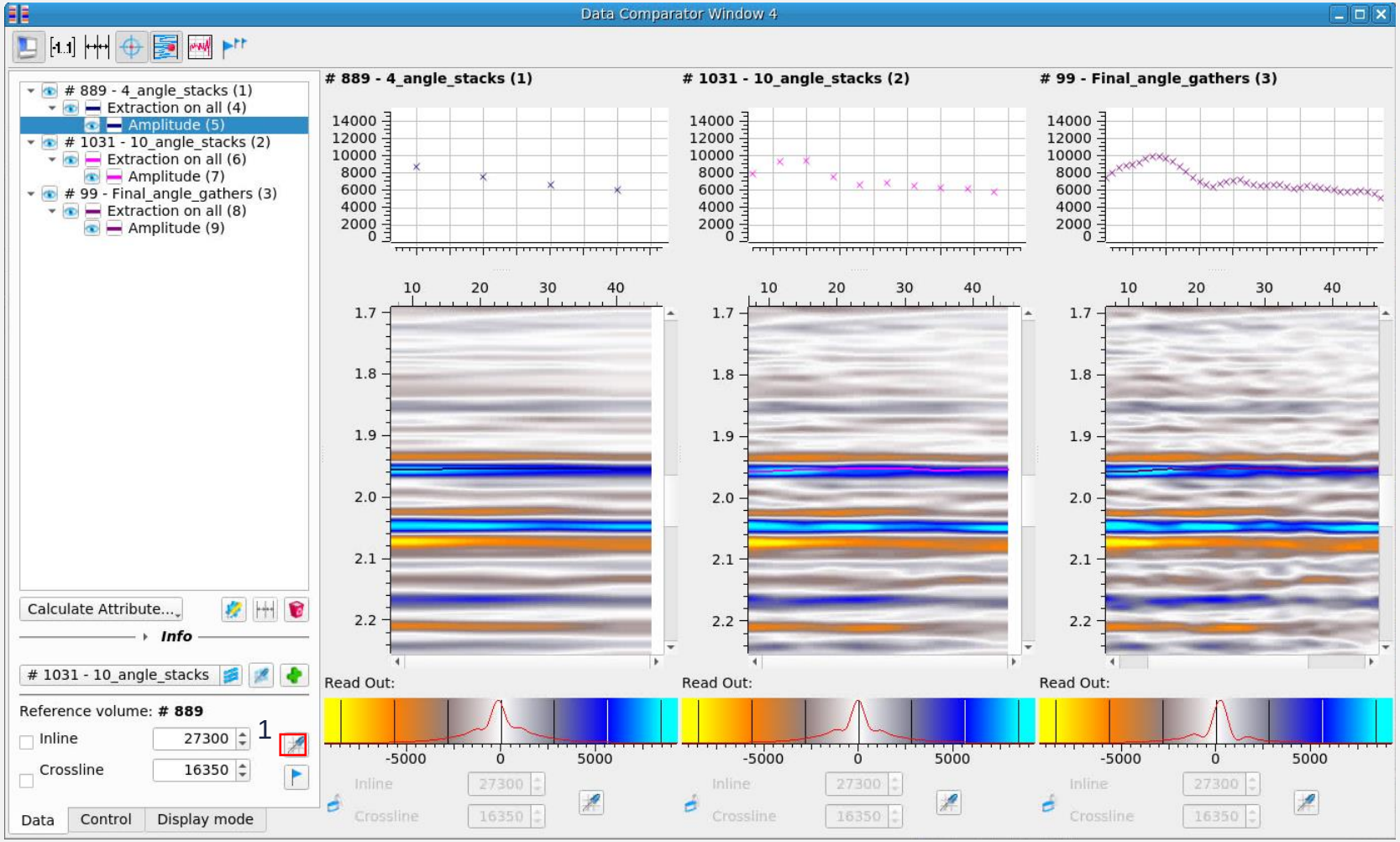
1. RMB click on one of the gathers & select “Extract Attributes on all panels…”
2. Toggle on “at horizon” and select **Top Frigg** event
3. Set Tracking Method to “Snap to maximum positive within window” and set Window half-length to 4ms (N.B. you can click on any units button to switch from s to ms)
4. Close Parameters window by clicking x

Compare pre-stack fold



1. RMB click on the amplitude axis and click “Setup axis”
2. Set the range from 0 to 15000
3. >OK

Compare pre-stack fold

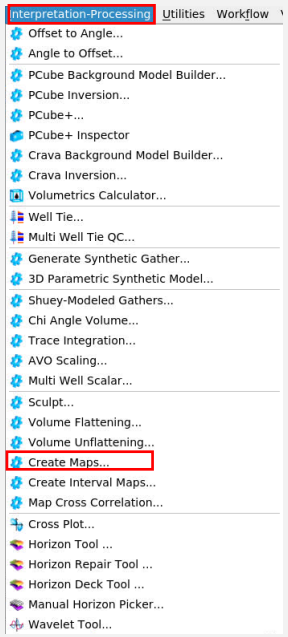


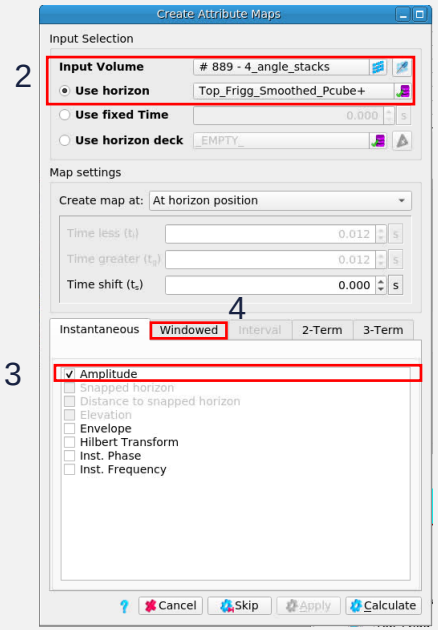
Are 4 angle stacks sufficient to establish the AVA class of the Top Frigg event?

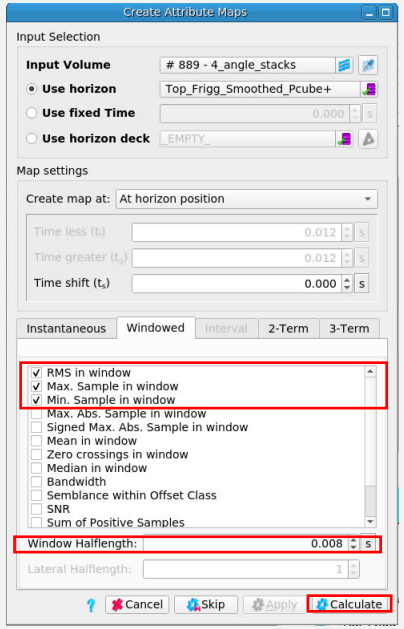
What additional information does the 10-fold gather contain?

1. Click on the eye-dropper icon and click on any location on the map to compare AVA response for different fold of input at different locations

Windowed pre-stack amplitude mapping





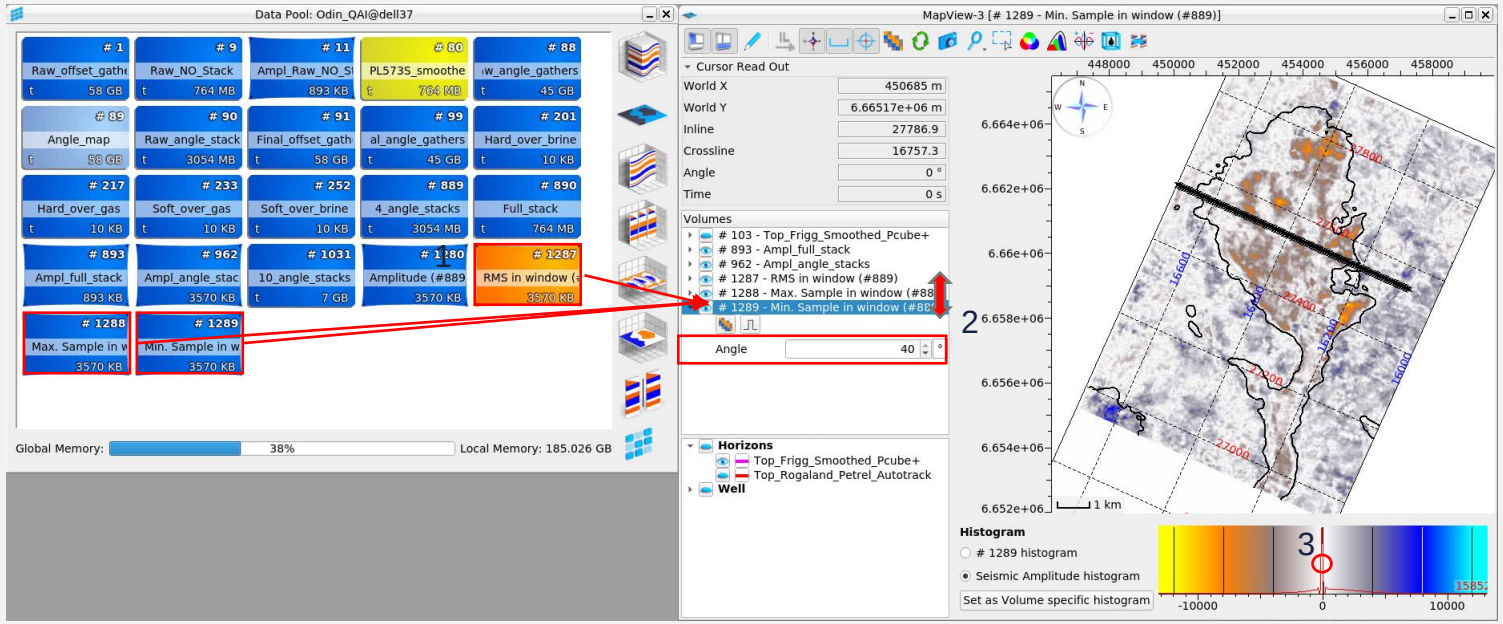


4. Click on the “Windowed” attribute tab
5. Select RMS, Max and Min sample in window
6. Set Window Halflength to **8ms**
7. > Calculate

From the top level menu, select Interpretation-Processing

1. > Create Maps…
2. Ensure that Input Volume is “4_angle_stacks” & horizon is **Top Frigg**
3. Deselect the Amplitude tick box

Windowed pre-stack amplitude mapping

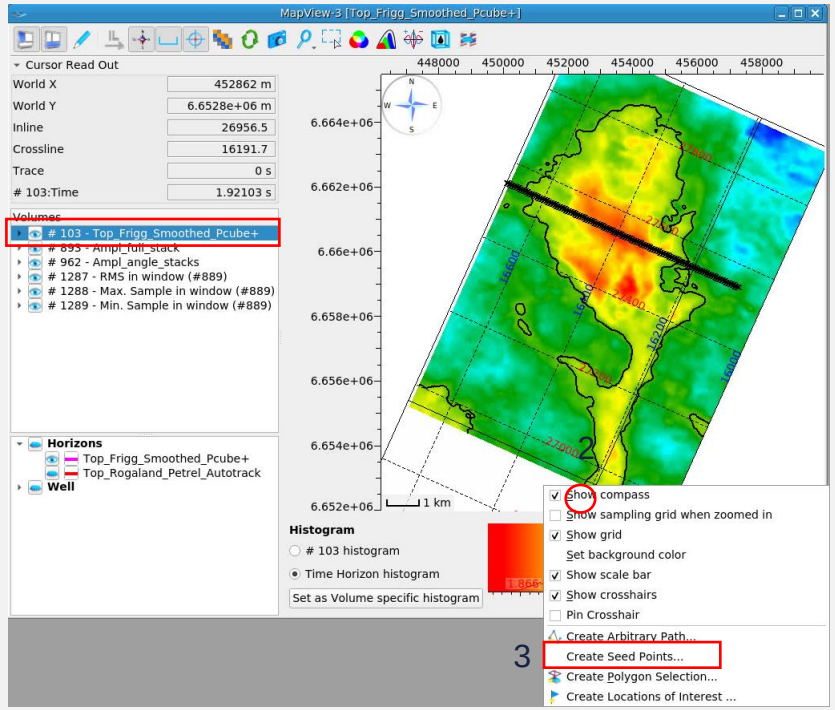


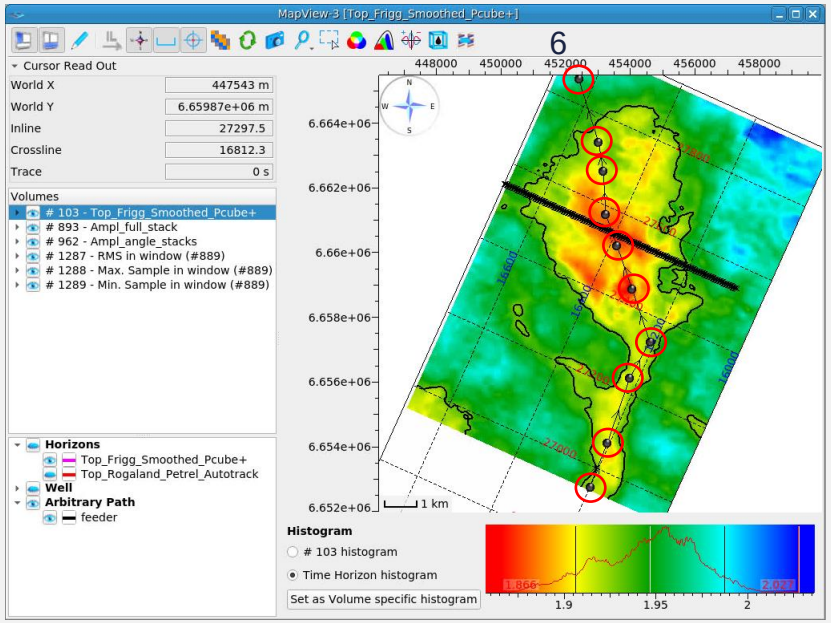
Which interval attribute maps appear to be of most interest?

How do they compare to the instantaneous amplitude maps?

