BREAM 3D

GIPPSLAND BASIN, OFFSHORE AUSTRALIA

SEISMIC DATA PROCESSING REPORT

FOR

ESSO AUSTRALIA PTY LTD

SUBMITTED BY

VERITAS GEOPHYSICAL (ASIA PACIFIC) PTE. LTD.

UNIT 06-01 UNION BUILDING

37 JALAN PEMIMPIN

SINGAPORE 577177

SEPTEMBER, 2007

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1. INTRODUCTION

1.1 GENERAL

This report describes the depth processing carried out on Bream 3D seismic data acquired in offshore Australia, Gippsland Basin for Esso Australia Pty Ltd. The work was an extension of the time domain processing performed earlier and which was fully described in a separate report. Details of the data acquisition, survey location survey can be found in that report and are not repeated here.

1.2 PROCESSING CONTRACTOR/ CENTRE, START/ FINISH

The data was processed by Veritas Geophysical (Asia Pacific) Pte Ltd in their Singapore centre. Processing started in May 2007, and was completed in August 2007.

1.3 PROCESSING OBJECTIVES

The primary objectives were to use CGGVeritas's state of art Controlled Beam Migration (CBM) algorithm to enhance S/N ratio and image quality (sub coal).

1.4 KEY PERSONNEL – CONTRACTOR AND ESSO AUSTRALIA PTY LTD

Contractor Personnel (Veritas DGC Singapore):

Don Pham	–	Vice President – Processing & Imaging Operations, responsible for all aspects of seismic data processing and overall control of projects
Joe Zhou	–	Processing Supervisor, responsible for project organisation and QC
Yongdeng Xiao	–	Geophysicist

Esso Australia Pty Ltd. Personnel:

Erik Neumann	–	EAPC Processing Geophysicist, Project Supervision
Peter J. Ryan	–	Geoscientist, Production Gippsland Geoscience

2. CONTROLLED BEAM MIGRATION

2.1 OVERVIEW

Controlled Beam Migration (CBM) is a new kind of beam migration. Compared with standard Kirchhoff and Wave Equation migration, CBM not only can image steep dips (>90 degree), but also can handle multi-pathing (see Table 1).

Table 1: Comparison of CBM, Kirchhoff and Wave Equation

	CBM	Kirchhoff	DS/CS WEM
Multi-Pathing	√		√
Steep dips (> 90°)	√	√	
Relative amplitude		√	
Output gathers	**Offset**	**Offset**	**Angle**
Anisotropy	**VTI, TTI**	**VTI, TTI**	**VTI**

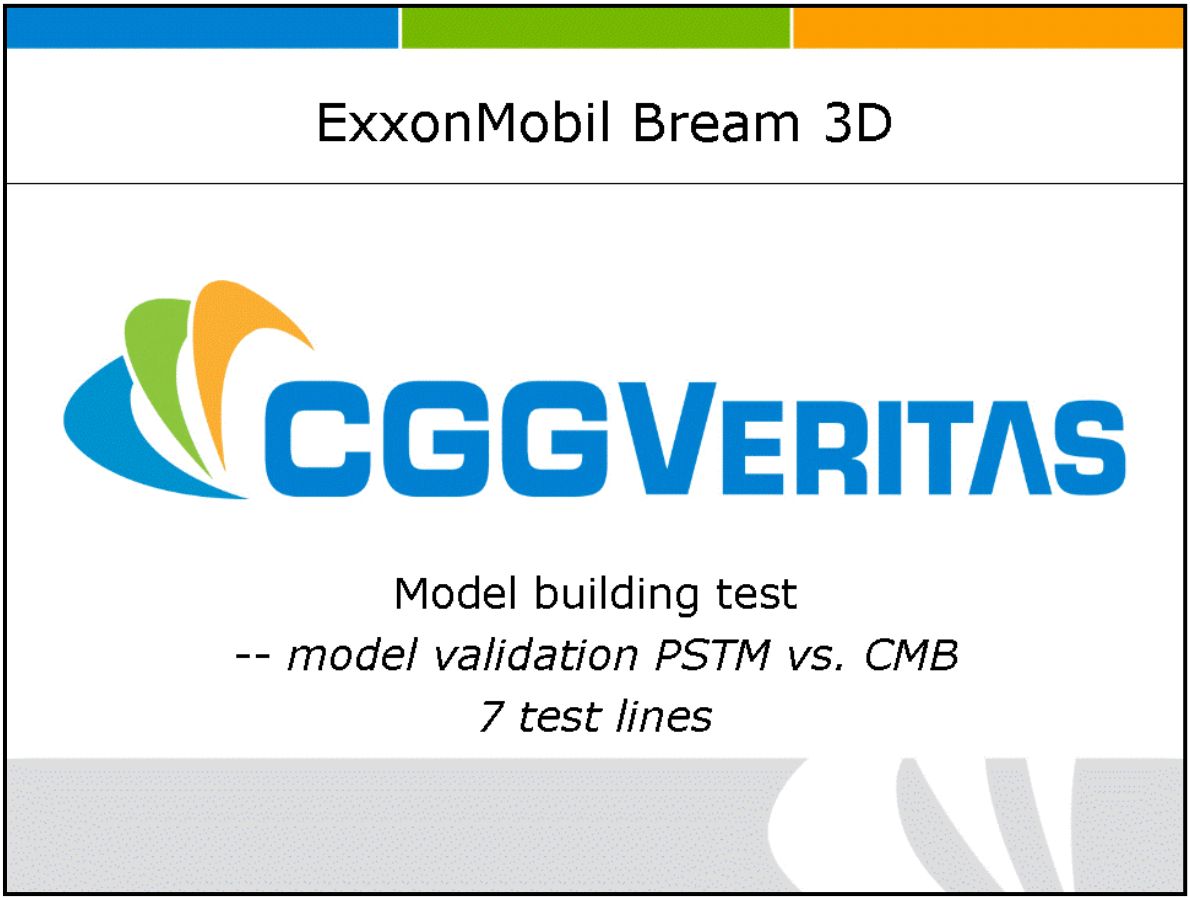
2.2 MIGRATION PARAMETER

- Migration aperture: 3000
- Depth step: 4m
- Maximum frequency: 60Hz
- Maximum dip: 90 degree
- Maximum migration depth: 7500m with 12.5x9.375m bin and 13000m with 12.5x18.75 bin

2.3 VELOCITY MODEL BUILDING

The model building was divided into the following steps:

- Created the initial velocity model by converting the PSTM velocity model to depth interval velocity field using Dix equation and smoothed the depth interval velocity after conversion.
- The first iteration tomographic update. The velocity update was limited in the layer between the water bottom plus 400m and the top of the coal horizon plus 1000m.
- Introduce a constant 4% Epsilon volume between a reflector 1000m above the top of the coal to top of coal horizon.
- Second iteration of tomographic update and get the final velocity model. The update was limited in the layer between the water bottom plus 400m and the top of the coal horizon plus 600m.

