

3D pre-stack seismic reflectivity analysis for interpreters



Practical exercises



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- Exercise 2 convert migrated offset gathers to angle gathers and create angle stacks; compare raw and final angle gathers
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 - Amplitude extraction on angle stacks & full stack
 - Create 10-fold partial pre-stack gathers
 - Compare with 1 deg angle gathers
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- Exercise 6 AVA analysis 2
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 - 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?



Exercise 1



Open the Odin_QAI project

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Export Data	2		4		Projects	Name Internal Near_Angle_Wavelet PL5735_smoothed_interval_velocities
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File name: config_PreStackPro.xml

Files of type: Project files (config_PreStackPro.xml)

Open

🗸 💥 Cancel

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From the top level menu:

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



Exercise 1

Load raw migrated offset gathers into memory



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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

		Load Multiple Volumes				
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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





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- Click the "synchronise viewers" icon in the **Gather** View
- LMB click in the Map View and toggle on "Enable", then LMB click anywhere on the map



- 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







3

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	Turn	on	the	Top	Roga	land	horizon	in tl	he	aather	view
	IUIII			IVP	rogu			III U		gainor	

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

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Create a raw near offset stack

	🦑 NMO	🧔 Azimuthal Velocity Conversion
Processin	ig 🤣 Stack Mute	🤣 Trace Interpolation
	🗛 Partial Stacking	
	🧔 🤣 COCA Sectorization	
i 👜 💾	👔 🤣 Butterworth Filter	
F	Frequency Filter	
	🔅 User Defined Filter	
	🤣 Spatial Smoothing Filter	
	🤹 Median Filter	
	🥼 Destriping	
	🤹 2D ECED Filter	
	🤹 3D ECED Filter	
	🤹 EPS 3D Filter	
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1	A 🕼 QComp	
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- Volume	😼 🧑 Inverse Radon	
Judicis_25	A Tau-P Deconvolution	
	2 Dip Filter	
	Adaptive Subtraction	
	₫ BMO	
	A RMO (Timeshifts)	
	Alian 2	
	Velocity Editor	
	Phase Rotation	
	A Spectral Balance	
	A Bandwidth Extension	
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	A Global Filter Matching	
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na Smooth	he 1 East Fourier Transformation	
19_511000	Inverse Fast Fourier Transformation	
	Resample 7 Axis	
	Bulk Time Shift	
	Seismic Time Depth Conversion	
	Well Calibrated Velocity Model	
	A Seismic BMS Amplitude Calculation	
	Velocity Conversion	
	* velocity conversion	



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





- 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...

3
nterpretation-Processing Utilities Workflow
🤣 Offset to Angle
🤹 Angle to Offset
PCube Background Model Builder
🤣 PCube Inversion
🤣 PCube+
PCube+ Inspector
🤹 Crava Background Model Builder
🦑 Crava Inversion
Volumetrics Calculator
<table-of-contents> Well Tie</table-of-contents>
∔ Multi Well Tie QC
🦑 Generate Synthetic Gather
🤣 3D Parametric Synthetic Model
🤹 Shuey-Modeled Gathers
🤣 Chi Angle Volume
🤣 Trace Integration
🤹 AVO Scaling
🤣 Multi Well Scalar
🤣 Sculpt
🤹 Volume Flattening
🤣 Volume Unflattening
🤣 Create Maps
🤹 Create Interval Maps
🔅 Map Cross Correlation
Hoross Plot
📚 Horizon Tool
📚 Horizon Repair Tool
📚 Horizon Deck Tool
🐳 Manual Horizon Picker
🚸 Wavelet Tool



- Ensure that Input Volume is "Raw_NO_Stack", horizon is Top Rogaland and the "Amplitude" box is ticked
- 6. > Calculate
- RMB click on the new map object and rename "Ampl_Raw_NO_Stack"

		Data Pool: Odin_QA	@dell37	_
# 1 Raw_offset_gathe t 58 GB	# 9 Raw_NO_Stack t 764 MB	# 11 Ampl_Raw_NO_S GES NO	7	
			1	~