1. LMB click and drag the three maps into the existing Map View
2. Toggle between the attribute maps and scroll through the angle ranges
3. Place cursor on the colour bar and use the mouse wheel to alter the dynamic range as required

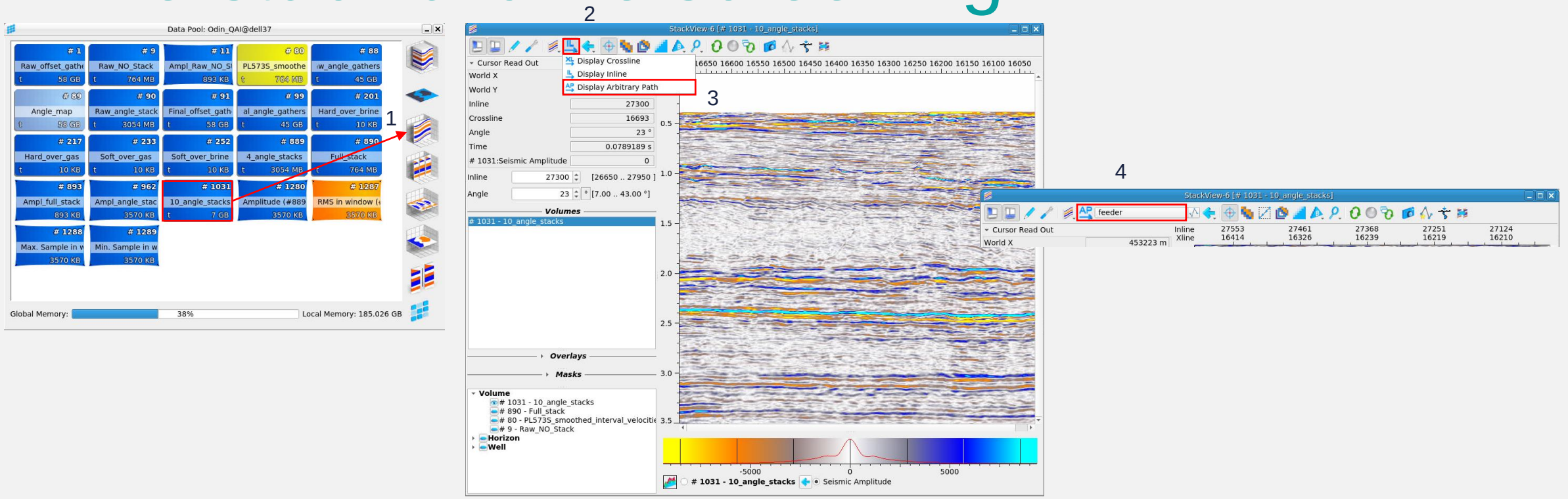
Pre-stack arbline screening





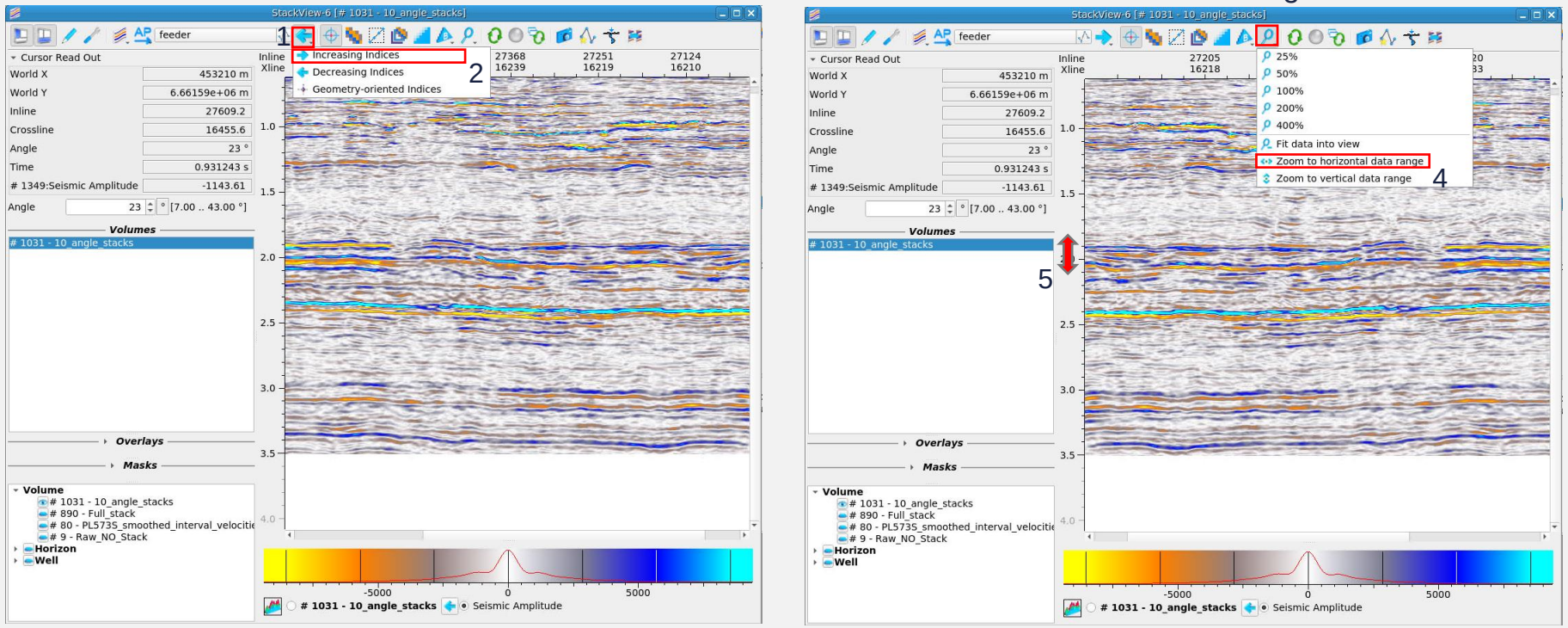
1. Display the **Top Frigg** structure map
2. RMB click on the map at a location where you would like to start the line
3. > Create Arbitrary Path…
4. Rename as “feeder”
5. > Create
6. Ctrl LMB click to add points to the line, along the axis of the fan

Pre-stack arbline screening - 1



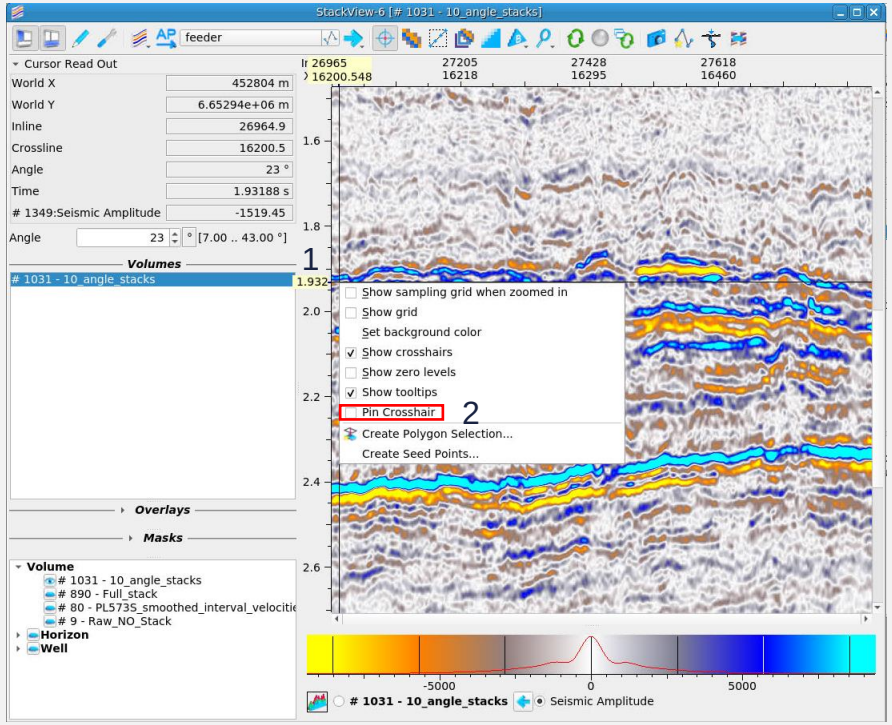
1. LMB click and drag the “10_angle_stack” volume into a new **Stack View**
2. In the **Stack View**, click on the “Display Inline” icon
3. > Display Arbitrary Path
4. Make sure the “feeder” arbitrary path is selected

Pre-stack arbline screening - 2

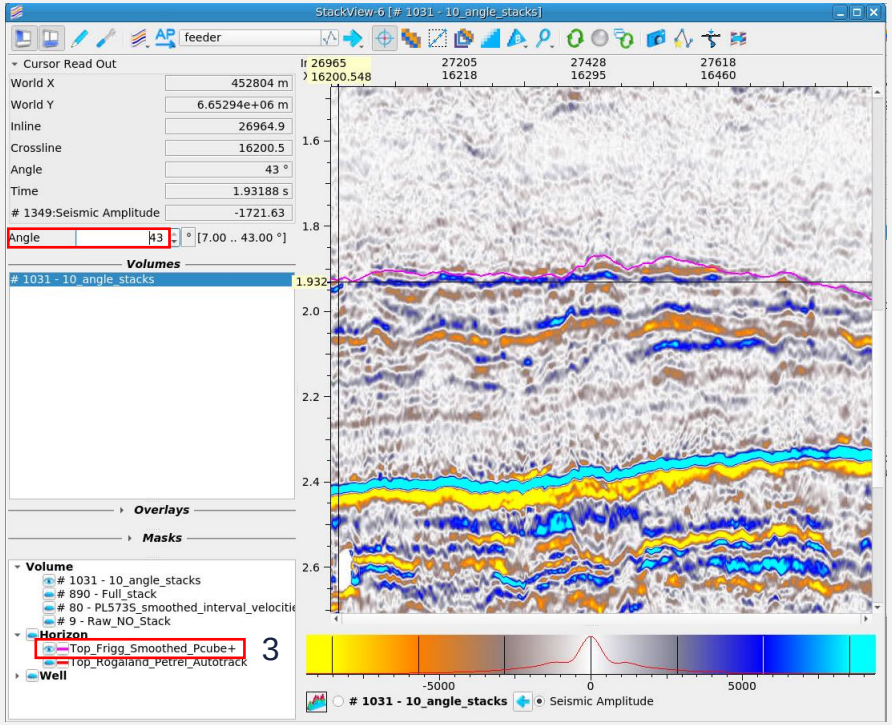


1. In the **Stack View**, click on the “indices” tab
2. > Increasing indices
3. Click on the “Set zoom level” tab
4. > Zoom to horizontal data range
5. Place the cursor on the vertical axis and zoom vertically around the 2.0s TWT level

Pre-stack arbline screening - 3



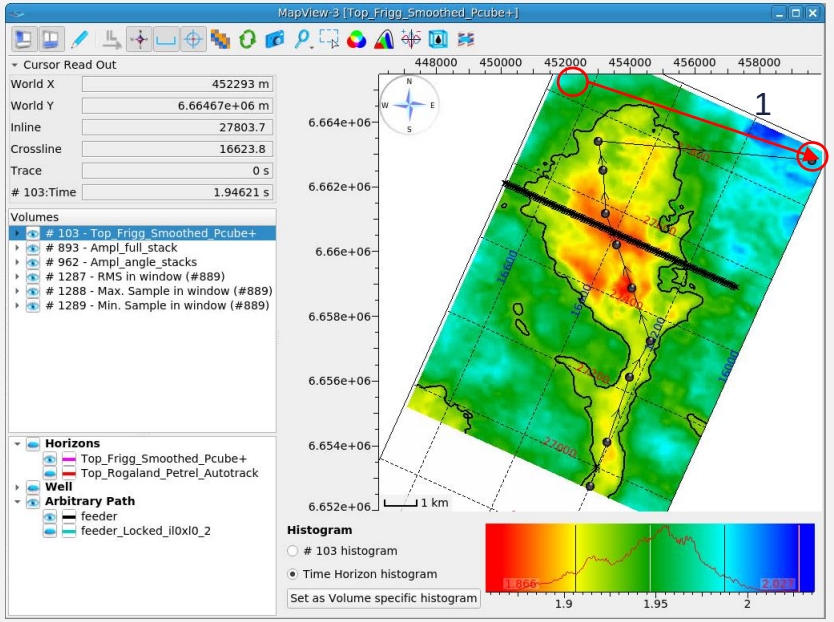
4



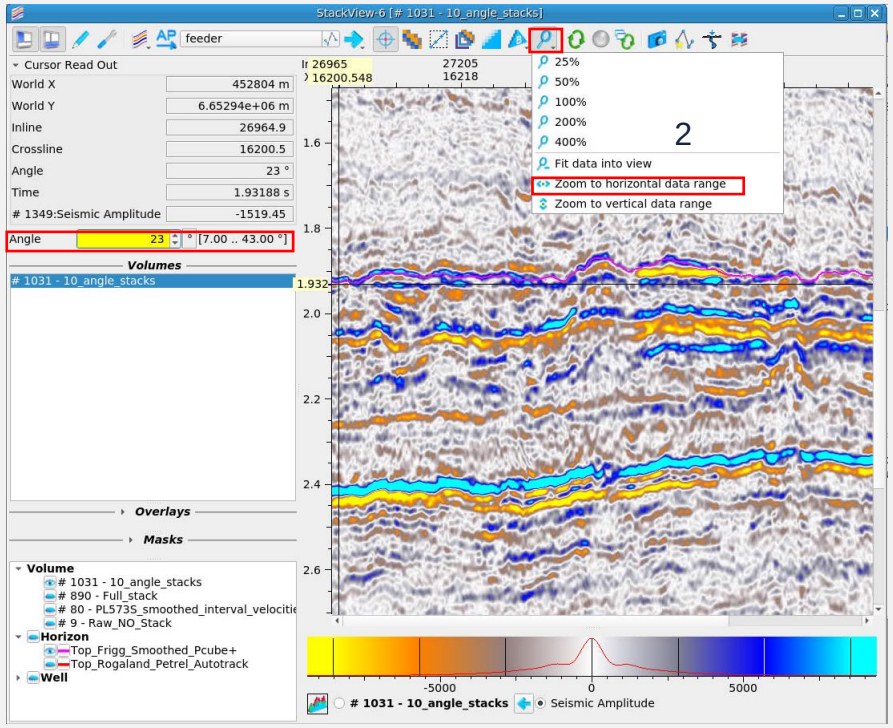
1. Place the cursor at 1.932s in the Stack View, RMB click
2. > Pin Crosshair
3. Turn on **Top Frigg** horizon
4. Pan through the angle ranges

What happens to the Top Frigg event as you scroll to higher angles?

Pre-stack arbline screening - 4



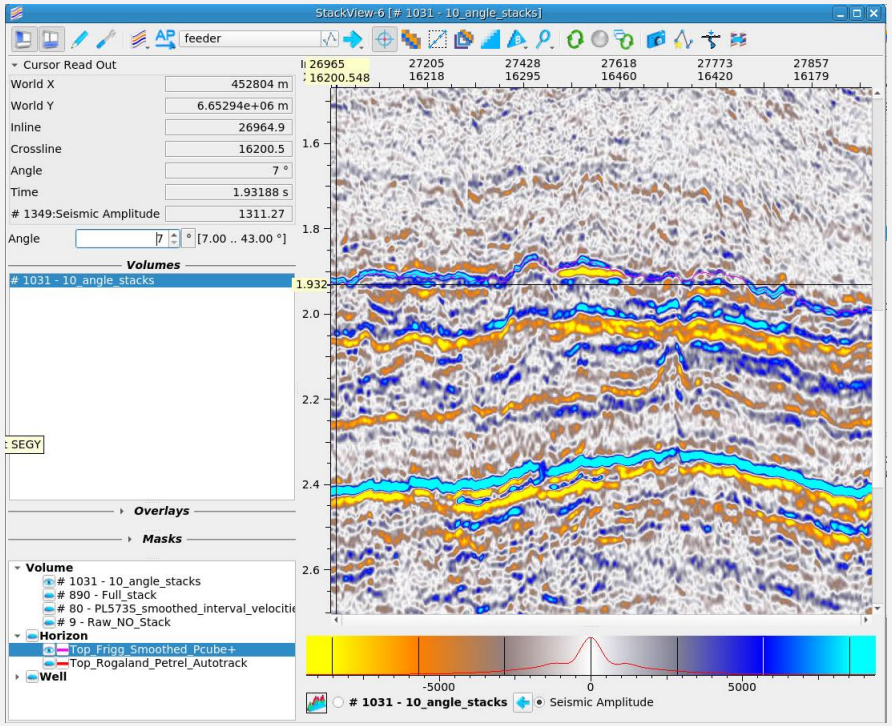
3

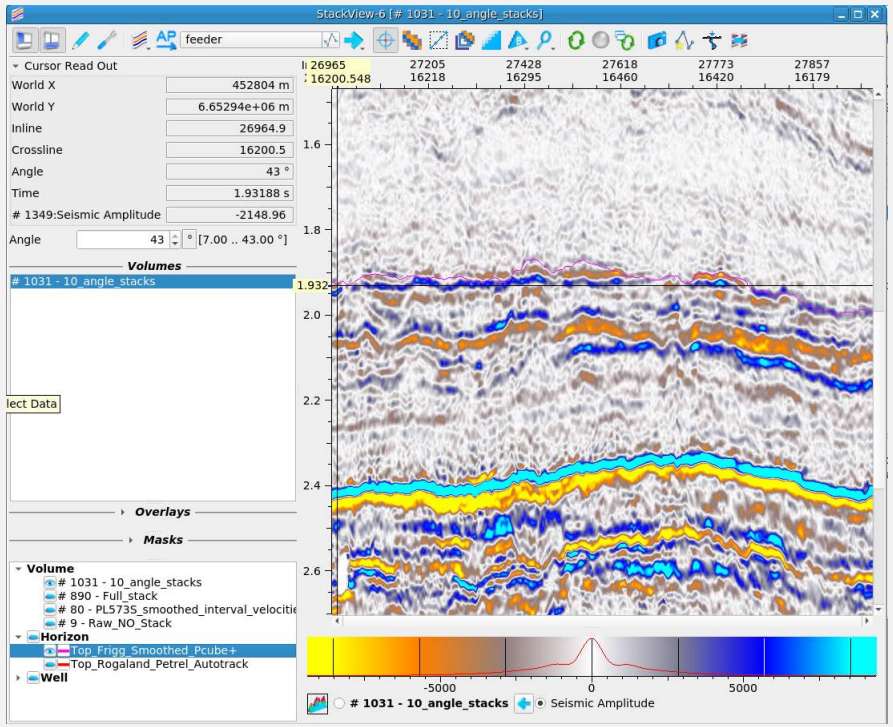


Do you notice anything different about the high angle response of the Top Frigg event below the 1.932s level?