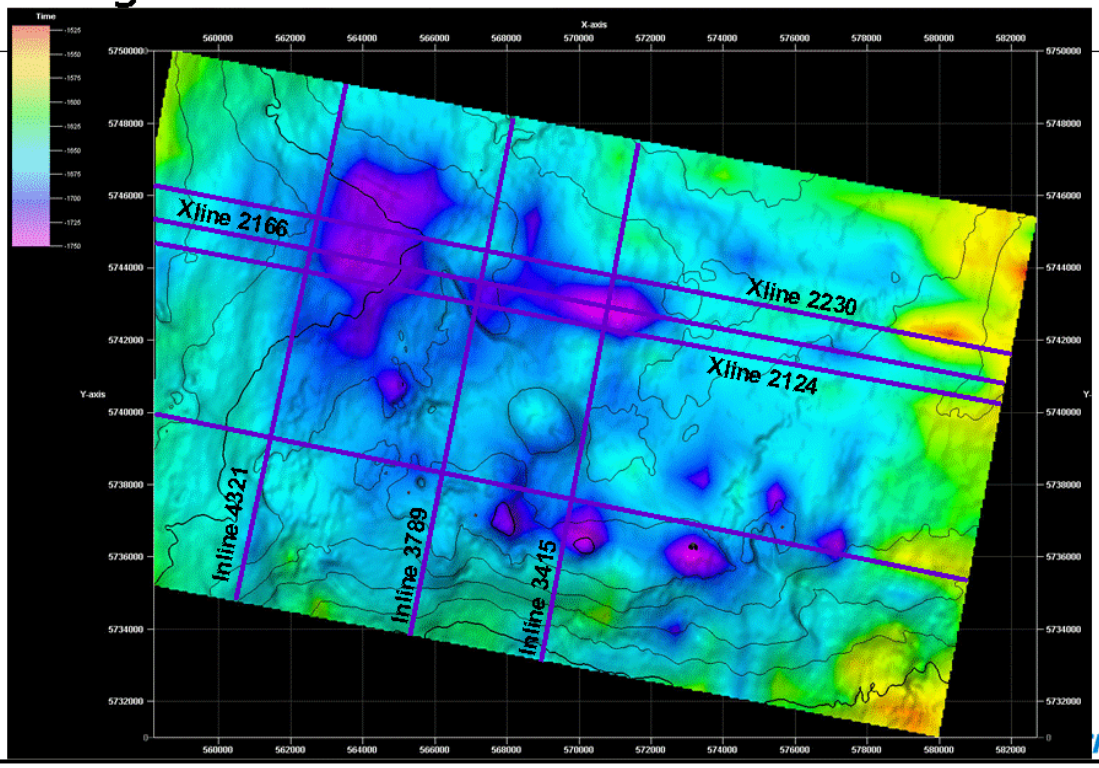


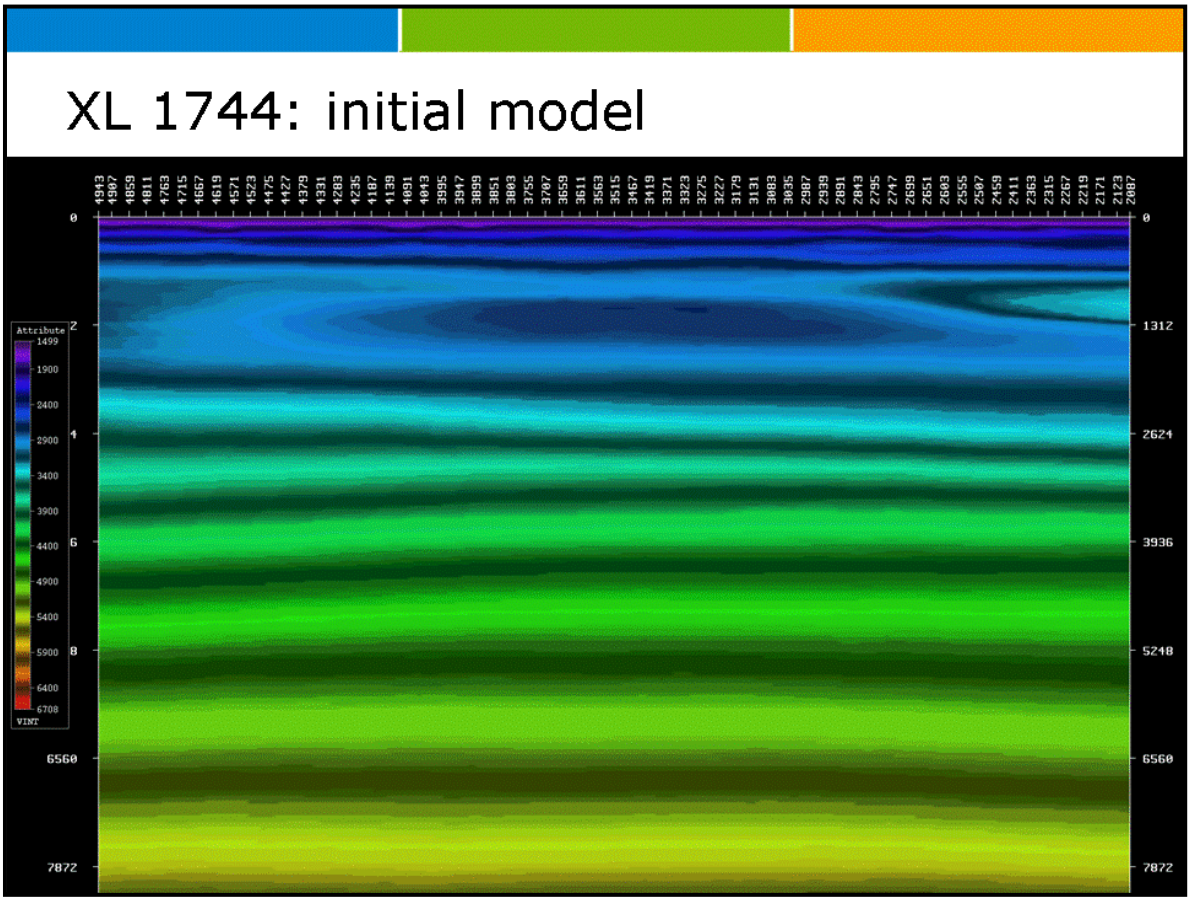
Outline

PSTM (w/ initial model) vs. CBM (w/ model after two iteration of tomography update)

- Migration aperture 3000m
- Anisotropy migration for CBM
- CBM depth stack and gathers are converted to time domain
- Migrate to 7500m
- Target crossline 1744, 2124, 2166, 2230, target inline 3415, 3789, 4321