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







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Offset-to-angle conversion

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10000

Utilities Workflow Offset to Angle.. 🎄 Angle to Offset. PCube Background Model Builder. PCube Inversion. **Offset Gather** PCube+ Input Volume # 1 - Raw offset gathers 2 🗃 PCube+ Inspector 0 Interval Velocit EMPT Crava Background Model Builder. RMS-Velocity Mapping EMPT Crava Inversion... Volumetrics Calculator Method: Plane layer ray tracing Well Tie. Inline 27300 ‡ Multi Well Tie OC Crossline 16350 ‡ Generate Synthetic Gather. Please select a matching interval velocity 3D Parametric Synthetic Model. with sampling starting at zero Shuev-Modeled Gathers. Angle Gather 2 Chi Angle Volume 1.5 Trace Integration. AVO Scaling. Multi Well Scalar 20 Sculpt Volume Flattening. Minimum Angle, α_{min} 0.00 ‡ ° [0.00 .. 79.00] 2 Volume Unflattening. 2.5 Maximum Angle, am 60.00 ‡ ° [1.00 .. 80.00] Create Maps. Angle Step, addet 1.00 ‡ ° [0.10 .. 78.00] Create Interval Maps. Map Cross Correlation. 3.0 Cross Plot. Horizon Tool . < Horizon Repair Tool Horizon Deck Tool . Manual Horizon Picker 4 Wavelet Tool. Parameters Preview Display mode -10000 0 Apply Apply C ? Cancel

From the top level menu

Select Interpretation-Processing

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



4. > Select



Select "PL5735_smoothed_interval_velocities"





View angle map on offset gathers



- RMB click and rename the 2 new volumes in the Data Pool to "Raw_angle_gathers" and "Angle Map"
- LMB click and drag the Angle Map into the **Overlays** box in the **Gather View**

The Gathering 2023



What data issues can be seen below 35°?

Below 45°?

Beyond 45°?



Create raw angle stacks

	🥸 NMO	🤹 Azimuthal Velocity Conversion			
Processing	🤣 Stack Mute	🤣 Trace Interpolation			
	🤣 Partial Stacking				
	🤣 COCA Sectorization				
🛍 <u>L</u>	🥸 Butterworth Filter		_		
	🤣 Frequency Filter	· .		Partial Stacking	
	🤣 User Defined Filter		Input Volume: # 8	8 - Raw_angle_gat	thers
	🤹 Spatial Smoothing Filter		Stack Direction(s):	Angle	O Ser
	🤣 Median Filter		Output Volume(s):	Pseudo PreStad	ck Se
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2 Separate Stacks 3 PreStackPro Select Stacking Range Add one sub-stack Add N sub-stack From Angle 5.00 🗘 ° [0.00 .. 90.00 To Anal 45.00 ‡ ° [0.00 .. 90.0 ncel 🛛 🧟 <u>C</u>alculate Nb of sub-stacks 4 2 [1..61] Cancel 5. 5 6. Separate Stacks ł Raw NO Stack Ampl Raw NO St PL573S smoothe Raw angle gat 15.00 25.00 35.00 Angle_map Raw_angle_stac 45.00 ncel 🥂 🔊 Calculate 6 Global Memory: 22% Local Memory: 185.026 GB

From the top level menu:



Exercise 2

- Select Processing ٠
 - 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°
 - Click "OK"
 - Click "Calculate"

RMB and rename new 7. volume "Raw_angle_stacks"



[°]

View raw angle stacks



- 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

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	Grphaned Well Logs [0]						
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	Extended Statistics [0]						

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

S			Load Multiple Volumes				
File	Inline	Crossline	Fold	Secondary Fold	Trace	Size	Content
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Offset-to-angle conversion

 PCube Background Model Builder PCube+ inspector Crava Background Model Builder PCube+ inspector Crava Background Model Builder Senerate Synthetic Gathers Shuey-Modele Gathers Solume Flattening Solume Flattening Solume Flattening Solume Flattening Solume Flattening Solume Flattening Solume Flattening	Angle to onsetti			
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From the top level menu

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Read Out

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Select Interpretation-Processing

- 1. > Offset to Angle...
- 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"







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**

The Gathering 2023









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 ٠
 - Post the Top Frigg event
 - Use the cursor to evaluate the AVA response
 - *How would you describe the behaviour?*