1. In the **Map View**, LMB click and drag the end point of the feeder arbline to the NE corner of the map
2. In the Stack View, Zoom to horizontal data range
3. Pan through the angles again

Pre-stack arbline screening - 5

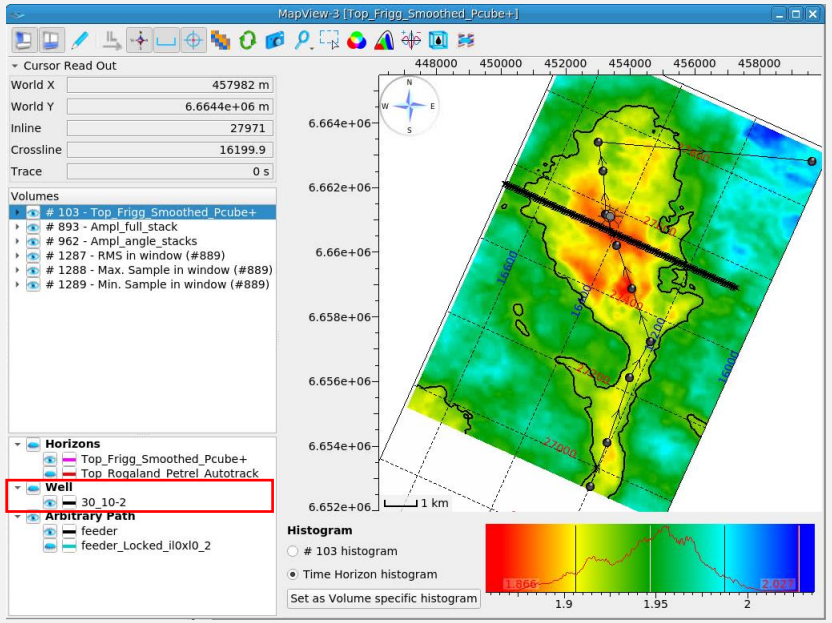


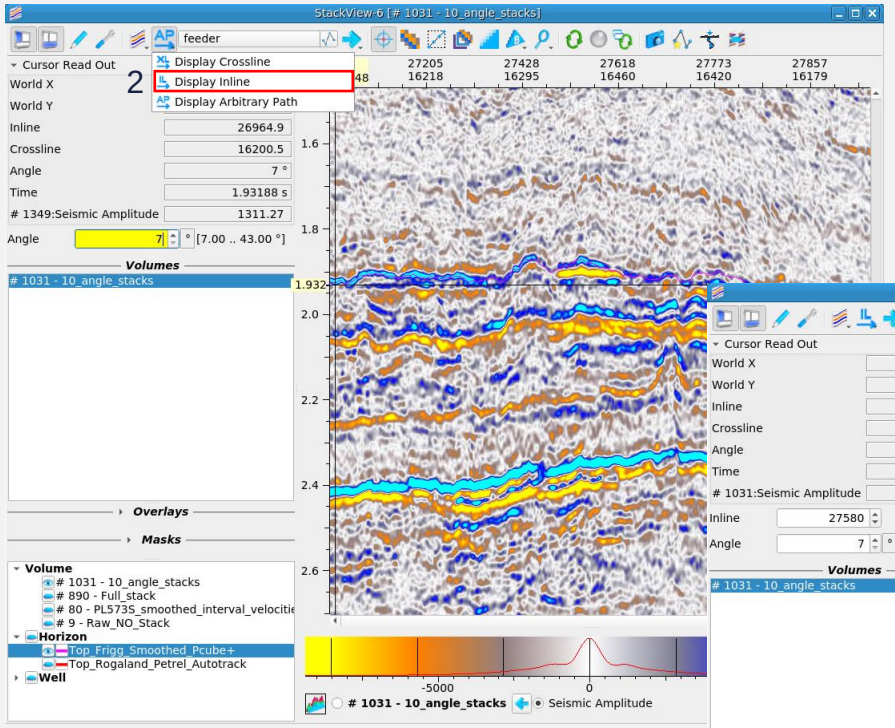


- At 7°, the Top Frigg event is a peak above and below the 1.932s level
- At 43 °, the event has all but disappeared or even reversed polarity above the 1.932s level, but remains a peak below

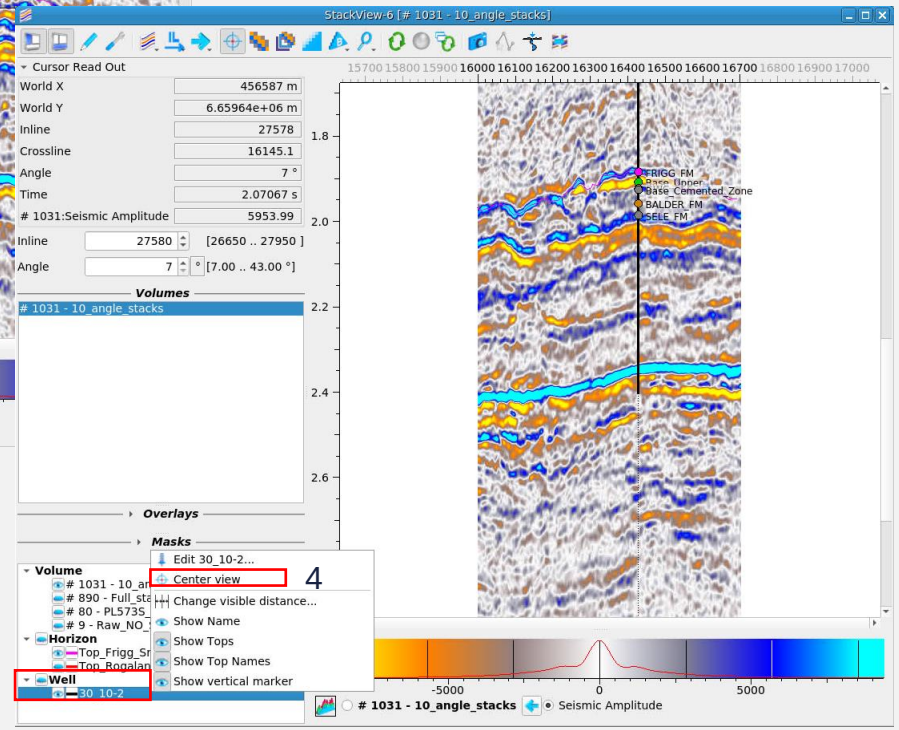
What might this be indicating?

Adding well control





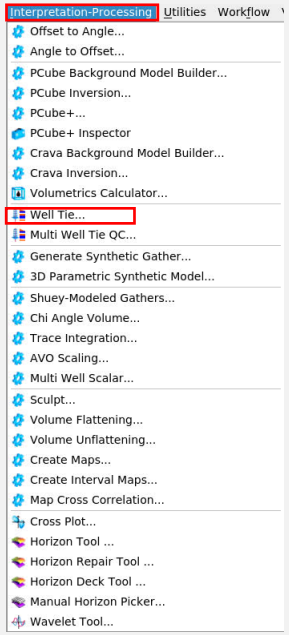
Well 30_10-2 discovered gas / gas condensate in the Frigg formation

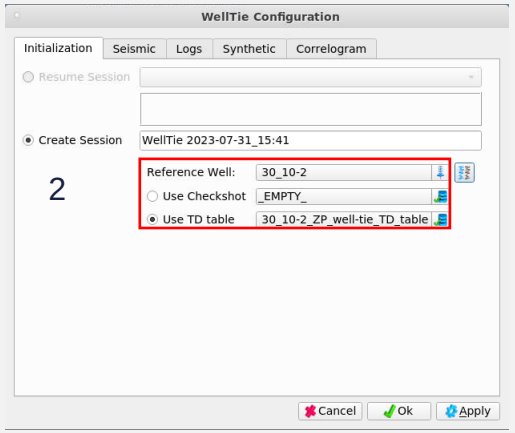


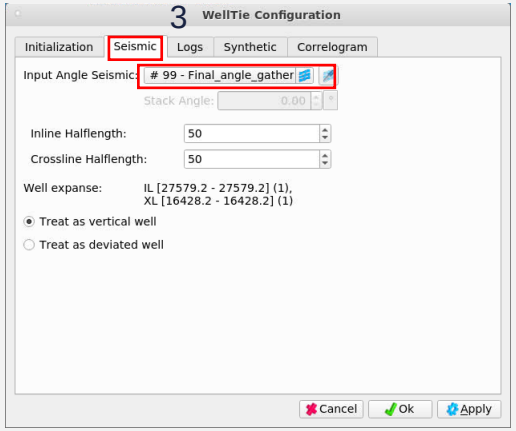
1. In the Map View, open the well list and toggle on well **30_10-2**
2. In the **Stack View**, switch back to “Display Inline”
3. Toggle on well **30_10-2**
4. RMB click on well **30_10-2** and select “Center view”

Create a pre-stack well-tie

1



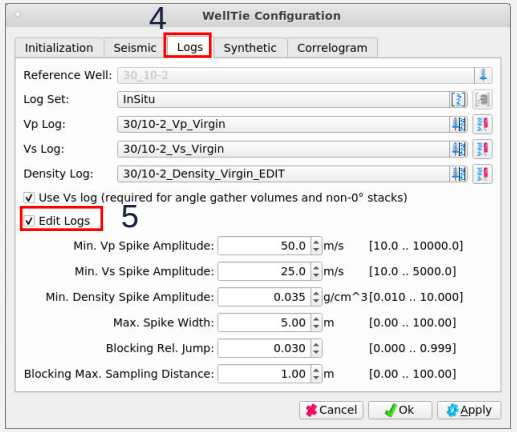


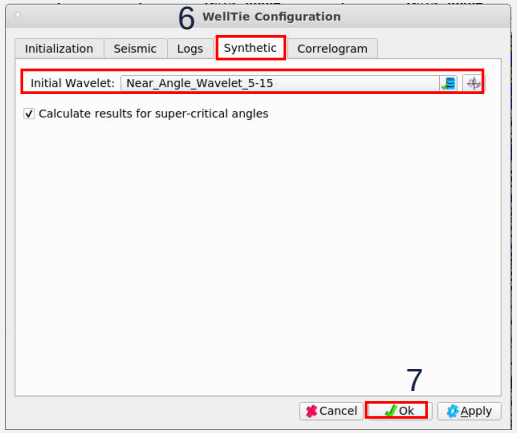


From the top level menu:

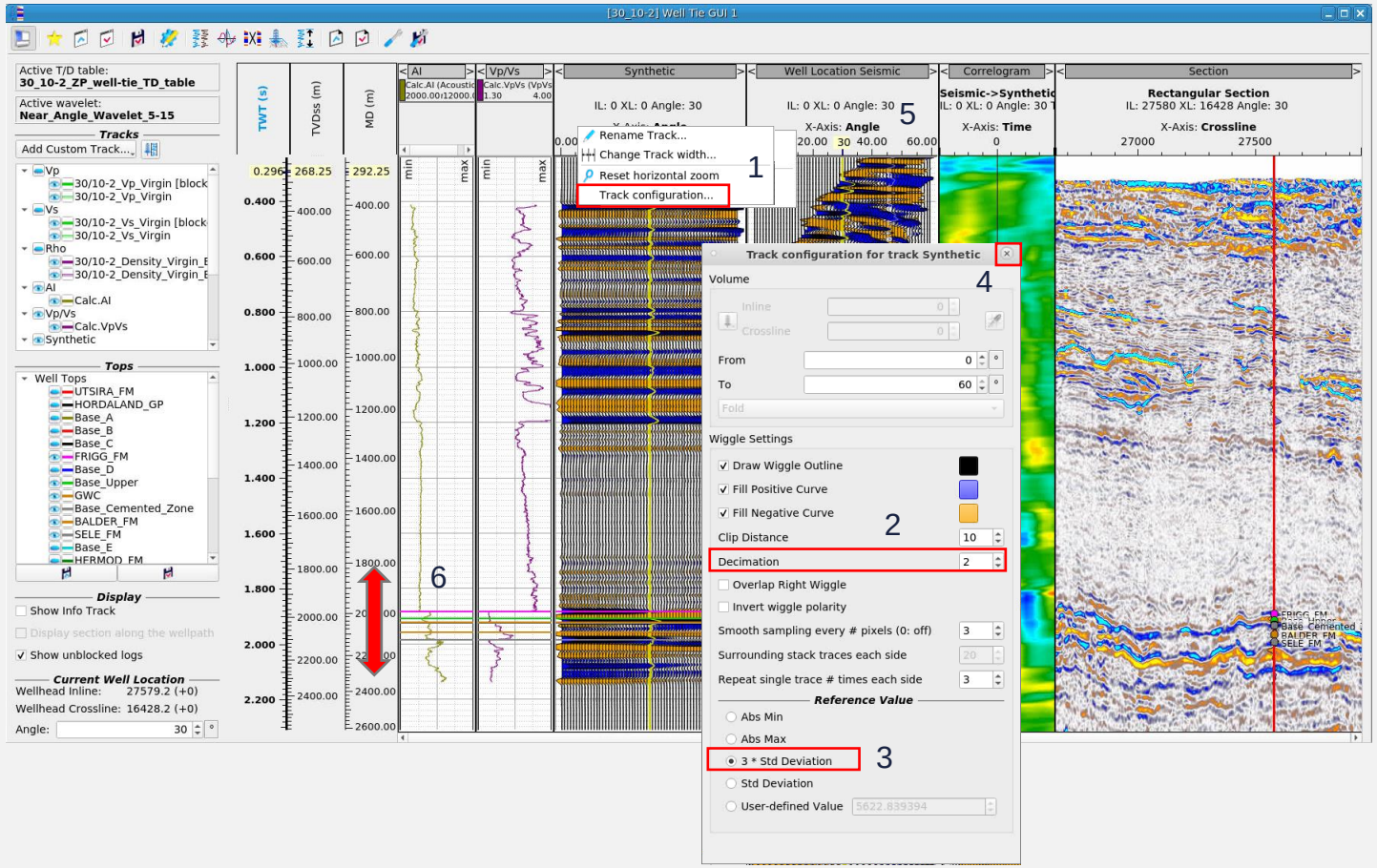
- Select Interpretation-Processing
  1. > Well Tie…
  2. Confirm that well **30_10-2** is selected
  3. Click “Seismic” tab and set input seismic to “Final_angle_gathers”

4. Click the “Logs” tab
5. Tick “Edit logs” and accept the default de-spiking parameters
6. Click the “Synthetic” tab and ensure that “Near_Angle_Wavelet_5-15” is selected
7. > OK