Target line locations

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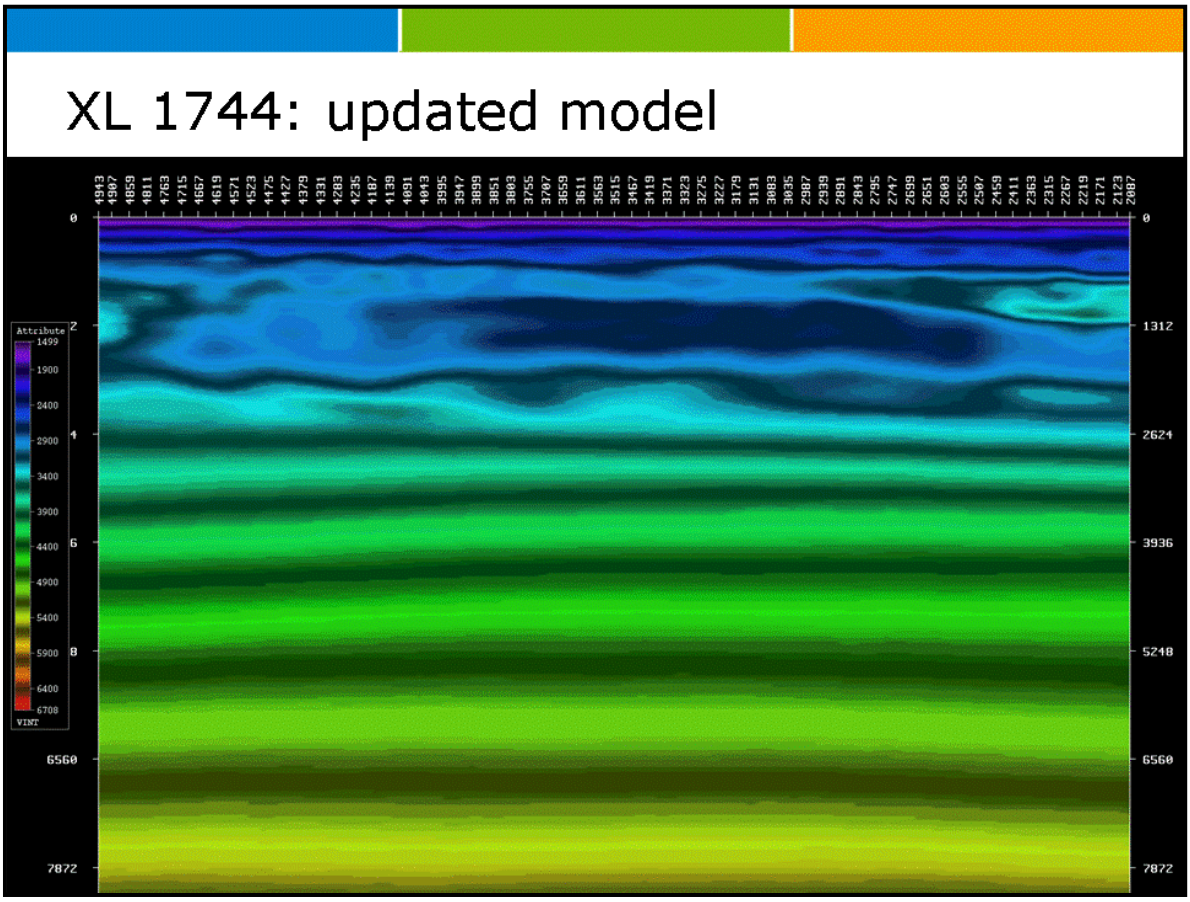
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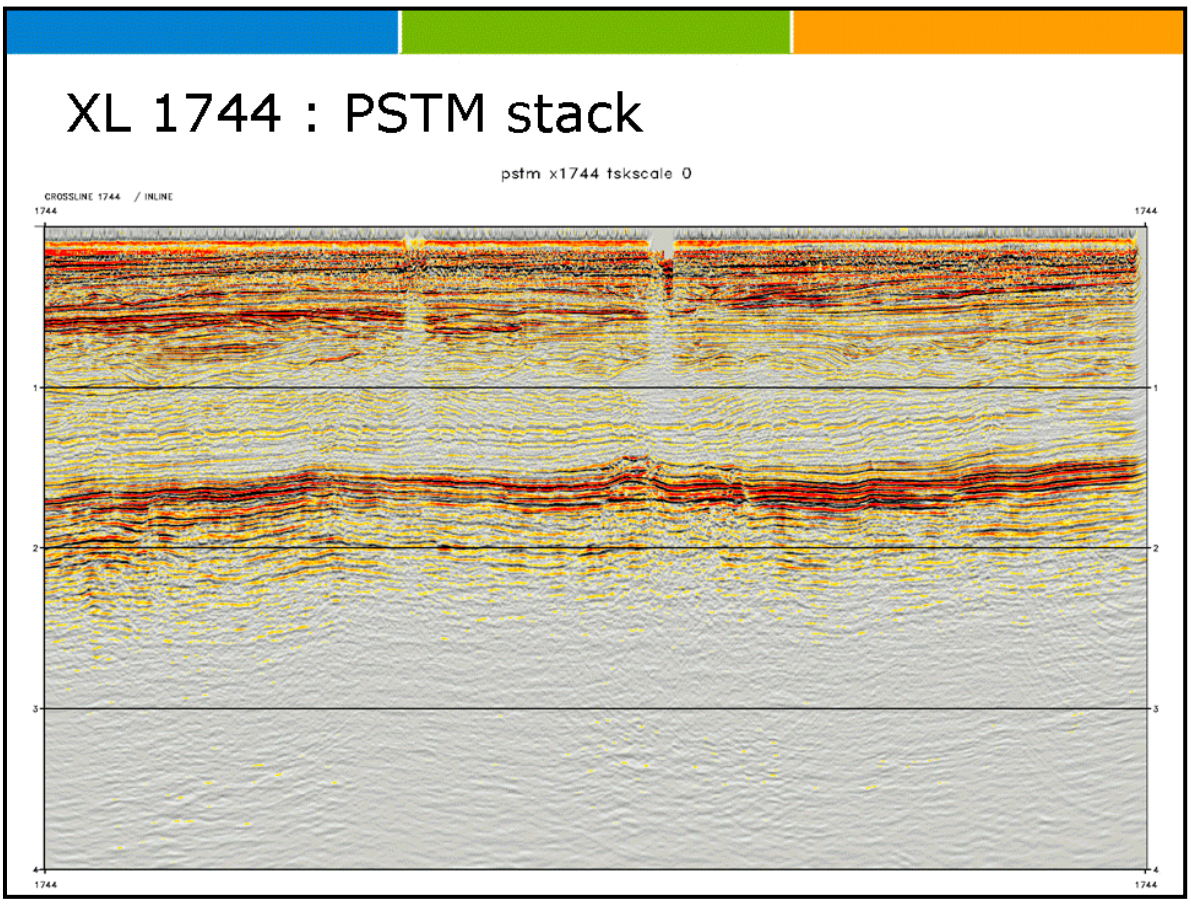
XL 1744 : PSTM stack