Exercise 3



Amplitude vs Angle (AVA) analysis

		Data Pool: Odin_Q/	Al@dell37		_ × _
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t 58 GB	t 3054 MB	t 58 GB	t 45 GB		
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				1	
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- 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

Data Compar	rator Window 1
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Amplitude vs Angle (AVA) analysis



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

SHARP REFLECTIONS

- 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



Save the Final_angle_gathers

3		Data Pool: Odin_Q	Al@dell37		_ ×
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- 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



Utilities Workflow Offset to Angle Angle to Offset.. PCube Background Model Builder. PCube Inversion. PCube+. PCube+ Inspector 🤹 Crava Background Model Builder.. Crava Inversion.. Volumetrics Calculator. <table-of-contents> Well Tie. La Multi Well Tie QC.. Generate Synthetic Gather. 3D Parametric Synthetic Model.. Shuey-Modeled Gathers.. 2 Chi Angle Volume... Trace Integration. AVO Scaling. 🤹 Multi Well Scalar. Sculpt. 🤣 Volume Flattening 🤣 Volume Unflattening.. 🥼 Create Maps.. 🤹 Create Interval Maps.. Map Cross Correlation... Scross Plot.. 🗣 Horizon Tool . 😵 Horizon Repair Tool . Horizon Deck Tool ... Manual Horizon Picker Wavelet Tool

From the top level menu:

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



3. > Hard_shale_over_brine_sand.m3d4. > 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

- RMB click "Set horizontal Plot ranges..."
- 2. Select 50% and click OK

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Set the ho	rizontal range to this extend around the average min-max range.
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- 3. > <u>De</u>select 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

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- 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?



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

					3D Para	ametric Syn	thetic Model											
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1D Initial Model TOP LAYER	3D Parametrie	Model Synthetic Setup	Simple Elast	ics		TWT TVDss MD (Angle: 0 X-Axis: Angle	Angle: 0 X-Axis: Angle	Init.Vp 1232.5	Log (Velo 50r3902.50	Init.Vs l	.og (Shea	Init.Rho Li	og (De	init.Al Log 2958.00r9	(Acou 366.0(nit.Vp/Vs L	Layers
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	0.895 📜 s	Vs: 600 ‡ m/s	Pore Pressu	re EMPTY	1	62				-		-		-		-		
Thickness	100.00 ‡ m	Rho: 2.400 \$ g/cm^3	Fluid 2 Sat	EMPTY		111	-			a mana	antii antii	*)()****					100100000000000	(interest of the second se
TARGET LAYE	ER	In Situ	Simple Elast	ics		11:												
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Start depth	1000.00 ‡ m	vp: 2/10 ∓ m/s	Porosity			800.0												
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Brine sand	100.00	In Situ	Simple Flast	ics		- 1 - 1												
Intersand		Fill values Calc. Vs/Rho)			1 1									······			
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Start TWT	1.074 ‡ 5	Vs: 1270 ‡ m/s	Pore Pressu	re EMPTY		1000												TARGET
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BOTTOM LAY	ER	In Situ	Simple Elast	ics		I I E												
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					State March	No para	meter set 0											
Output Vp, Vs,	Rho volumes	Output RMS volume		Output volume	size: 10 KB	No para	meter set					✓ Sh	low samp	ole rea	douts	🛃 Sa	ve logs	to project
Output AI, Vp/V	/s volumes	Output used axes vol	umes			No para											-In	
													*	cance		ip	Apply Apply	Calculate

- 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?

	Set horizontal plot range
Set the	horizontal range to this extend around the average min-max range.
Extent	50.00 🗘 % [10.00 90.00]
	Gancel

4. > Calculate to generate the model





Rename model and create a copy to edit



- Rename the new Parametric model "Soft_over_gas"
- 2. RMB click the "Soft_over_gas" icon
- 3. > Edit copy...



100000

Model 4 – soft shale over brine sand



- 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?