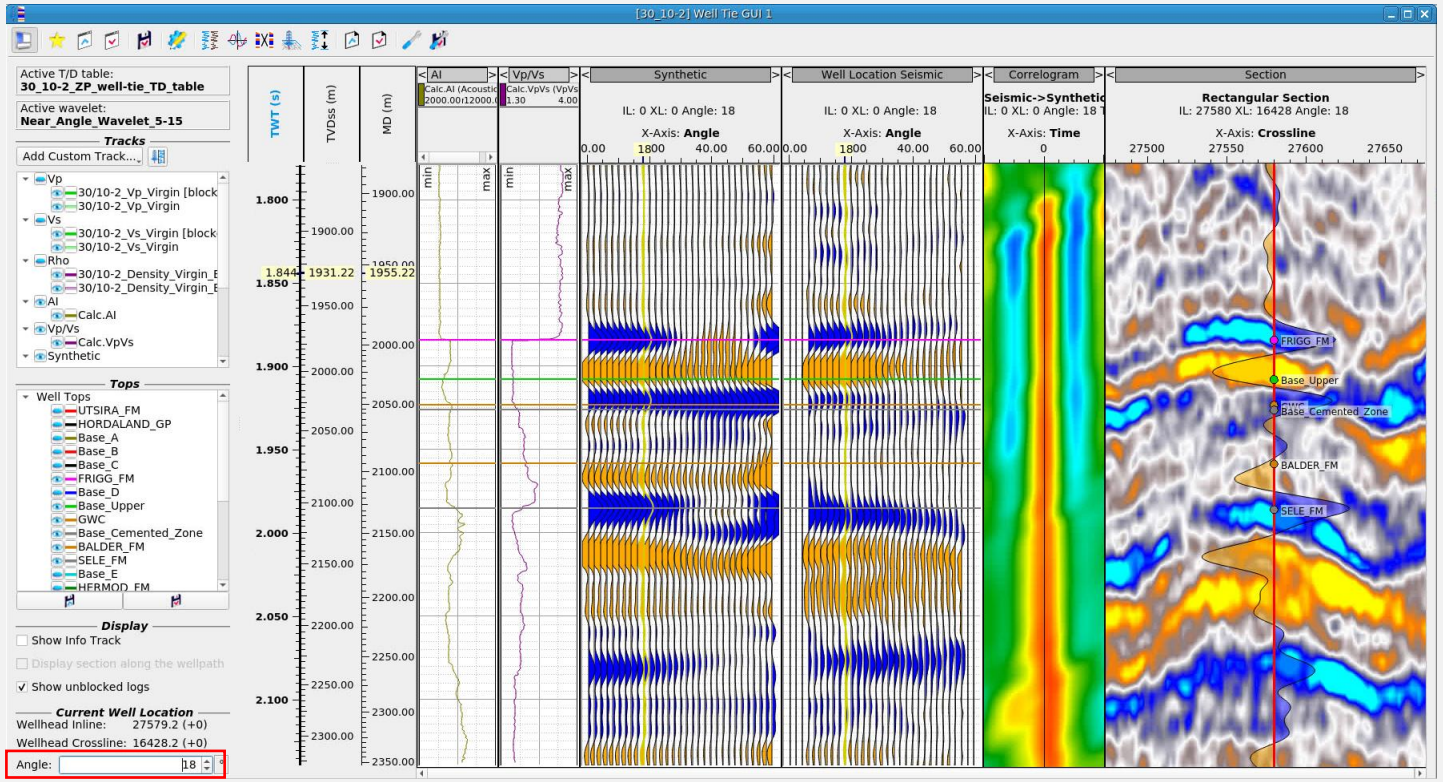


Customise display settings



1. RMB click in the header of the “Synthetic” track and select “Track Configuration”
2. Set Decimation to 2
3. Set scaling reference value to 3* Std Deviation
4. Click the x to close the dialogue box
5. Repeat for the “Well Location Seismic” track
6. Position the cursor on the vertical axis and use the mouse wheel to zoom into the zone of interest

Compare synthetic & seismic AVA response



1

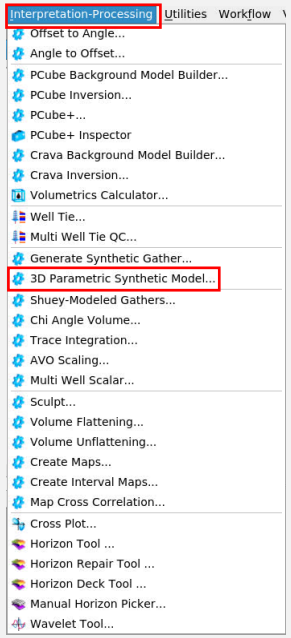
1. Scroll through the angle range and observe the correlogram strength

At what angle does the quality of the well-tie start to diminish?

Do you observe the same AVA response at Top Frigg in both synthetic and seismic gathers?

What AVA class do you observe at Top Frigg?

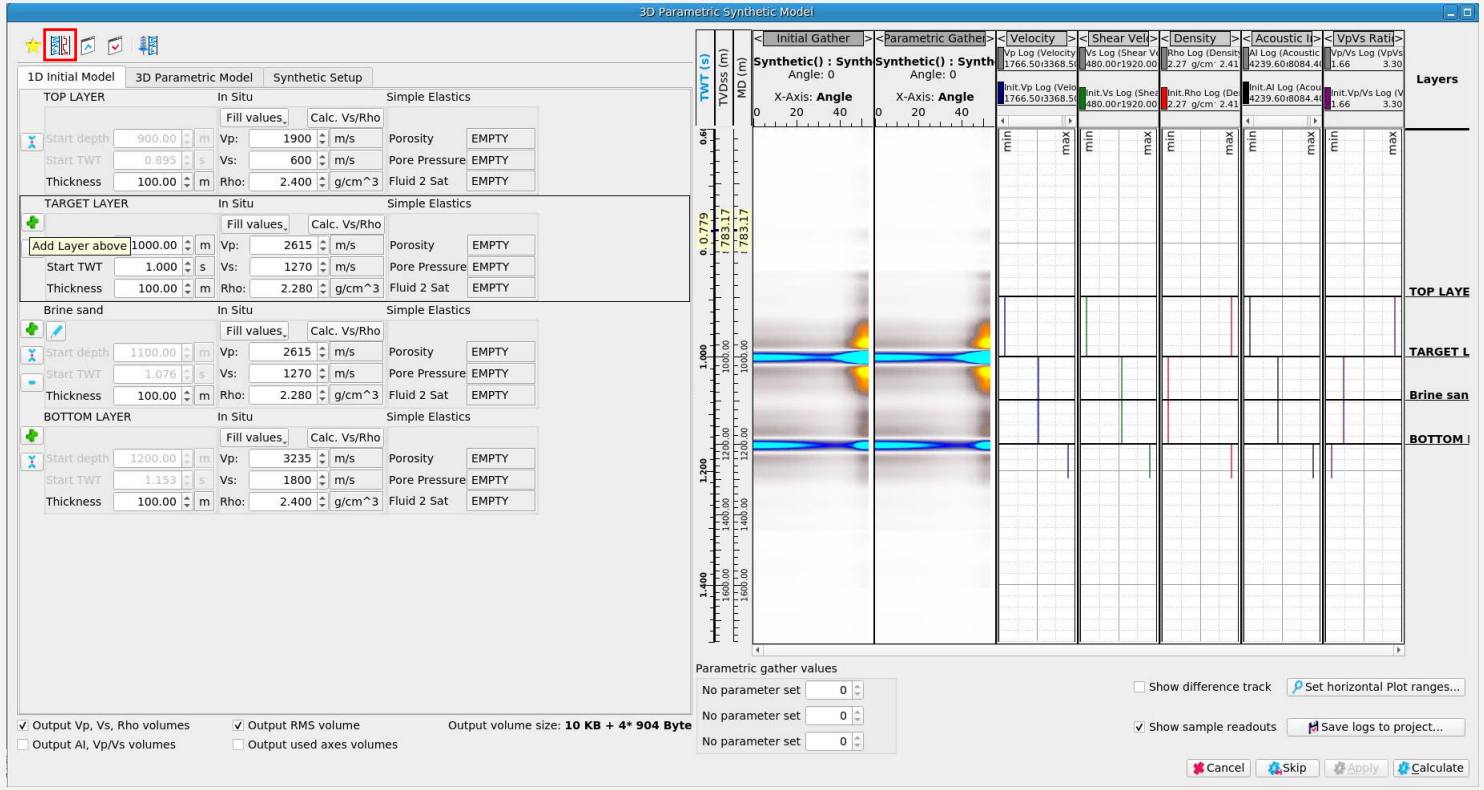
Building models from well control



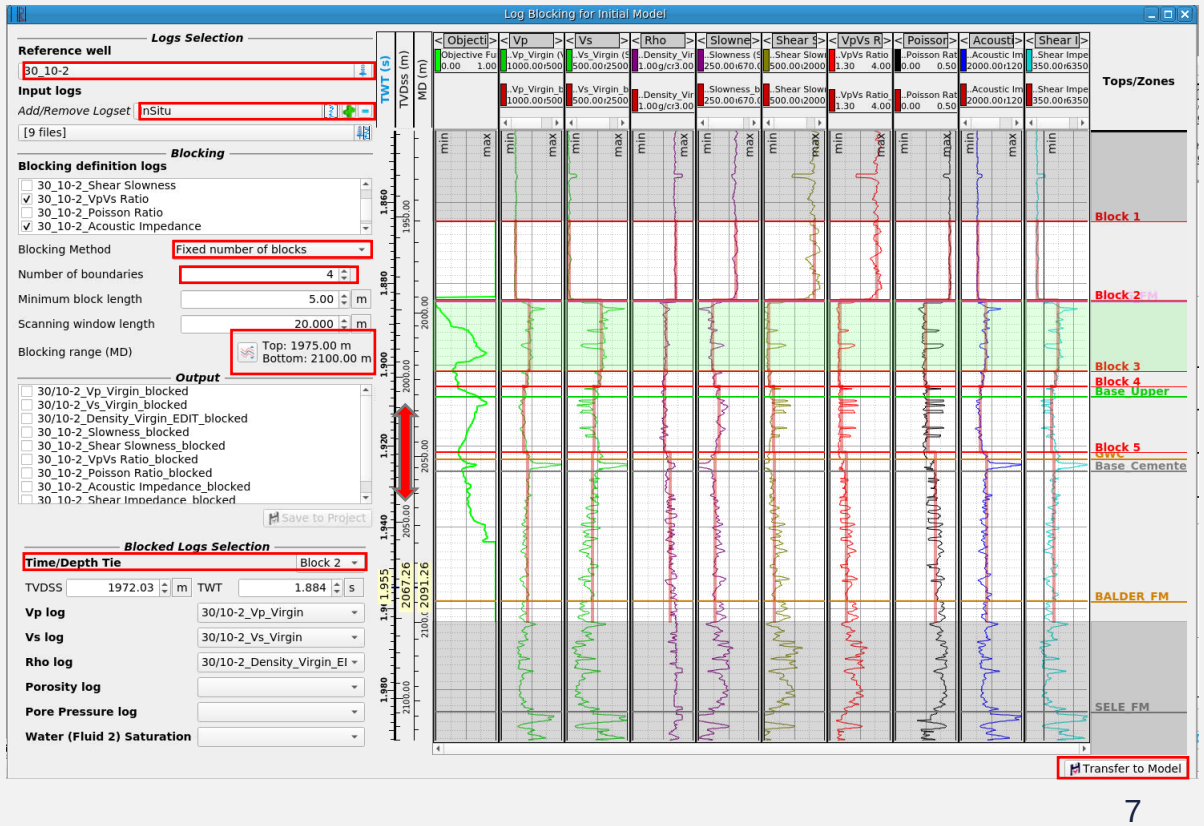
1

From the top level menu:

- Select Interpretation-Processing
  1. > 3D Parametric Synthetic Model…
  2. Click the “Log blocking for Initial Model” icon in the top left corner of the modelling window



Building models from well control

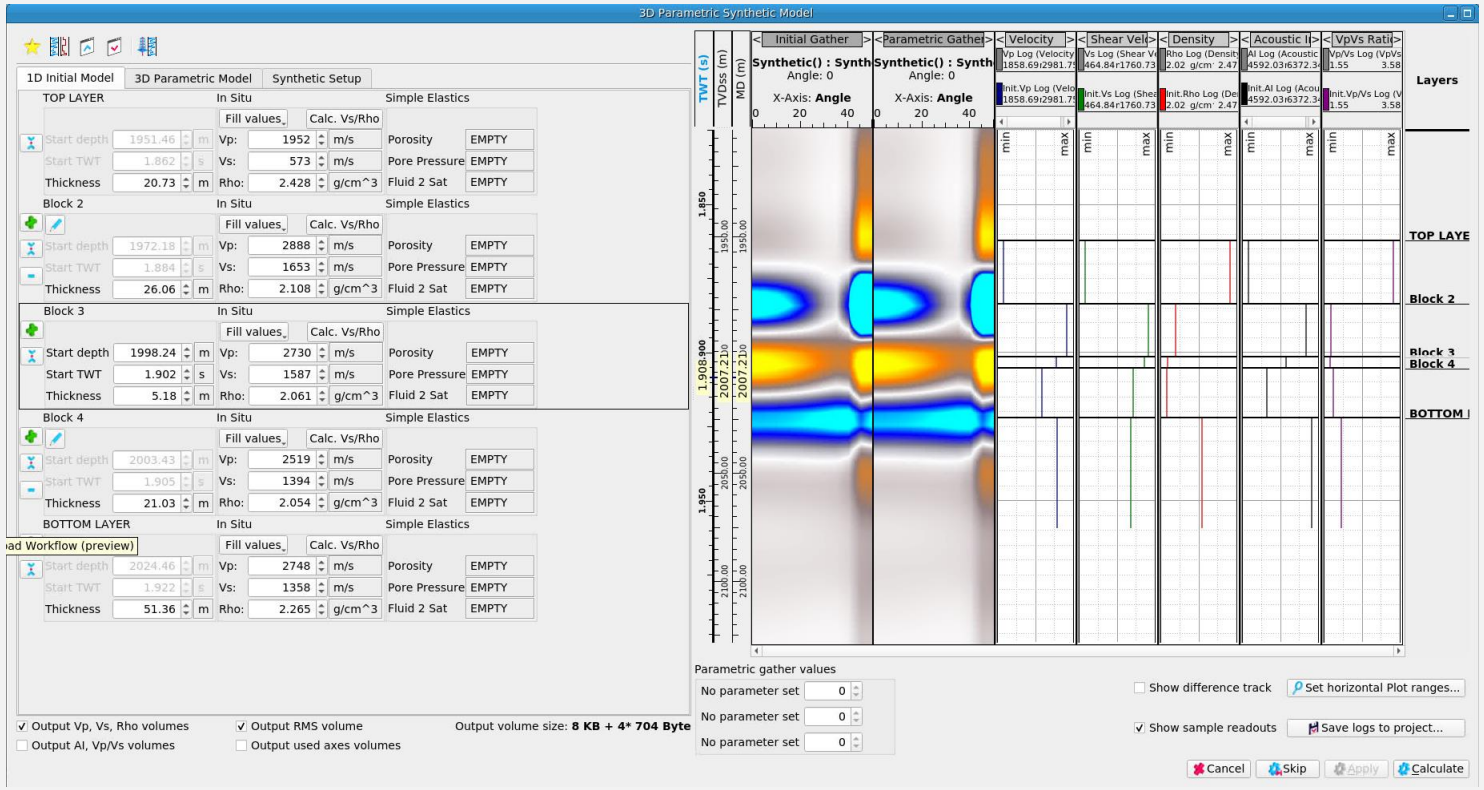


1. Select well **30_10-2**
2. Select “InSitu” log set and click the **Green + icon**
3. Choose the “Fixed number of blocks” Blocking Method and set the Number of boundaries to **4**
4. Set the Blocking range to **1975-2100m** MD
5. Zoom the display to the blocked interval
6. Set the Time/Depth Tie to “Block 2”
7. > Transfer to Model

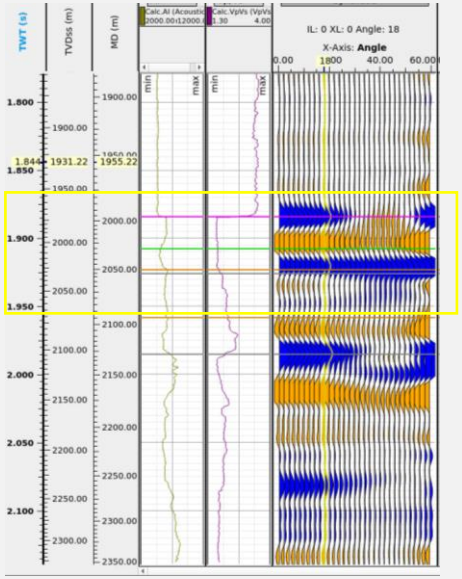
This creates a 5 layer blocked model around the target Frigg reservoir – Blocks 2, 3 & 4 lying within the gas bearing reservoir

Does the blocking recognise the cemented zone at the GWC?