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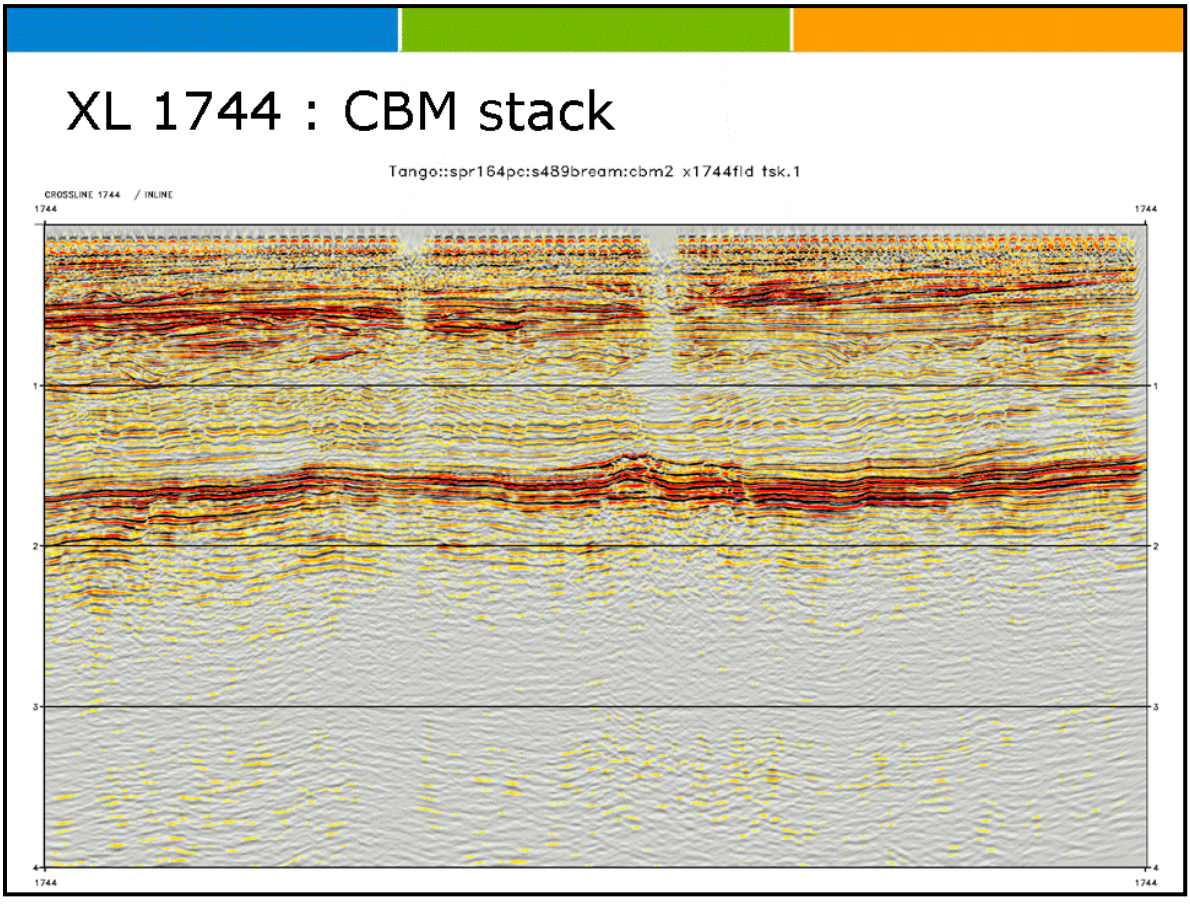

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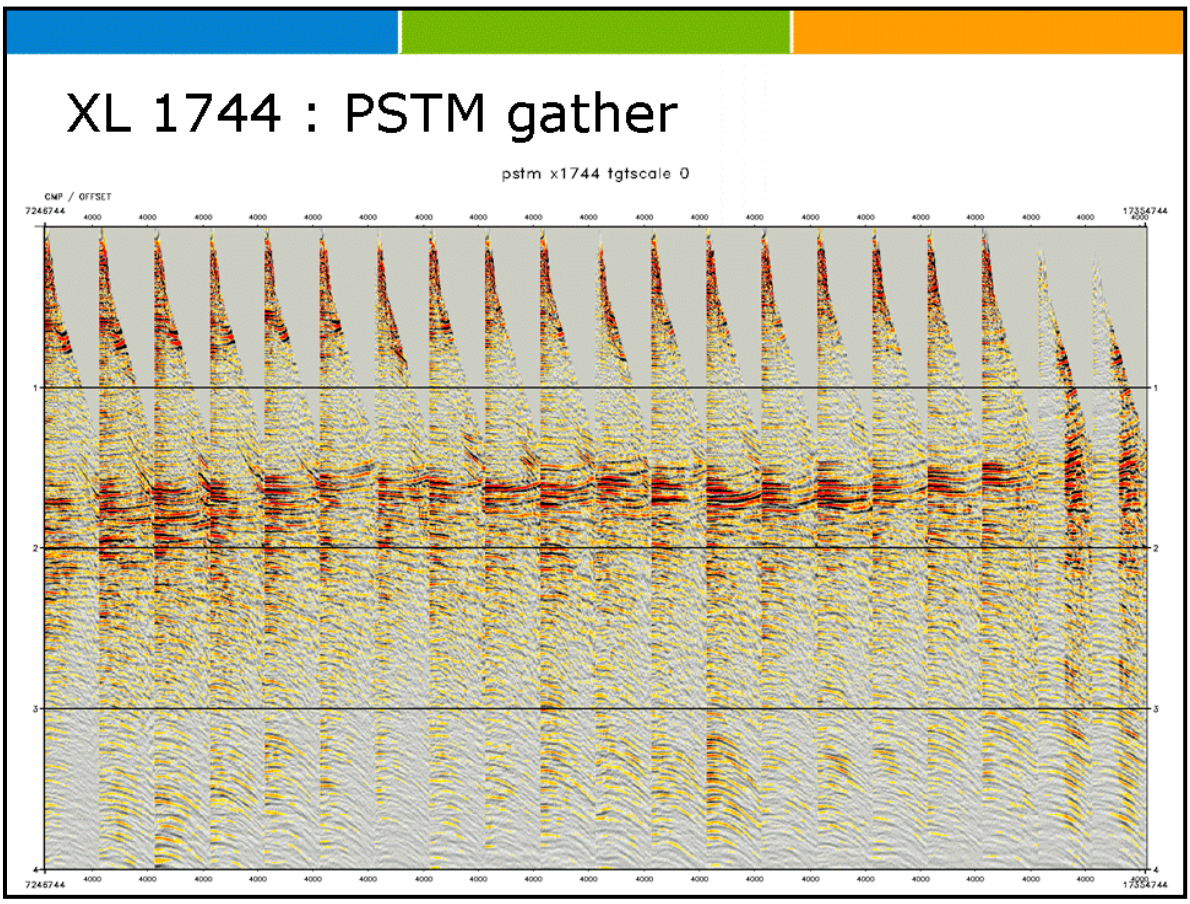