4. > Calculate to generate the model





Rename model and compare the 4 models

		Data Pool: Odin_Q	Al@dell37		—B
# 1	# 9	# 11	# 80	# 88	N
Raw_offset_gathe	Raw_NO_Stack	Ampl_Raw_NO_St	PL573S_smoothe	w_angle_gathers	V
t 58 GB	t 764 MB	893 KB	t 764 MB	t 45 GB	
€ 89	# 90	# 91	# 99	# 201	
Angle_map	aw_angle_stacks	Final_offset_gath	Final_angle_gath	Hard_over_brine	
t 58 GB	t 3054 MB	t 58 GB	t 45 GB	t 10 KB	
# 217	# 233	# 252	1		V
Hard_over_gas	Soft_over_gas	Soft_over_brine			TH
t 10 KB	t 10 KB	t 10 KB			
					-
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1. Rename the new Parametric model "Soft_over_brine"

h		Data Pool: Odin_Q	AI@dell37	
#1	#9	# 11	# 80 # 88	
Raw_offset_gathe	Raw_NO_Stack	Ampl_Raw_NO_St	PL5735_smoothe w_angle_gathers	8
t 58 GB	t 764 MB	893 KB	t 764 MB t 45 GB	
# 89	# 90	# 91	# 99 # 201	۶
Angle_map	taw_angle_stacks	Final_offset_gath	Final_angle_gath Hard_over_brine	
t 58 GB	t 3054 MB	t 58 GB	t 45 GB t 10 KB	
# 217	# 233	# 252	3	
Hard over gas	Soft over gas	Soft over brine	Select all	Ctrl+A
t 10 KB	t 10 KB	t 10 KB	Deselect all	Ctrl+Shift+A
Child Manager		4	 Show selected volumes in 3D Viewer Show selected volumes in Gather viewer Show selected volumes in Stack viewer Show selected volumes in Top View Show selected volumes in a Data Comparate Show selected volume Show selected volumes in a Data Comparate Show selected volume Show selected volumes in a Data Comparate Show selected volume Show selected volumes in a Data Comparate Show selected volume Show selected volumes in a Data Comparate Show selected volume Show selected volumes in a Data Comparate Show selected volume Show selected volumes in a Data Comparate Show selected volumes in a Data Comparate Show selected volume Show selected volumes in a Data Comparate Show selected volume Show selected volumes in a Data Comparate Show selected volume Show selected volumes in a Data Comparate Show selected volume Show selected volumes in a Data Comparate Show selected volume Show selected volumes Show selected volumes Show selected volumes in a Data Comparate Show selected volume Show selected volumes Show selected volumese Show selected volumes Show selected volumes Show selected vol	or
Clobal Memory.		50%	Create workflow from selected volumes	Ctrl+Shift+W
			 Delete selected volumes Delete all 	Shift+Del

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







Extract AVA responses at Top Target





3

- 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





- 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

		Data Comparator Window 3		
📘 [t.1] ++ 🕁 🛃 🛃 🚩				
	# 201 - Hard_over_brine (1)	# 217 - Hard_over_gas (3)	# 233 - Soft_over_gas (5)	# 252 - Soft_over_brine (7)
* 💽 # 201 - Hard_over_brine (1)				
Amplitude (10)	15000	15000	15000	15000
# 201 - Hard_over_brine (2)	10000	10000	10000	
👻 🔤 📥 Extraction on all (11)	5000 -	5000 -	5000 - X X X	5000
Amplitude (12)	0 * * * * * * * * * * *	- 0 -	- 0	- 0
* (1) # 217 - Hard_over_gas (3)	-5000	-5000 = X × × × × × × × × × ×	-5000 -	-5000
Amplitude (14)	-15000	-15000 - × ×	-15000	-15000
# 217 - Hard over gas (4)		- ¹	, <u> </u>	
🝷 💽 📥 Extraction on all (15)				
💿 📥 Amplitude (16)	0 10 20 30 40 50	0 10 20 30 40 50	0 10 20 30 40 50	0 10 20 30 40 50
# 233 - Soft_over_gas (5)	السياسيالسيالسياليسار	ىلىسىلىسىلىسىلى	ىلىستىستىستىسى	ا مانسانسانسانسا
• • • • Extraction on all (17)	0.90	0.90	0.90	0.90
- # 233 - Soft over gas (6)				
🝷 💽 🚍 Extraction on all (19)	0.95	0.95	0.95	0.95
💿 🛁 Amplitude (20)	0.55		0.55	1
 # 252 - Soft_over_brine (7) 	1			
 Extraction on all (21) Amplitude (22) 	1.00	1.00	1.00	1.00
✓	1			
🔹 🔤 📥 Extraction on all (23)	1.05 -	1.05 -	1.05 -	1.05 -
💿 🛏 Amplitude (24)		-		
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> Info	1.20	1.20	1.20	1.20
	4	▼ +	*	▼
# 252 - Soft over brine 🛛 🌌 🌲	1 Decident	, i j	Paral Para	Provident (
	Read Out:	Read Out:	Read Out:	Read Out:
Reference volume: # 201				
n Inline 0 *	-4179.123	57	9486.481	16.274
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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
 - Add 4 sub-stacks between angles of 5° and 45° 5.
 - 6. > OK