5 layer blocked synthetic model – in situ

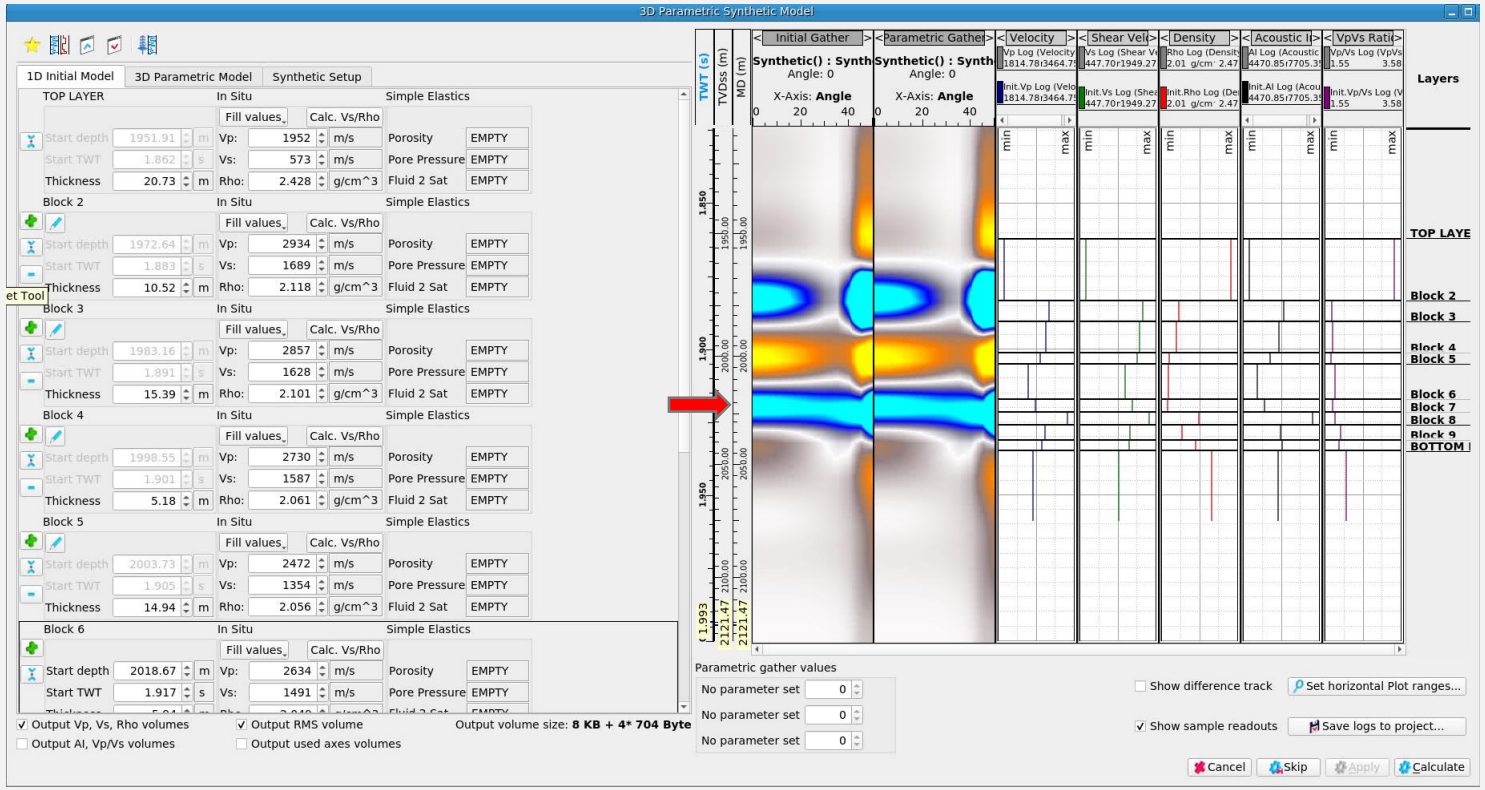


How does the blocked model response compare to the synthetic seismogram?



Change the number of boundaries in the Log blocking window to 9 and update the model

10 layer blocked synthetic model – in situ



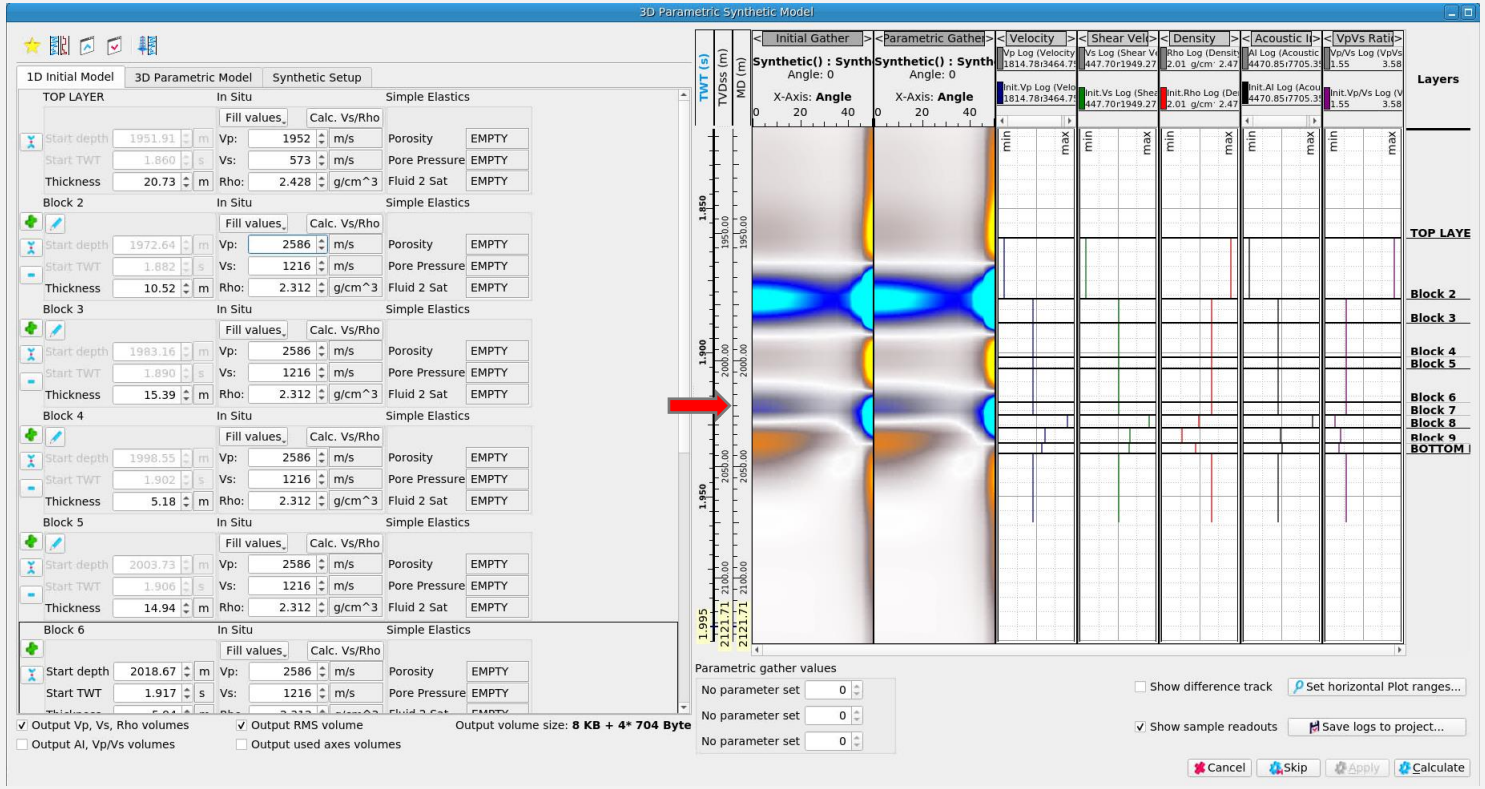
Do the additional layers significantly alter the modelled Top Frigg response?

What might be giving rise to the change in behaviour of the event near the base of the gas bearing interval between the two models?

Try altering the elastic properties of Blocks 2-6 to be the same as the Bottom Layer (copy & paste the parameters)

- This replaces the gas bearing interval with brine sand properties

10 layer blocked synthetic model – brine sand



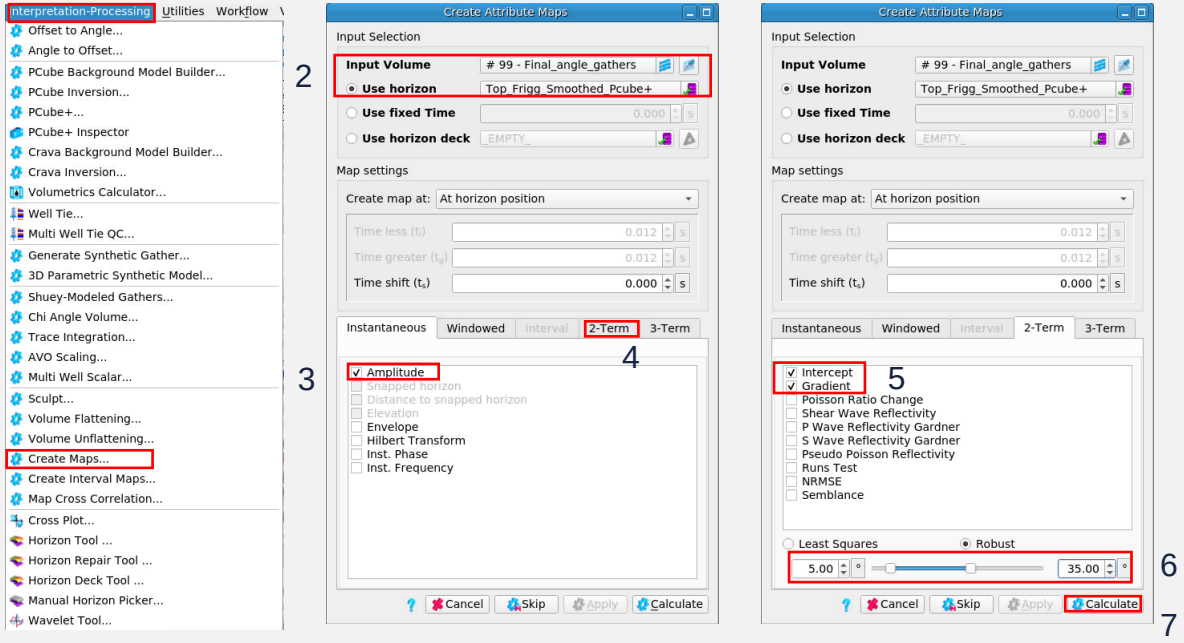
Does this help explain some of the map and section observations from earlier in the exercise?

How?

Exercise 6

- AVA analysis 2
  - *Compute intercept & gradient from mapped amplitude; cross-plot; describe class*
  - *Compute Chi 25°, 50° maps*
  - *Generate angle dependent spectral decomposition maps*

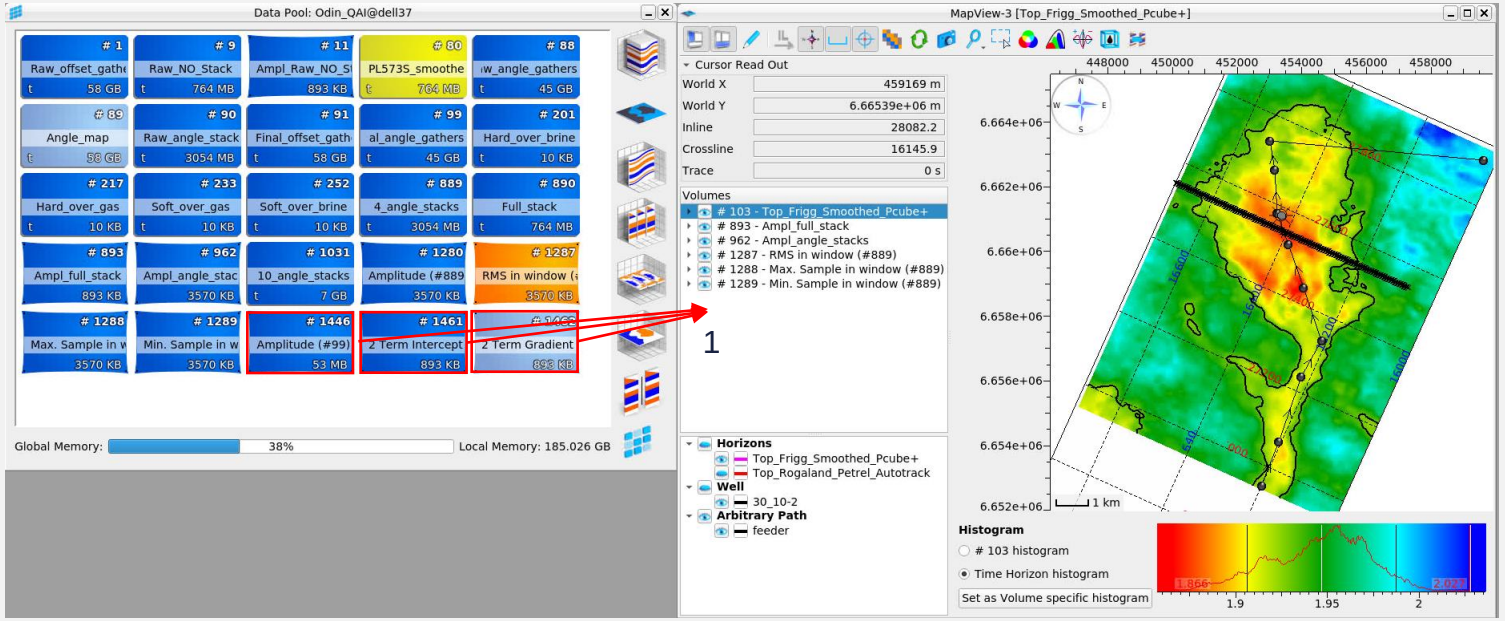
Generate Intercept & Gradient maps



Continuing in the Odin_QAI project, from the top level menu, select Interpretation-Processing

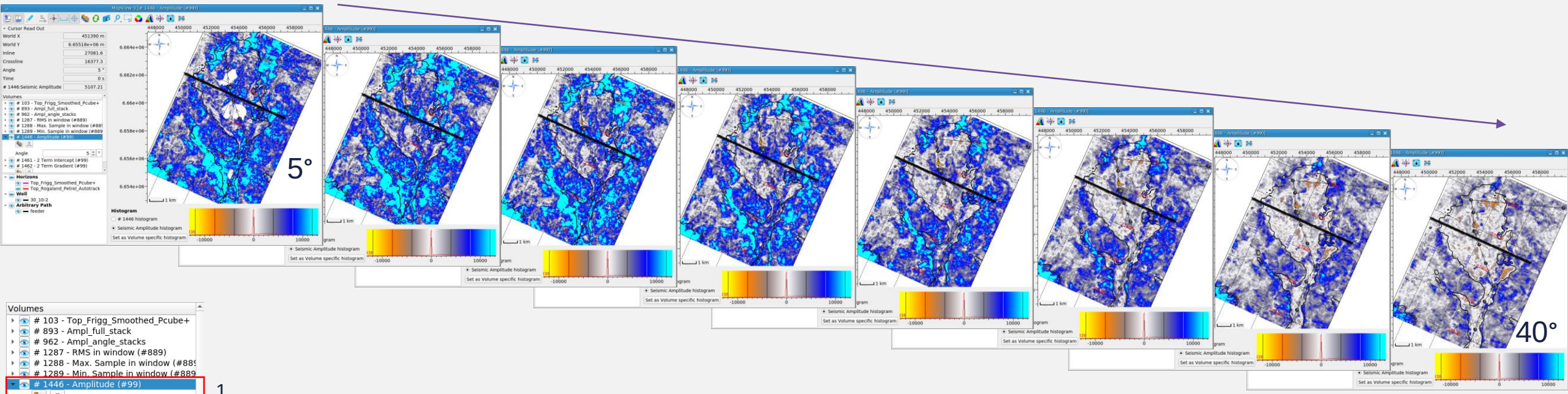
1. > Create Maps…
2. Set Input Volume to “Final_angle_gathers” & horizon to **Top Frigg**
3. Select the “Amplitude” tick box
4. Click on the “2-term” tab
5. Check the tick boxes for “Intercept” and “Gradient”
6. Set the calculation range from 5°-35°
7. > Calculate