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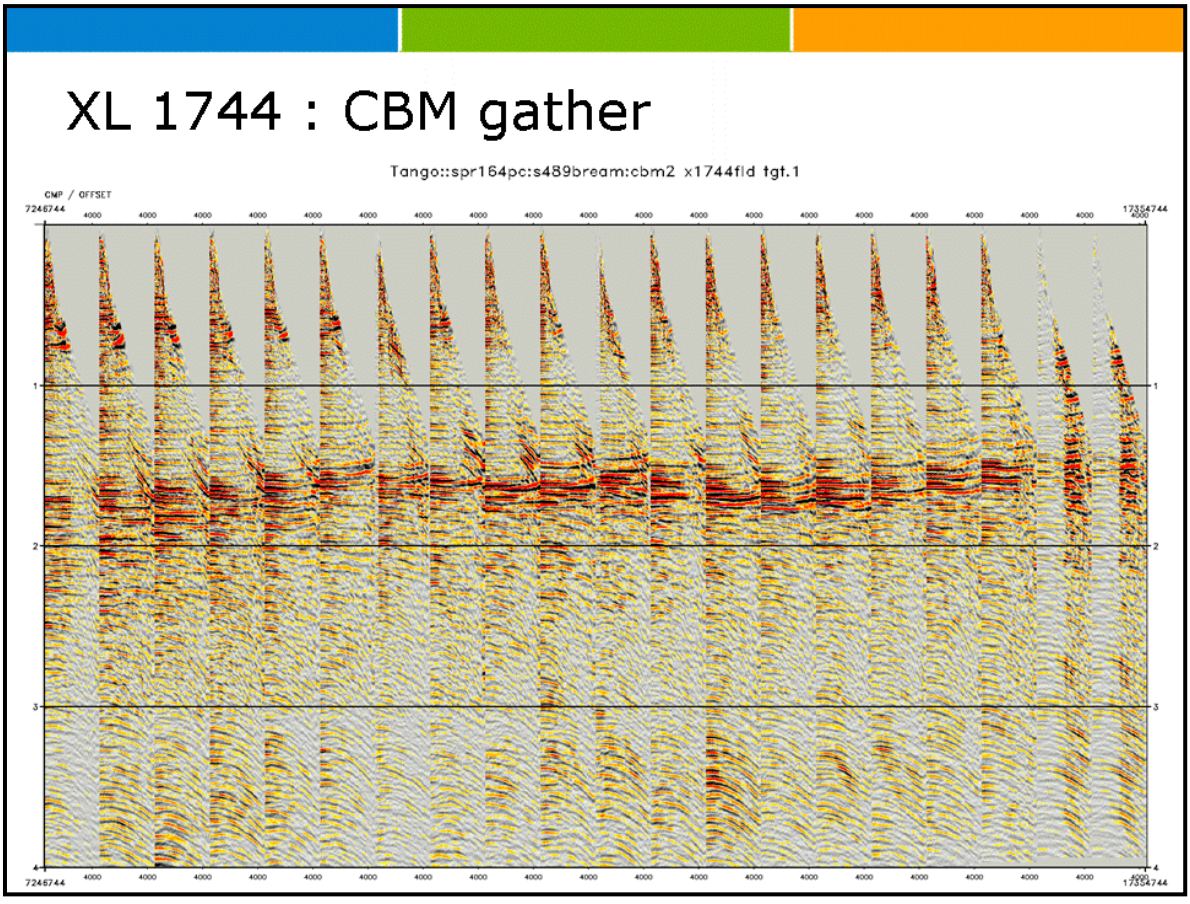