[0.00 .. 90.00]

[0.00 .. 90.00]

[1..61]

ØK

6

X Cancel

la ^

7. > Calculate

42

SHARP REFLECTIONS

4

SHARP REFLECTIONS

Rename and view angle stacks



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The Gathering 2023



Create a Full Stack



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

6

7. > Calculate

4



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

4		Data Pool: Odin_Q	Al@dell37		G
# 1 Raw_offset_gathe	# 9 Raw_NO_Stack	# 11 Ampl_Raw_NO_St	# 80 PL5735_smooth	# 88 e iw_angle_gathers	ø
# 50 GB	# 90 taw_angle_stacks t 8054 MB # 288	# 91 Final_offset_gath t 58 GB # 252	Final_angle_gath t 45 GB	Hard_over_brine t 10 KB	1 <
Hard_over_gas	Soft_over_gas	Soft_over_brine	4_angle_stacks t 3054 MB	Full_stack t 764 MB	
Global Memory:		37%		Local Memory: 185.026	GB 📑

- 1. Double click the Map View icon in the Data Pool
- 2. Turn on the **Top Frigg** horizon
- 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



Exercise 5





- 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



From the top level menu, select Interpretation-Processing

- 1. > Create Maps...
- Ensure that Input Volume is "Full_stack", horizon is **Top** 2. Frigg and the "Amplitude" box is ticked
- 3. > Calculate

🤹 Sculpt.

4. RMB click on the new map object and rename "Ampl_Full_stack"

Set as Volume specific histogram

-10000

Drag and drop the "Ampl_Full_stack" map into 5. 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



-10000

962 histogram

Seismic Amplitude histogram
 Set as Volume specific histogram

Compare amplitude maps by angle





Create a 10-fold Pseudo pre-stack volume

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45.00 2

10 3

0.00 .. 90.001

[0.00 .. 90.00]

[1..61]

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7. In the Data Pool, RMB click and rename

the new volume "10_angle_stacks"

X Cancel



From the top level menu:

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



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Compare pre-stack fold



- w angle gathe lard over brin Full_stack Local Memory: 185.026 GB Drag & drop "4_angle_stacks" volume into a new Data "10_angle_stacks" volume into Inline Crossline
 - 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

×

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



8000 8000 3. >OK 6000 6000 4000 4000 2000 2000

Compare pre-stack fold



- RMB click on the amplitude axis and click "Setup axis" 1.
- 2. Set the range from 0 to 15000



Exercise 5



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?