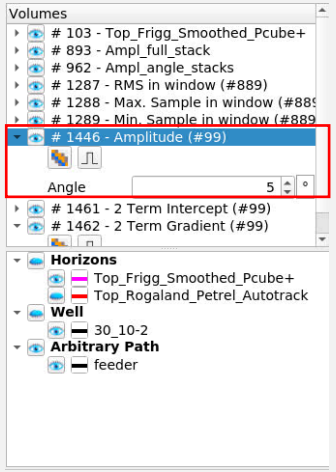
View maps



1. LMB click and drag the 3 new map objects from the Data Pool into the **Map View**

Scroll full angle gather amplitude maps



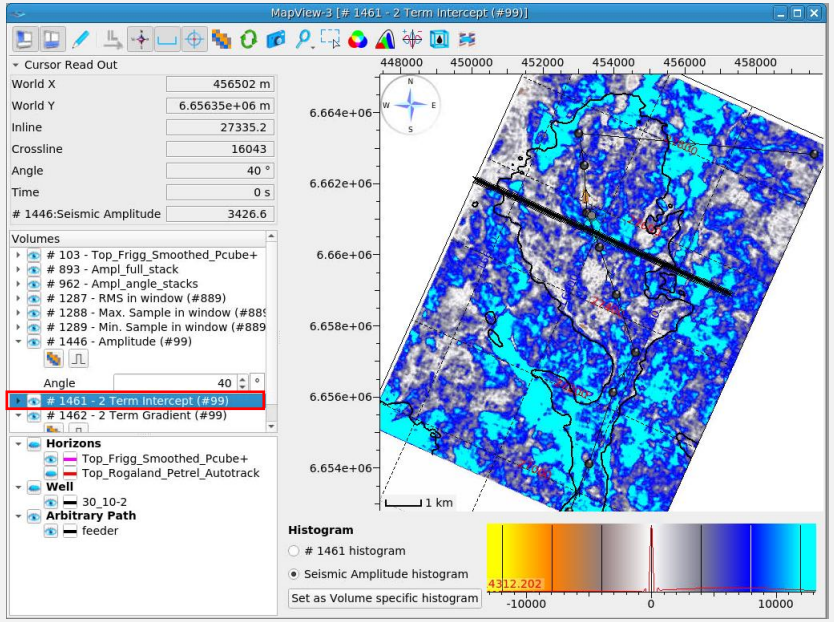


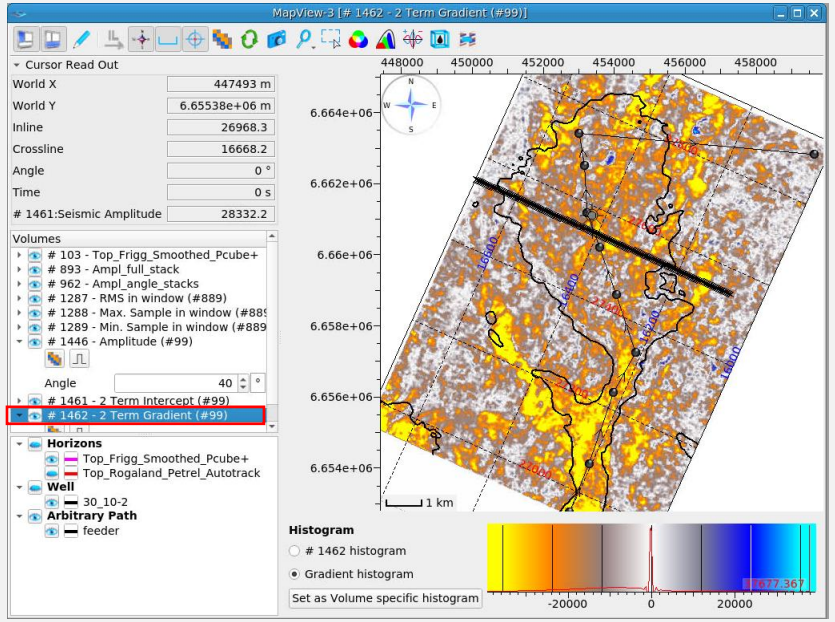
1

1. Click on the **Amplitude map** object in the **Map View** list and scroll through the angles

Describe what you see at different angles

Compare Intercept & Gradient Maps



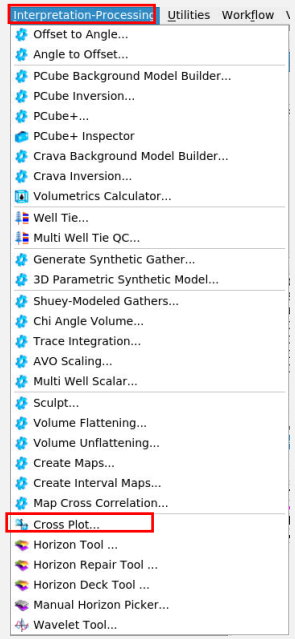


Toggle between Intercept and Gradient maps in Map View

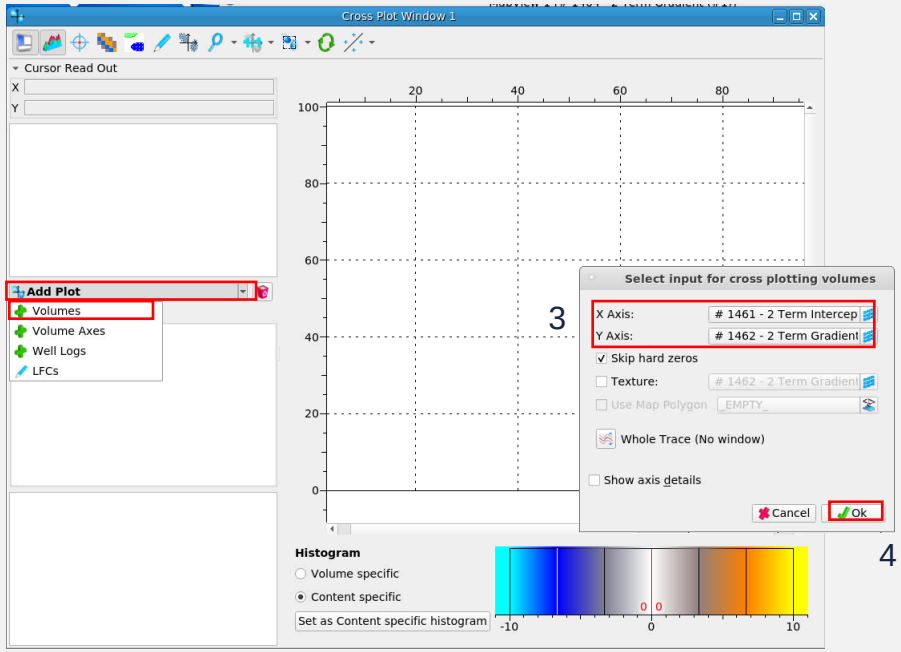
What sign is the predominant Intercept? What sign is the predominant Gradient?

What is the predominant AVA class?

Intercept & Gradient cross-plot



1

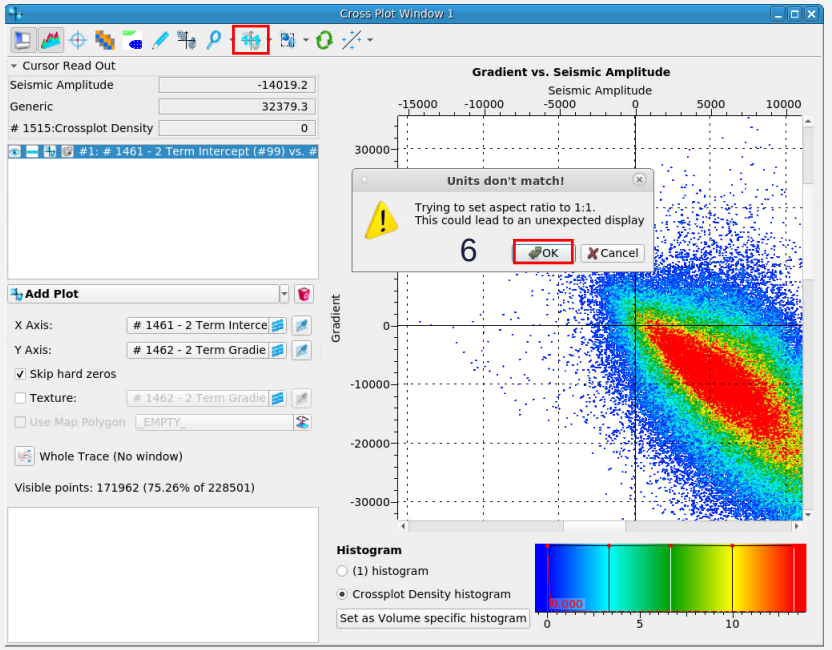


2

3

4

5



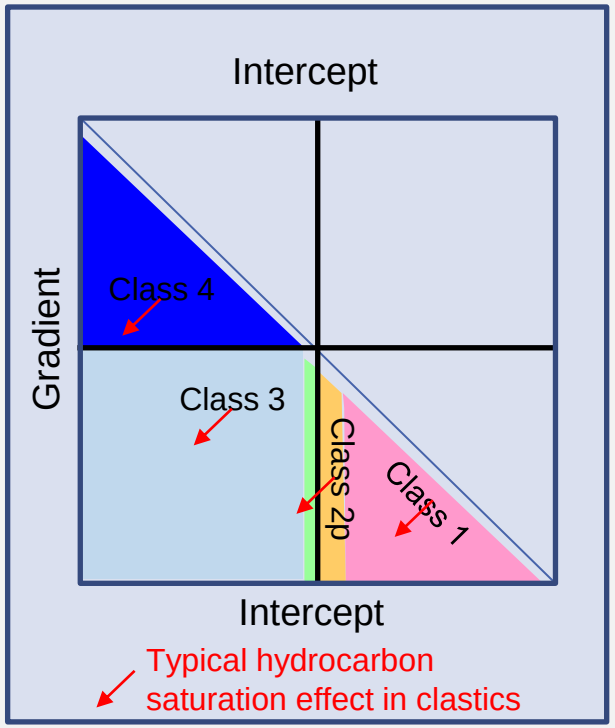
6

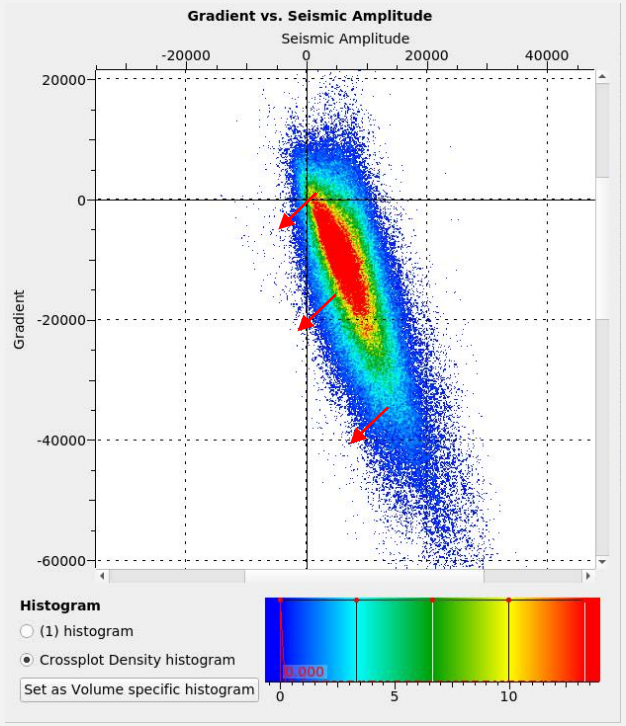
From the top level menu, select Interpretation-Processing

1. > Cross Plot…
2. In the Cross Plot View, click Add Plot > Volumes
3. Select the **Intercept map** for the X Axis, **Gradient Map** for the Y Axis
4. > OK

5. Click “Reset aspect ratio to 1:1” icon
6. Click “OK” in pop-up dialogue box

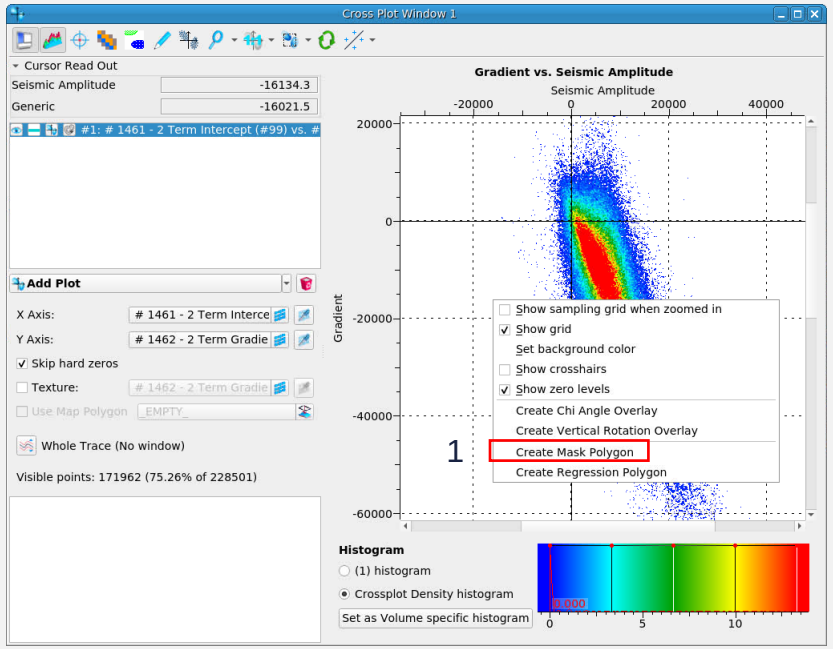
Intercept & Gradient cross-plot analysis

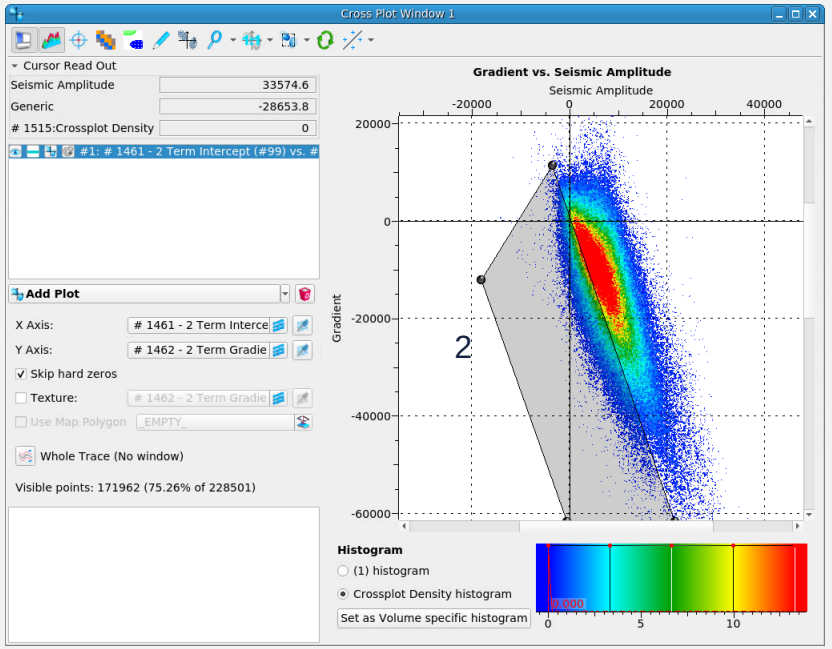




Remembering our hydrocarbon fluid effect on I-G crossplot, we can use different techniques to screen for fluid effects at top reservoir horizons