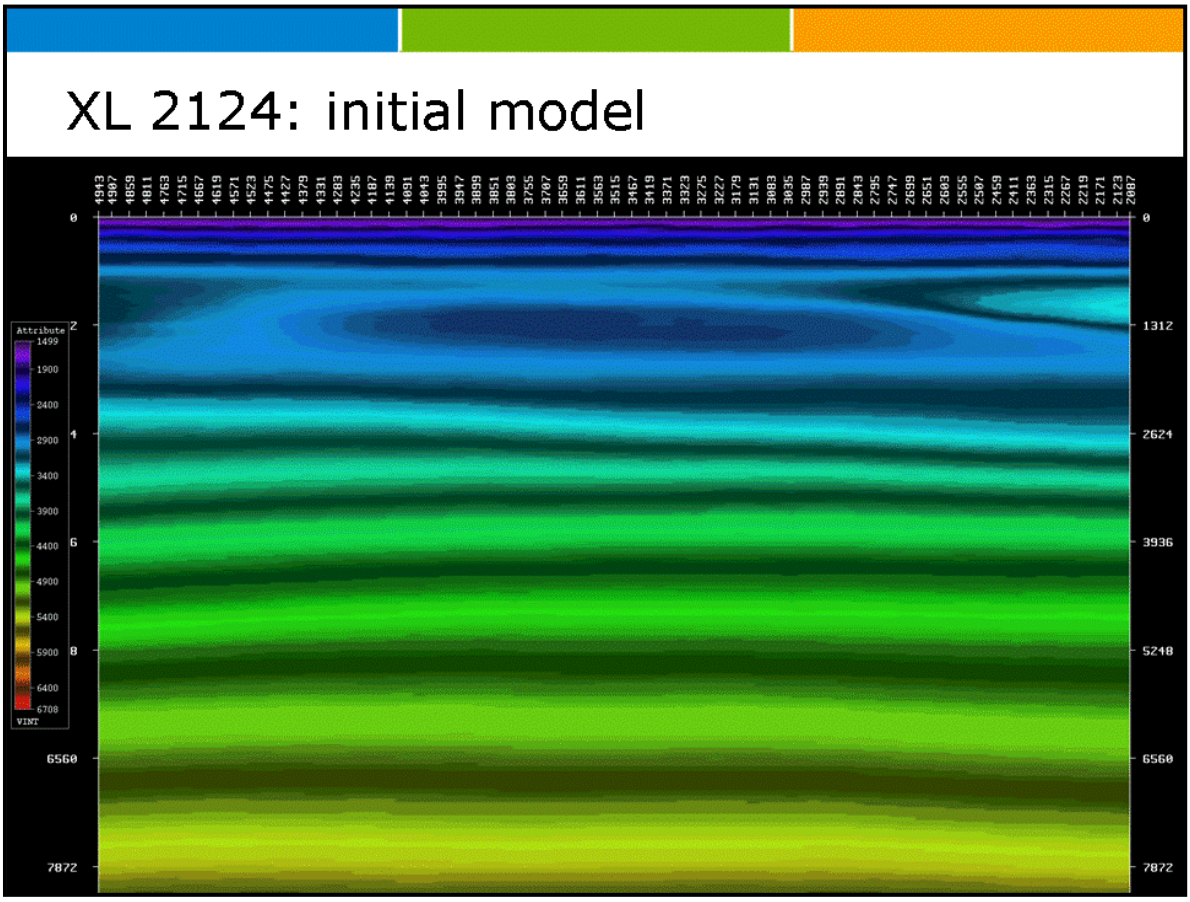
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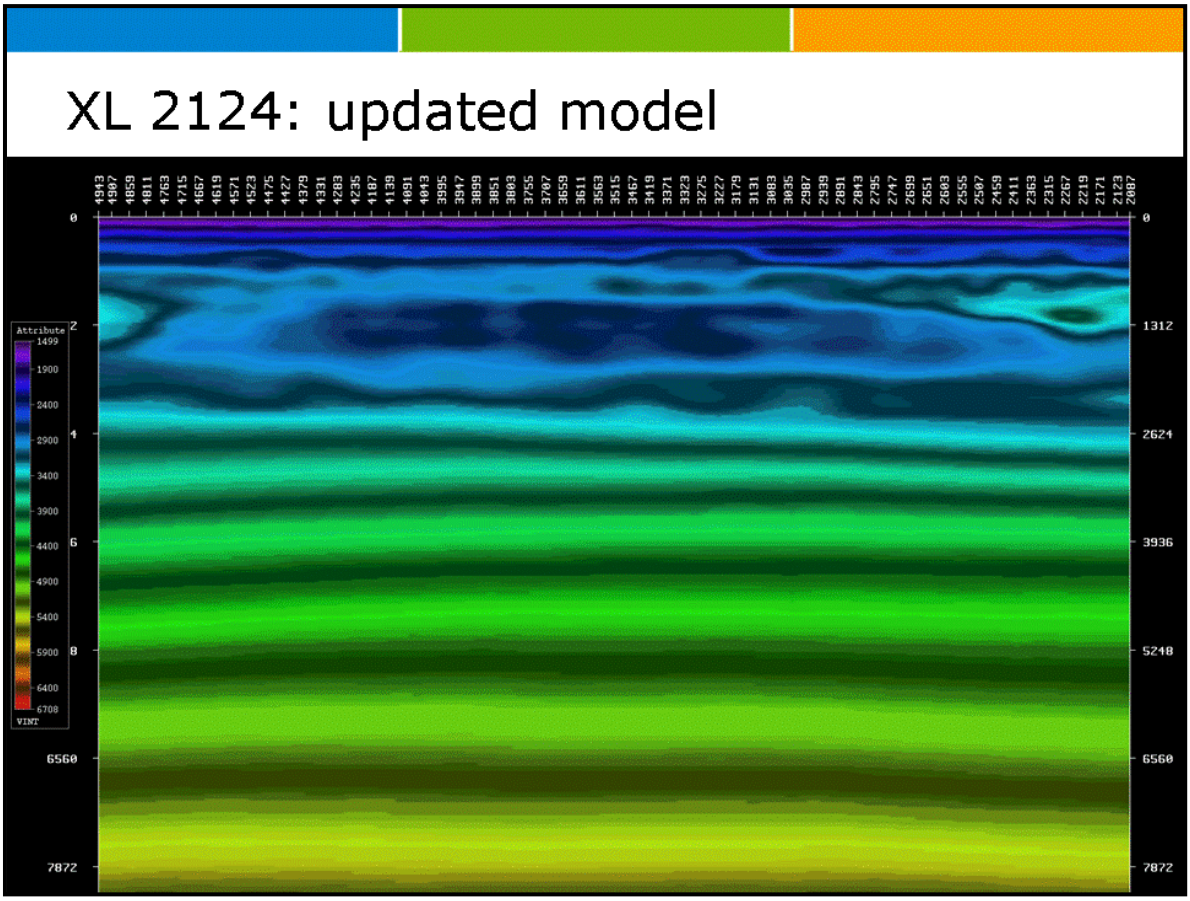
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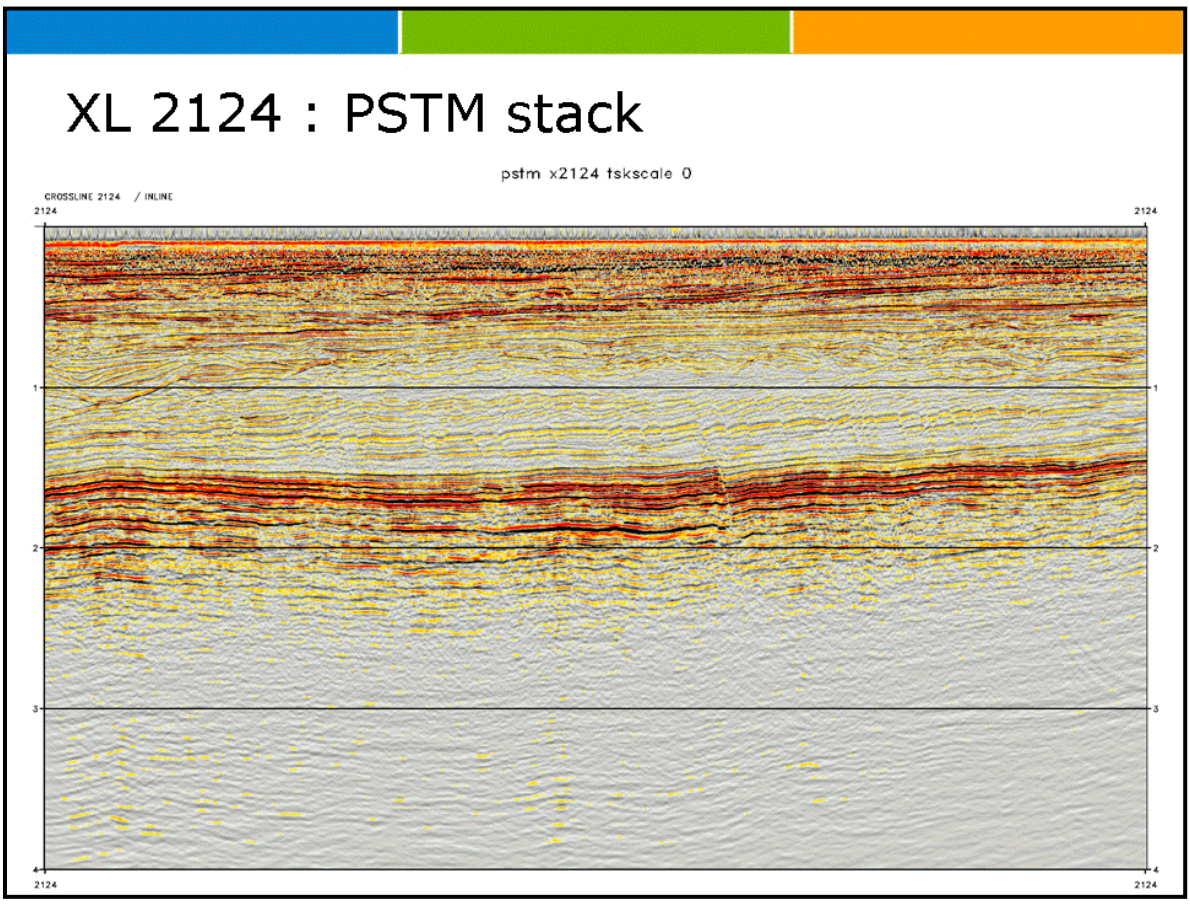
XL 2124 : PSTM stack