 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

889 - 4 angle stacks

0.000 ‡ s

0.008 🗘 s

🙋 Calculate

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7

2-Term 3-Term

Interpretation-Processing Utilities Workflow		Creai	e Attribute Maps		Create Attribute Maps
🤣 Offset to Angle		Input Selection		Input Selection	
Angle to Offset		input Selection			
PCube Background Model Builder	2	Input Volume	# 889 - 4_angle_stacks 💋 🎽	Input Volume	# 889 - 4_ang
🤣 PCube Inversion	~	• Use horizon	Top_Frigg_Smoothed_Pcube+	 Use horizon 	Top_Frigg_Sm
PCube+		O Use fixed Time	0.000 🗘 s	O Use fixed Ti	me
PCube+ Inspector		O Use horizon deck	EMPTY	O Use horizon	deck EMPTY
🤣 Crava Background Model Builder		o ose nonzon deek			
🦑 Crava Inversion		Map settings		Map settings	
Volumetrics Calculator		Create map at: At hor	izon position	Create map at:	At horizon position
<table-of-contents> Well Tie</table-of-contents>					
∔ Multi Well Tie QC			0.012 🗘 5	Time less (t _i)	
🤹 Generate Synthetic Gather			0.012 2 5	Time greater (*	
🤹 3D Parametric Synthetic Model		Time shift (t)	0.000 1 5	Time shift (t_)	
🤹 Shuey-Modeled Gathers		Time Shine (0g)	1		
🤣 Chi Angle Volume		Laster Laster Last	4		Windowed
Trace Integration		Instantaneous Wind	fowed Interval 2-Term 3-Term	Instantaneous	windowed
🤣 AVO Scaling	0				
🤣 Multi Well Scalar	3	✓ Amplitude		✓ RMS in winde	ow e in window
🤣 Sculpt		Distance to snapped	ed horizon	✓ Min. Sample	in window
🤣 Volume Flattening		Elevation		Max. Abs. Sa Signed Max	Ample in window
🤣 Volume Unflattening		Hilbert Transform		Mean in wind	dow
🤣 Create Maps		Inst. Phase		Zero crossin Median in wi	gs in window indow
Create Interval Maps		_ msc. rrequency		Bandwidth	
4 Map Cross Correlation				Semblance v	within Offset Class
Hoross Plot				Sum of Posit	ive Samples
📚 Horizon Tool				Window Halflen	gth:
📚 Horizon Repair Tool				Lateral Haifleng	th:
📚 Horizon Deck Tool					
😻 Manual Horizon Picker		? 🗱 Canc	el 🤹 Skip 🧔 Apply 🖉 Calculate	? 2	🕻 Cancel 🛛 🔥 Skip
🚸 Wavelet Tool	l				

From the top level menu, select Interpretation-Processing

- 1. > Create Maps...
- Ensure that Input Volume is "4 angle stacks" & horizon is 2. **Top Frigg**
- <u>Deselect</u> the Amplitude tick box 3.

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

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





4

5

* feede

2 Cancel

Create

Visualization Interpolation Distance:

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
- Ctrl LMB click to add points to the line, along the axis of the fan





- 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





- 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



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







- 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





· Curso

World 3

World)

Crossline

Volumes # 3

1.

2.

3.

Inline

Trace

Create a pre-stack well-tie

Interpretation-Processing Utilities Workflow	WellTie Configuration	
🤣 Offset to Angle	wenne coniguration	
🔅 Angle to Offset	Initialization Seismic Logs Synthetic Correlogram	
PCube Background Model Builder	Resume Section	
🤹 PCube Inversion		
🤣 PCube+		
PCube+ Inspector	Create Costien Multie 2022 07 23 35:41	Q WellTie Configuration
🤹 Crava Background Model Builder	Create Session WeilTie 2023-07-31_15:41	
🦑 Crava Inversion	Reference Well: 30_10-2	Initialization Seismic Logs Synthetic Correlogram
Volumetrics Calculator	2 Use Checkshot EMPTY	Input Angle Seismic: # 99 - Final angle gather 😹 🌌
See Well Tie	Use TD table 30 10-2 7P well-tie TD table	Stack Angle
<table-of-contents></table-of-contents>		Stack Angle: 0.00
🤹 Generate Synthetic Gather		Inline Halflength: 50
3D Parametric Synthetic Model		Crossline Halflength: 50
🤹 Shuey-Modeled Gathers		
🤣 Chi Angle Volume		Well expanse: IL [27579.2 - 27579.2] (1), XL [16428.2 - 16428.2] (1)
Trace Integration		Treat as vertical well
🎄 AVO Scaling		
🔅 Multi Well Scalar		
🔅 Sculpt		
🤣 Volume Flattening	🗱 Cancel 🛛 🏑 Ok 🛛 🙋 <u>A</u> pply	
🔅 Volume Unflattening		
4 Create Maps		
4 Create Interval Maps		
4 Map Cross Correlation		
tross Plot		Cancel Ok dana
< Horizon Tool		The second secon
📚 Horizon Repair Tool		
📚 Horizon Deck Tool	From the ten lovel me	
🔏 Manual Horizon Picker	FIOTI THE TOP LEVEL ME	HIU.
🕀 Wavelet Tool		