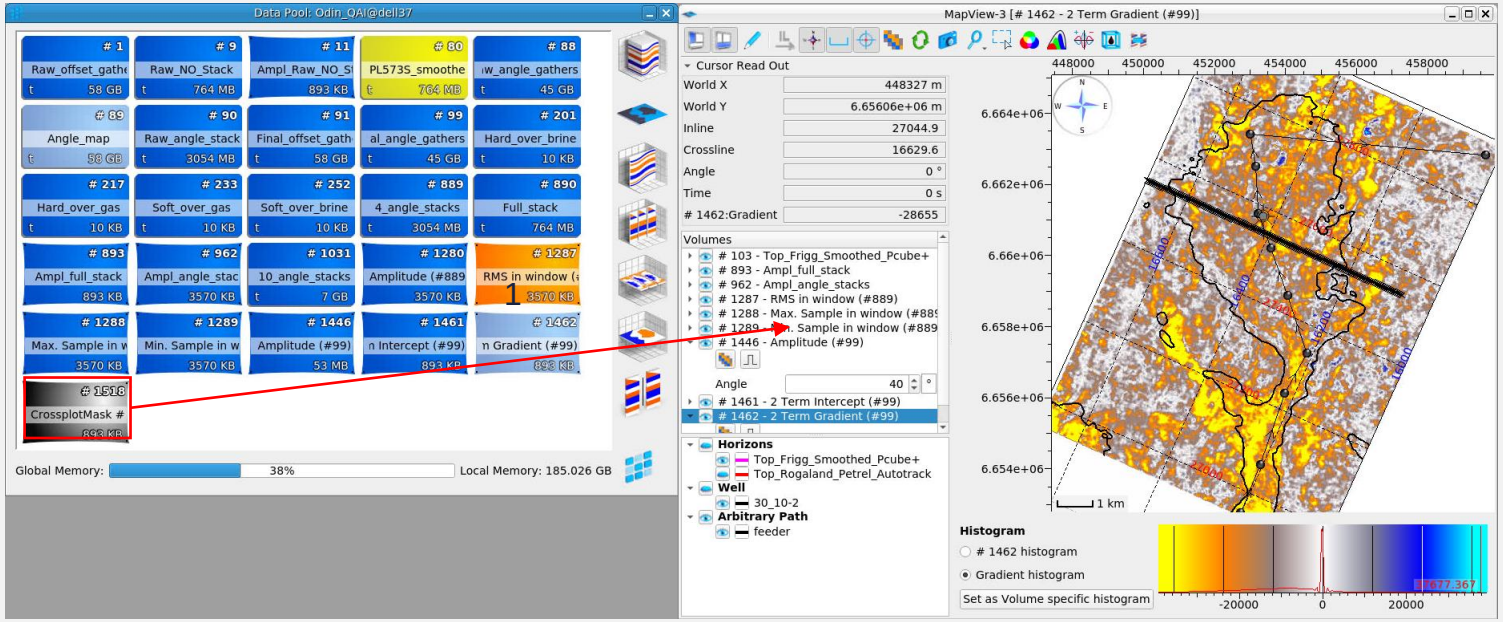
Cross-plot polygon masking

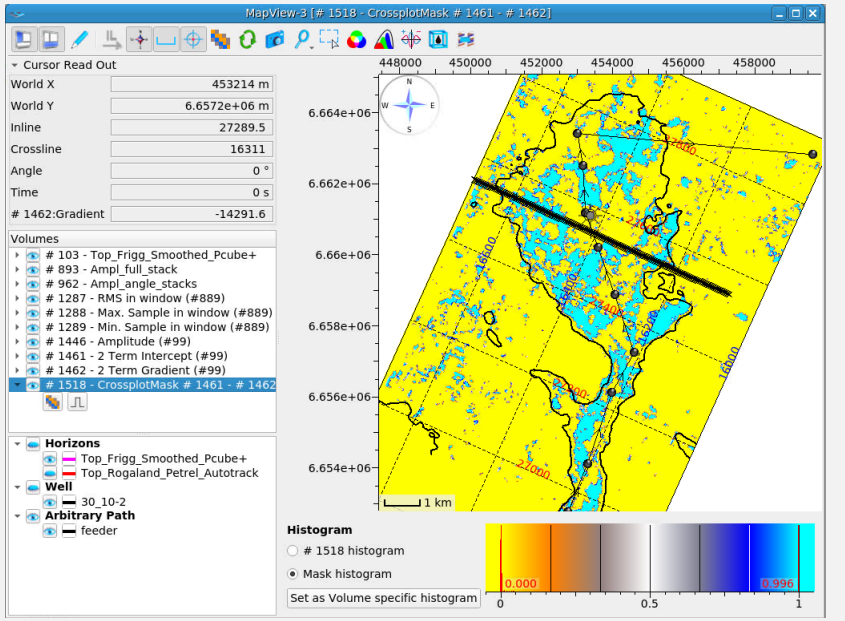


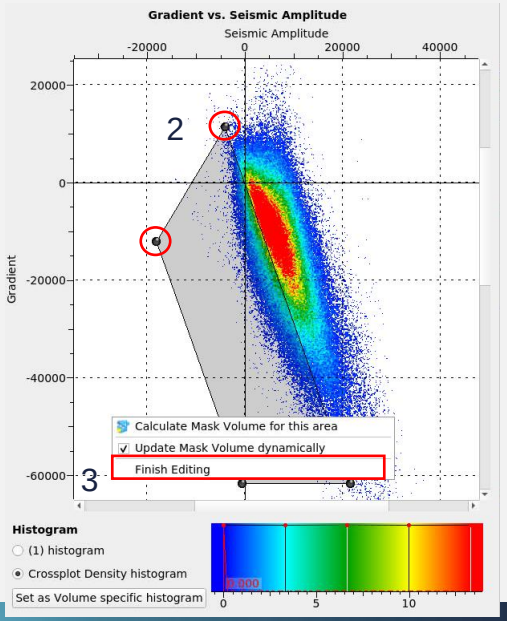


1. RMB click in the cross-plot area and select “Create Mask Polygon”
2. LMB click and drag the polygon corner points to include possible hydrocarbon affected points within the polygon area

Cross-plot polygon masking

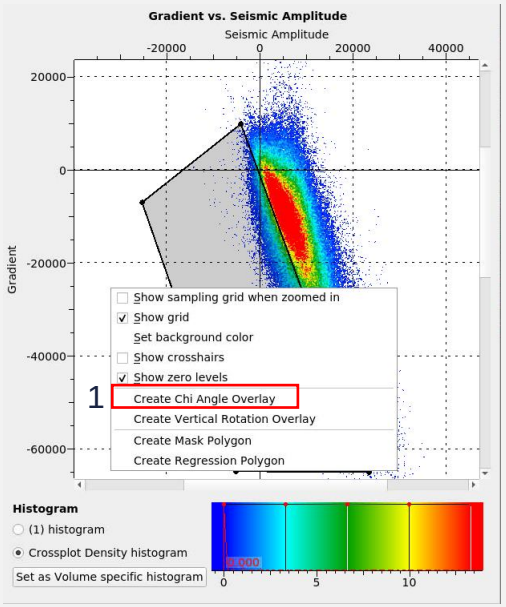


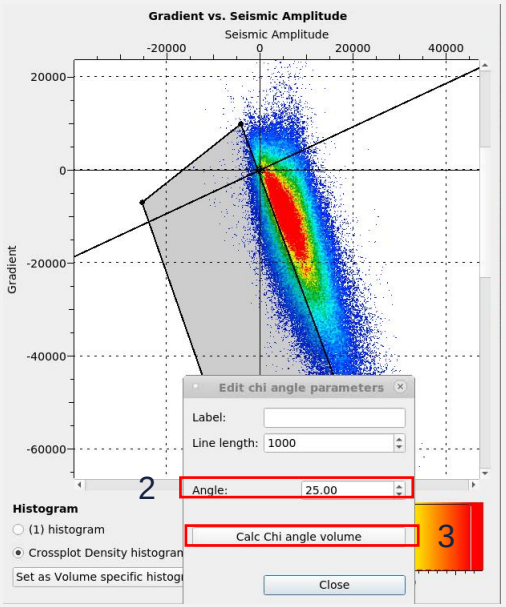


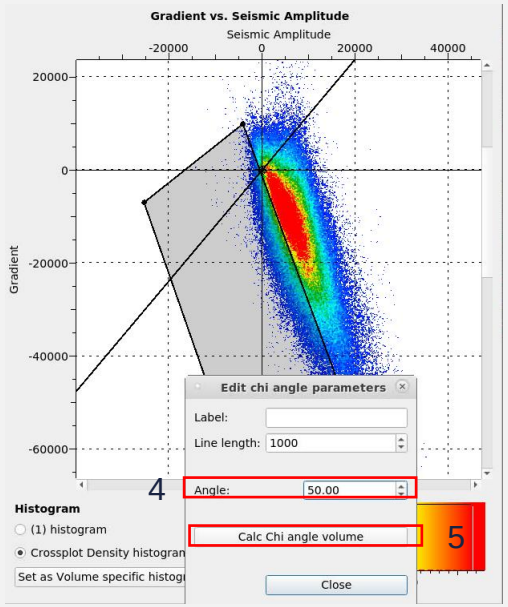


1. LMB click and drag the new “CrossplotMask” object from the Data Pool into the **Map View**. *Where to the mask points lie relative to structural closure?*
2. Drag the corner points of your mask polygon around and observe the impact on the polygon mask in map view (this is interactive)
3. When you are happy with your polygon, RMB click in the polygon > Finish Editing

Chi Angle volume generation (weighted stacking)

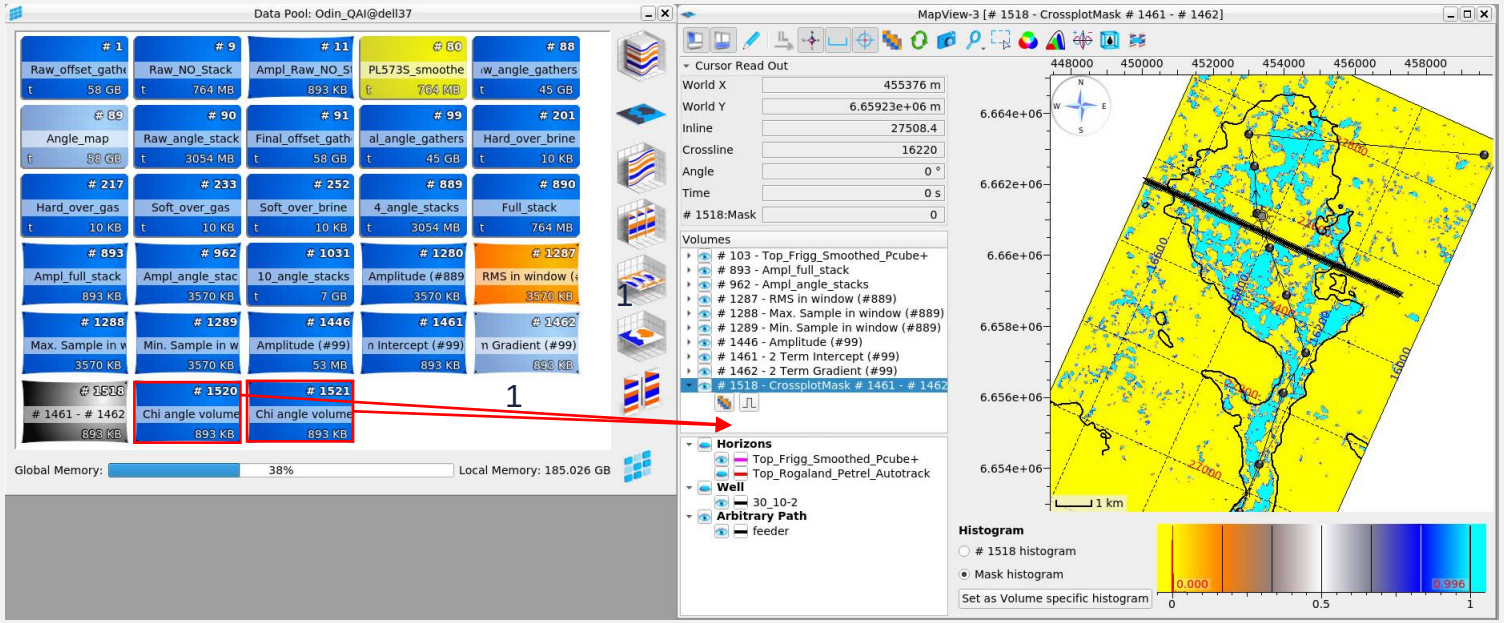






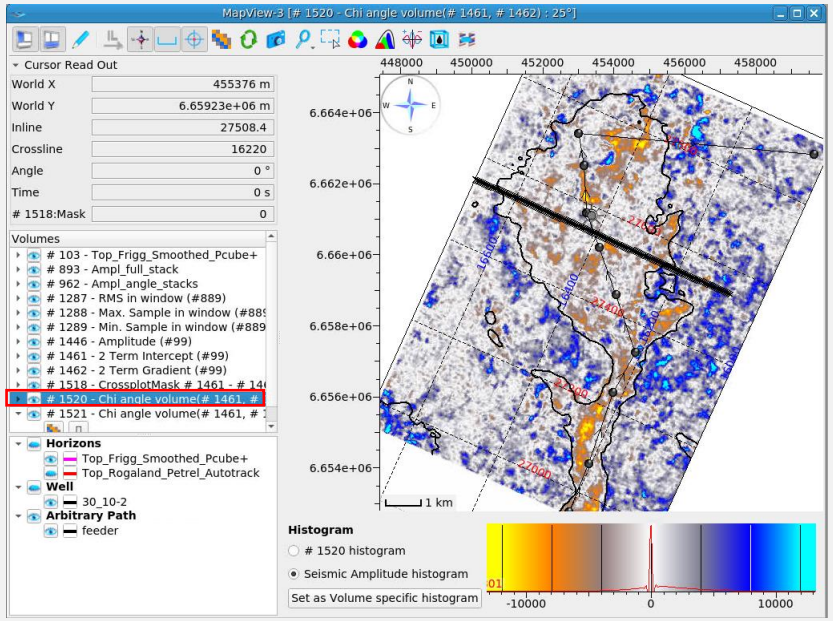
1. RMB click in the cross-plot > Create Chi Angle Overlay
2. Scroll through the Chi angles until the axis is perpendicular to the background trend (c. 25°) – this should provide the best angle with which to determine fluid effects
3. > Calc Chi angle volume
4. Change the Chi angle to 50° - c. Connolly's theoretical angle for Poisson's Ratio
5. > Calc Chi angle volume

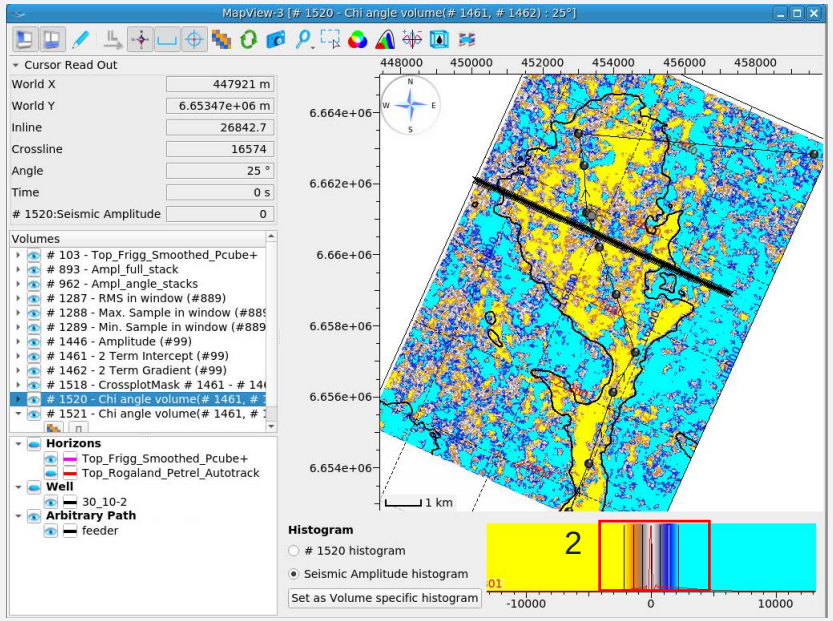
Chi Angle volume generation (weighted stacking)