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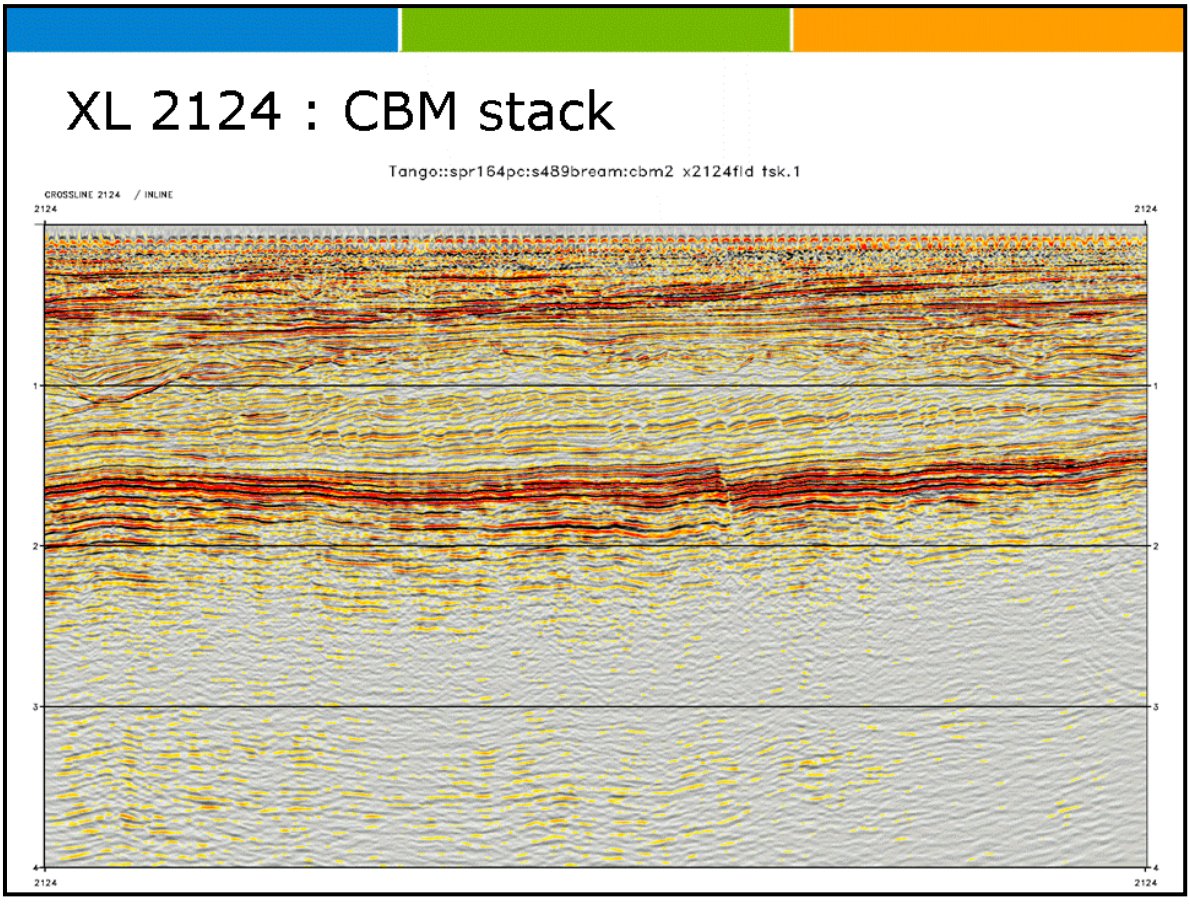

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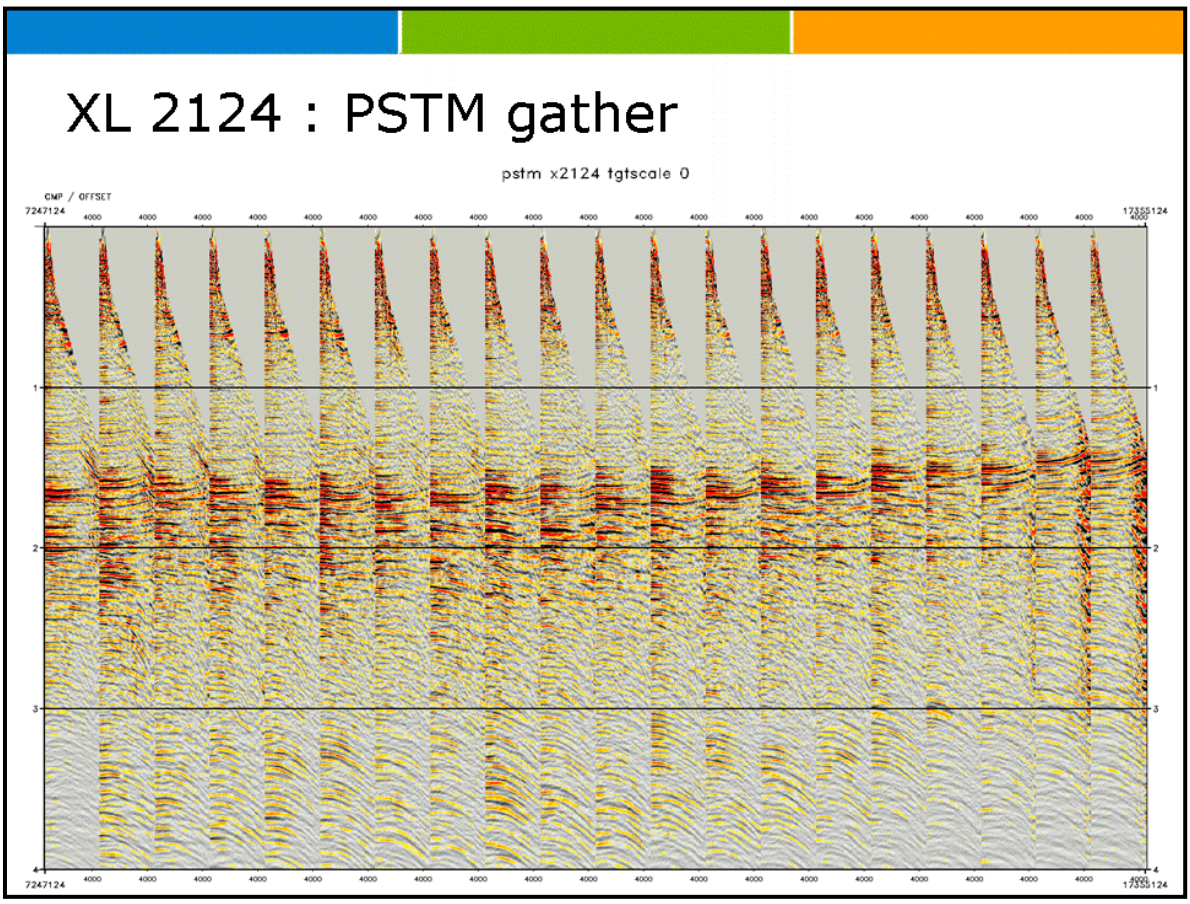