- 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

Initialization	Seismic Logs Syn	thetic	Correlogr	am			
Reference We	30_10-2					1	
Log Set:	InSitu						
Vp Log:	30/10-2_Vp_Virgin				48		
Vs Log:	30/10-2_Vs_Virgin				48		
Density Log:	30/10-2_Density_Virgin_EDIT						
✓ Edit Logs	5						
✓ Edit Logs Min. \	D /p Spike Amplitude:	50.	0 ‡ m/s	[10.0	10000.0]		
✓ Edit Logs Min. \ Min. \	D /p Spike Amplitude: /s Spike Amplitude:	50.	0 ‡ m/s	[10.0 [10.0	10000.0] 5000.0]		
▼ Edit Logs Min. \ Min. ' Min. Densi	D Vp Spike Amplitude: Vs Spike Amplitude:	50. 25. 0.03	0 ‡ m/s 0 ‡ m/s 5 ‡ g/cm	[10.0 [10.0 1^3[0.01	10000.0] 5000.0] 0 10.000]		
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✓ Edit Logs Min. \ Min. ¹ Min. Densi	D Vp Spike Amplitude: Vs Spike Amplitude: ty Spike Amplitude: Max. Spike Width: Blocking Rel. Jump:	50. 25. 0.03 5.0 0.03	0 ‡ m/s 0 ‡ m/s 5 ‡ g/cm 0 ‡ m 0 ‡	[10.0 [10.0 1^3[0.01 [0.00 [0.00	10000.0] 5000.0] 0 10.000] 100.00] 0 0.999]		
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1

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



Exercise 5



Compare synthetic & seismic AVA response



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



TOP LAYE

TARGET L

Utilities Workflow Offset to Angle. Angle to Offset.. PCube Background Model Builder.. PCube Inversion.. PCube+.. PCube+ Inspector 🤣 Crava Background Model Builder... Crava Inversion... Volumetrics Calculator.. Well Tie.. La Multi Well Tie QC..

Generate Synthetic Gather. 🤹 3D Parametric Synthetic Model.. Shuey-Modeled Gathers... Chi Angle Volume... Trace Integration. 4 AVO Scaling.. 🤹 Multi Well Scalar. 🕫 Sculpt... 💋 Volume Flattening.. Volume Unflattening... 🥼 Create Maps.. 🤣 Create Interval Maps... Map Cross Correlation... Scross Plot.. ፍ Horizon Tool .. 📚 Horizon Repair Tool . Horizon Deck Tool ... Se Manual Horizon Picker Wavelet Tool

From the top level menu:

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

1D Initial Model 3D Param	etric Model	Synthetic Setup	Simple Elastic	s	TMT VDss	Angle: 0	Angle: 0 X-Axis: Angle	Init.Vp	Log (Vek	o Init.Vs	Log (Shea	Init.Rho	Log (De	Init.Al Log	(Acou	Vp/Vs
	Fill va	lues_ Calc. Vs/Rho			E F	0 20 40	0 20 40	4	1013300.5	480.00	r1920.00	2.27 g/c	:m ⁻ 2.41	4233.00100	1.66	
Start depth 900.00	m Vp:	1900 ‡ m/s	Porosity	EMPTY	9			E	Xei	i.E	ax	-E	ax	uiu Luiu	nin	
Start TWT 0.895	s Vs:	600 🗘 m/s	Pore Pressure	EMPTY	11			-	F	5	F	-	F		5 -	
Thickness 100.00	m Rho:	2.400 ‡ g/cm^3	Fluid 2 Sat	EMPTY	14											anna fana Tanan fana
TARGET LAYER	In Situ		Simple Elastic	s		-										
*	Fill va	lues_ Calc. Vs/Rho			33.1	1.55										
Add Layer above 1000.00	m Vp:	2615 ‡ m/s	Porosity	EMPTY	0.1	2										
Start TWT 1.000	s Vs:	1270 ‡ m/s	Pore Pressure	EMPTY												
Thickness 100.00	m Rho:	2.280 ‡ g/cm^3	Fluid 2 Sat	EMPTY	\$											
Brine sand	In Situ		Simple Elastic	S	11											
<u>₹</u>	Fill va	lues Calc. Vs/Rho														
Start depth 1100.00	m Vp:	2615 ‡ m/s	Porosity	EMPTY	1.00											-
• Start TWT 1.076	s Vs:	1270 ‡ m/s	Pore Pressure	EMPTY		-										
Thickness 100.00	m Rho:	2.280 ‡ g/cm^3	Fluid 2 Sat	EMPTY	- - E										_	
BOTTOM LAYER	In Situ		Simple Elastic	S	1.5										1	
	Fill va	lues Calc. Vs/Rho		[200											
Start depth 1200.00	m vp:	3235 - m/s	Porosity	EMPTY	8	-										and dark
Start IWI	s vs:	1800 - m/s	Pore Pressure	EMPTY	"F _F											
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					Paramet	ric gather values										
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					No para	ameter set 0										
✓ Output Vp, Vs, Rho volumes	V 01	utput RMS volume	Ou	tput volume size: 10 KB	+ 4* 904 Byte						V Sł	now sam	ple rea	adouts	H Save	logs



Building models from well control



- 1. Select well **30_10-2**
- 2. Select "InSitu" log set and click the Green + icon
- 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

7

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

The Gathering 2023



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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





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

Describe what you see at different angles



💿 # 1462 - 2 Term Gradient (#99)

Top_Frigg_Smoothed_Pcube+
Top_Rogaland_Petrel_Autotrack

Horizons

Well 30_10-2 Arbitrary Path Feeder



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

Interpretation-Processing Utilities Workflow \		4	Cros	ss Plot Window 1			_ 🗆 🗙
🤹 Offset to Angle		T A A	# - M - O . X				
🧛 Angle to Offset				·			
PCube Background Model Builder		Cursor Read Out					
PCube Inversion		x		20 40		60	80
PCube+		Y	100-				<u> </u>
PCube+ Inspector							
🤹 Crava Background Model Builder							
🤹 Crava Inversion			80				
🚺 Volumetrics Calculator			80-				
Nell Tie			_				
E Multi Well Tie QC			-				
🤹 Generate Synthetic Gather			60				
3D Parametric Synthetic Model			-			Select input for cross plotting volum	
Shuey-Modeled Gathers	0	Add Plot			_		
🌵 Chi Angle Volume	2	P Volumes	-		3	X Axis:	# 1461 - 2 Term Intercep
🥼 Trace Integration		Volume Axes	40			Y Axis:	# 1462 - 2 Term Gradient
🌵 AVO Scaling		e Well Logs	-			 Skip hard zeros 	
🦑 Multi Well Scalar		/ LFCs	-			Texture:	# 1462 - 2 Term Gradient
🦑 Sculpt							
Volume Flattening			20				
🤣 Volume Unflattening			1			🥳 Whole Trace (I	No window)
🤹 Create Maps							
🤣 Create Interval Maps						Show axis <u>d</u> etails	
4 Map Cross Correlation							Cancel 0
Tross Plot			•				ancer do
🝣 Horizon Tool			Histogram				
📚 Horizon Repair Tool			O Volume si	pecific			
ፍ Horizon Deck Tool			O Volume s	pecific			
🔏 Manual Horizon Picker			Content s	specific		0 0	
🖶 Wavelet Tool			Set as Conte	ent specific histogram -10		0	10

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

SHARP REFLECTIONS



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



- 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°

50000 Socard Keep

Amplitude

Read Out

5000

60

4.0 9.8 23.9 58.5

1.0

- 2.5

5



100000

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
- Select "Final_angle_gathers" as Input Volume
- Set Angle to 10° 6.
- Set Horizon to **Top Frigg**
- 8. > Keep

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

50000 🐒 Discard 🛃 Keep

100000

8



3

Angle dependent spectral decomposition



Exercise 6



🗱 Cancel 🛛 🥑 Ok

3

- 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?