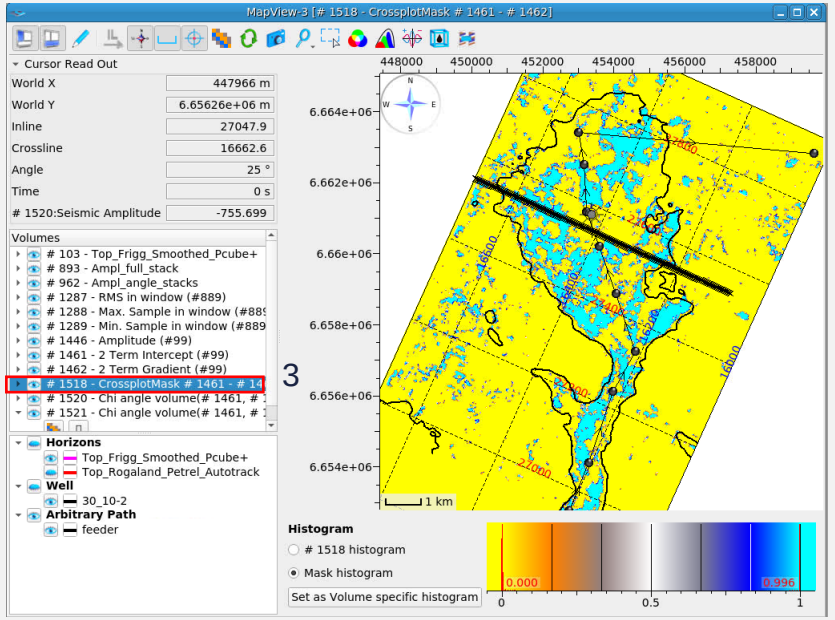


1. LMB click & drag the two Chi angle map objects into the **Map View**

25° Chi Angle map



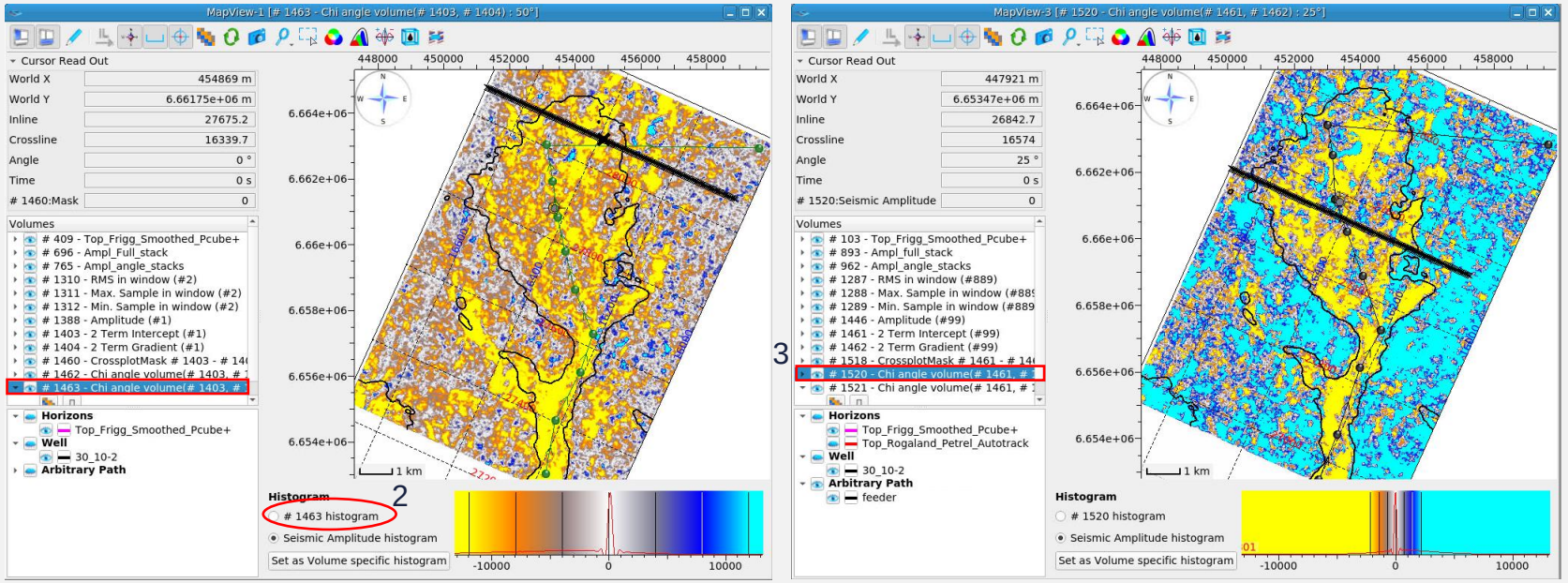




1. View the 25° Chi angle map
2. Place the cursor in the centre of the histogram and use the mouse wheel to compress the colour bar
3. Toggle between the Chi 25° map and the CrossplotMask map

Do the two approaches identify the same potential fluid effects?

50° Chi Angle map

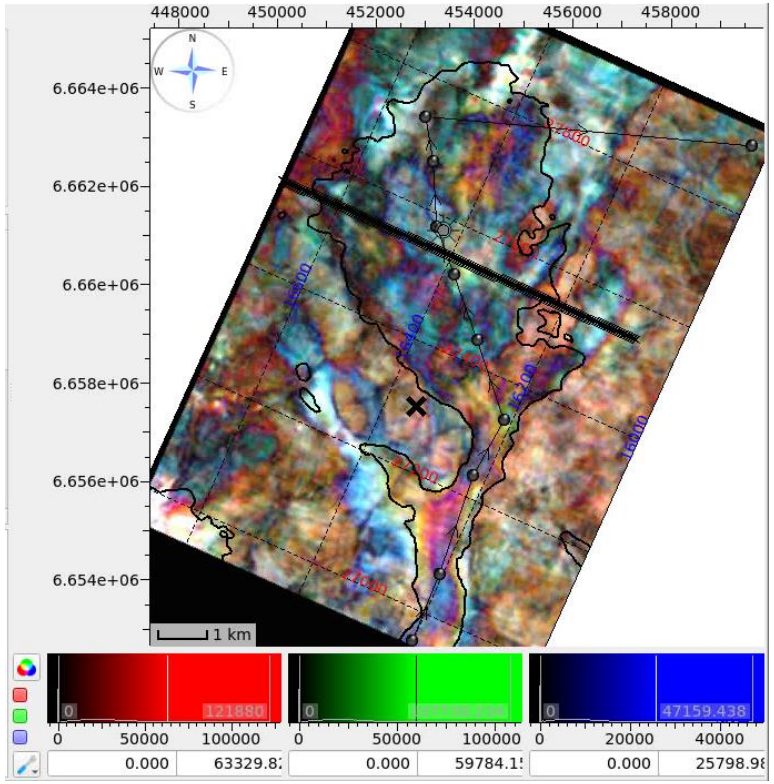


What differences do you observe between the maps?

How would you interpret those differences?

1. View the 50° Chi angle map
2. Toggle on the object histogram
3. Toggle between the Chi 50° map and the Chi 25° map

Spectral decomposition

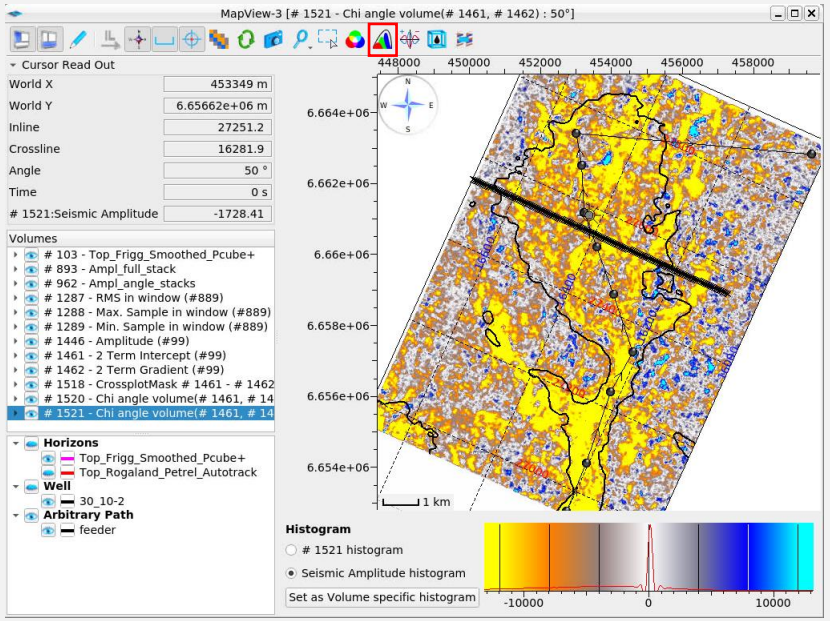


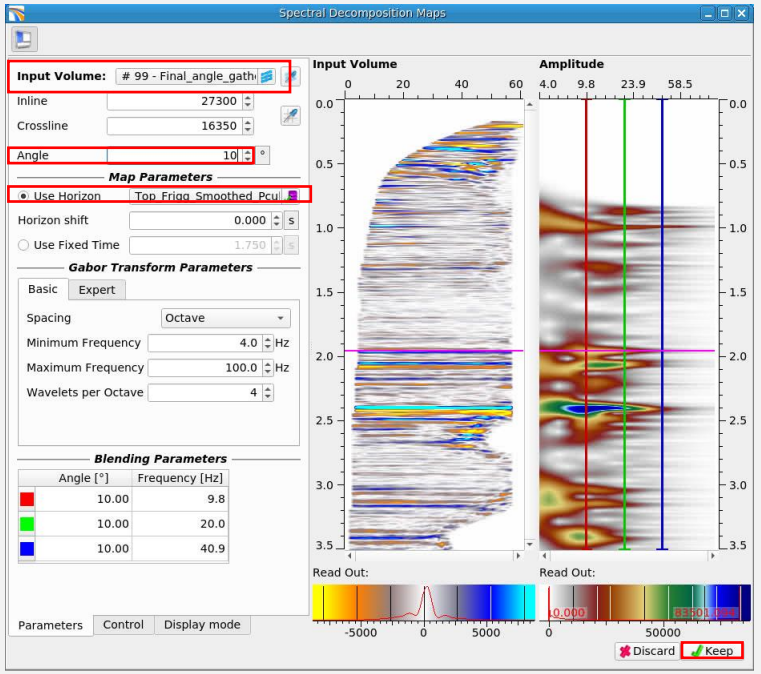
Spectral Decomposition is a method employed to aid in the interpretation of seismic data by improving thin bed resolution and showing temporal bed thickness variability.

The combination of discrete frequency volumes through RGB colour blending is the most common visualisation technique employed to identify geological bodies. The selection of appropriate frequency bands depends on the range of thicknesses of the target geobodies; higher frequencies selected to detect thinner bodies, lower frequencies selected to detect thicker bodies.

Applying spectral decomposition to **pre-stack data volumes** is another method whereby lithological and fluid effects may be discriminated

Angle dependent spectral decomposition



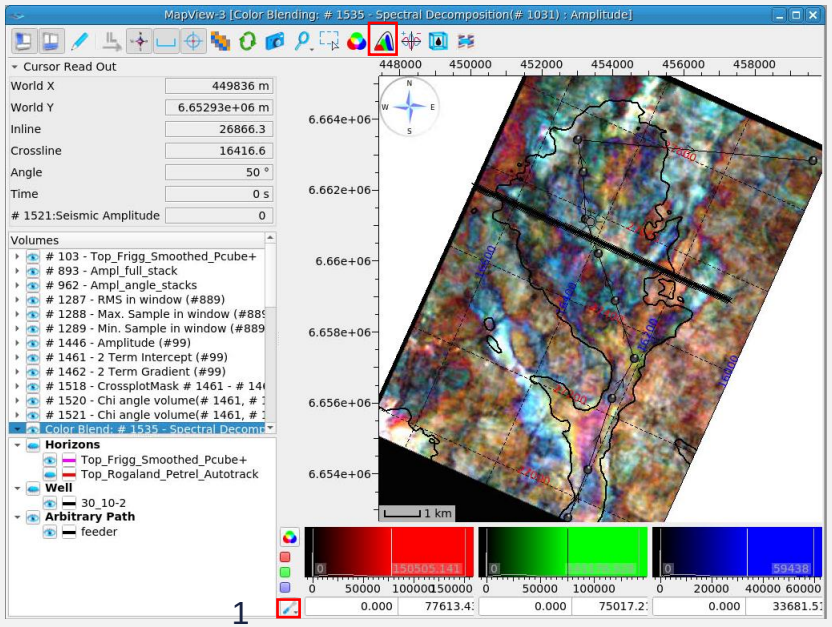


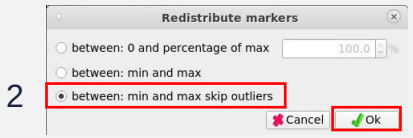
1. Click on the “Spectral Decomposition” icon in the existing **Map View**
2. Select “Final_angle_gathers” as Input Volume
3. Set Angle to **10°**
4. Set Horizon to **Top Frigg**
5. > Keep

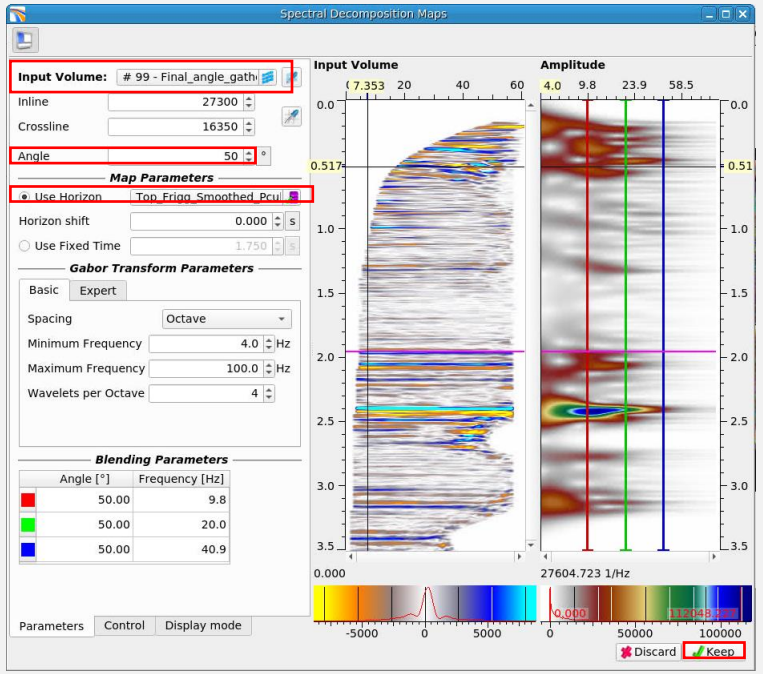
This generates a spectral decomposition map at the Top Frigg at an angle of 10°

SHARP REFLECTIONS

Angle dependent spectral decomposition





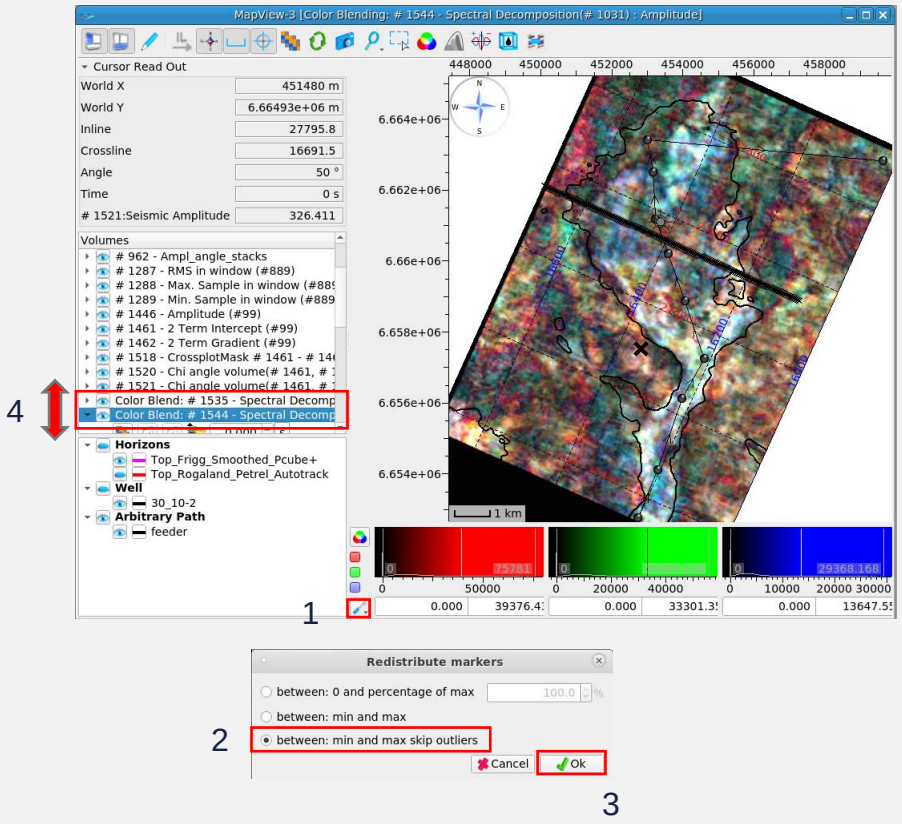


1. Click on the “Redistribute Markers” icon
2. Select “between: min and max skip outliers”
3. >OK
4. Click on the “Spectral Decomposition” icon in the existing Map View
5. Select “Final_angle_gathers” as Input Volume
6. Set Angle to **10°**
7. Set Horizon to **Top Frigg**
8. > Keep

This generates a spectral decomposition map at the Top Frigg at an angle of 50°

SHARP REFLECTIONS

Angle dependent spectral decomposition



1. Click on the “Redistribute Markers” icon
2. Select “between: min and max skip outliers”
3. >OK
4. Toggle between the 10° and 50° angle spectral decomposition maps

What differences do you notice between the two maps?

How do you interpret those differences?

The GATHERing Knowledge Exchange

SHARP REFLECTIONS