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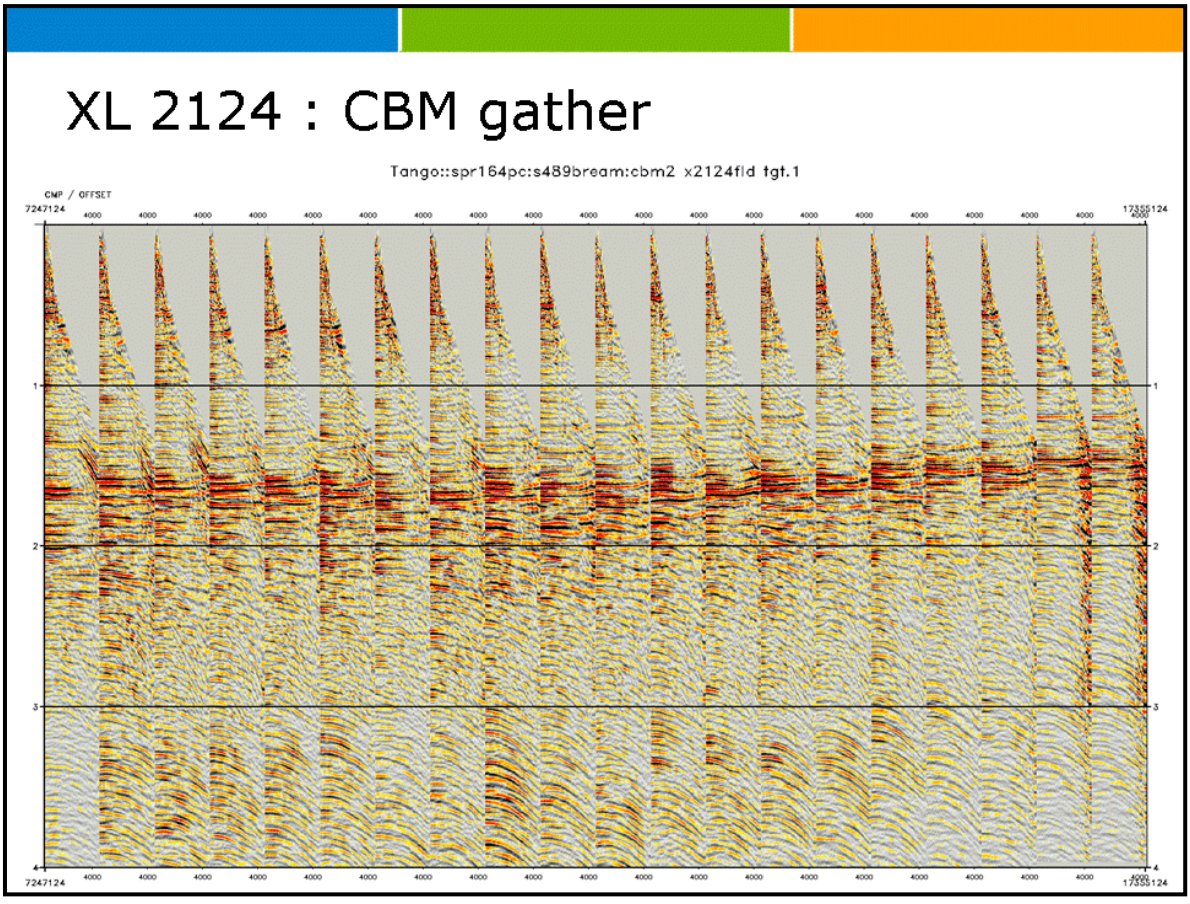

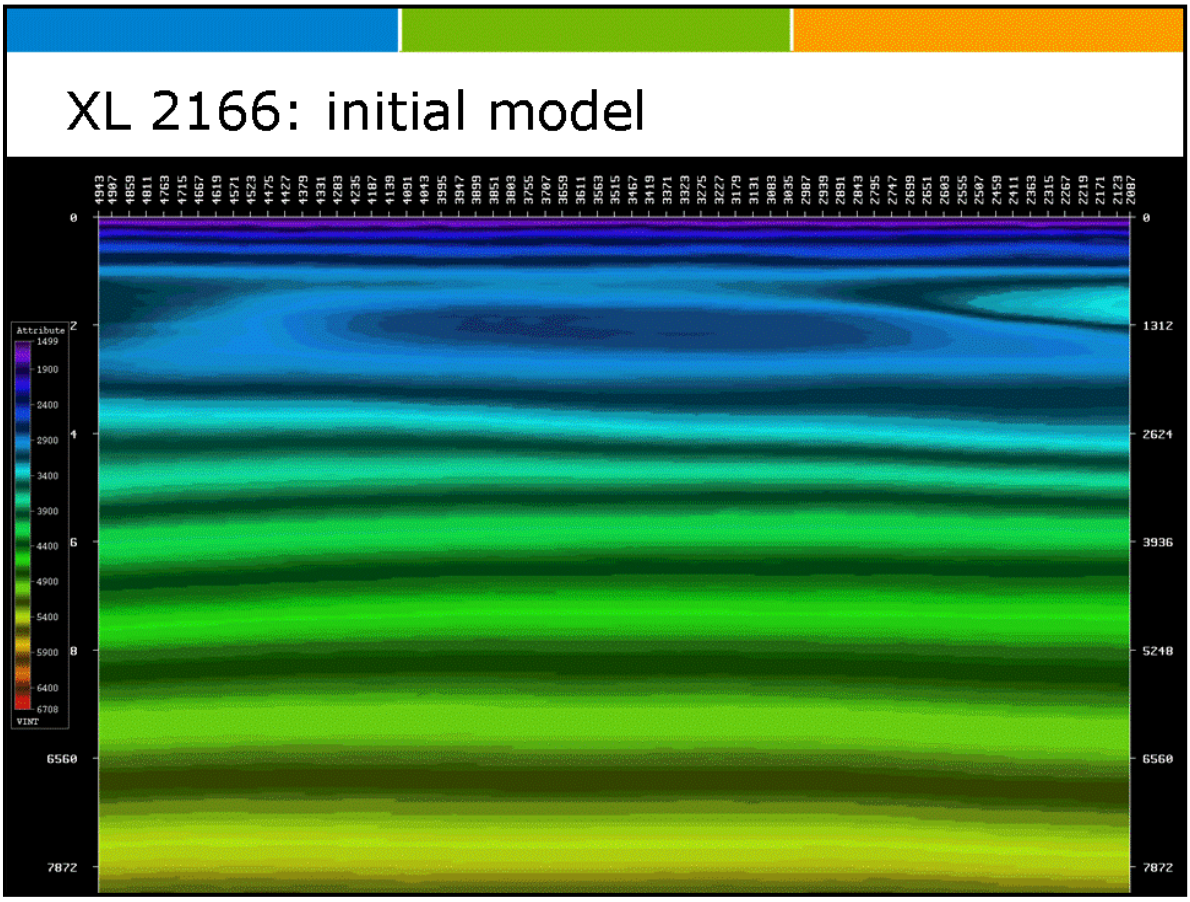
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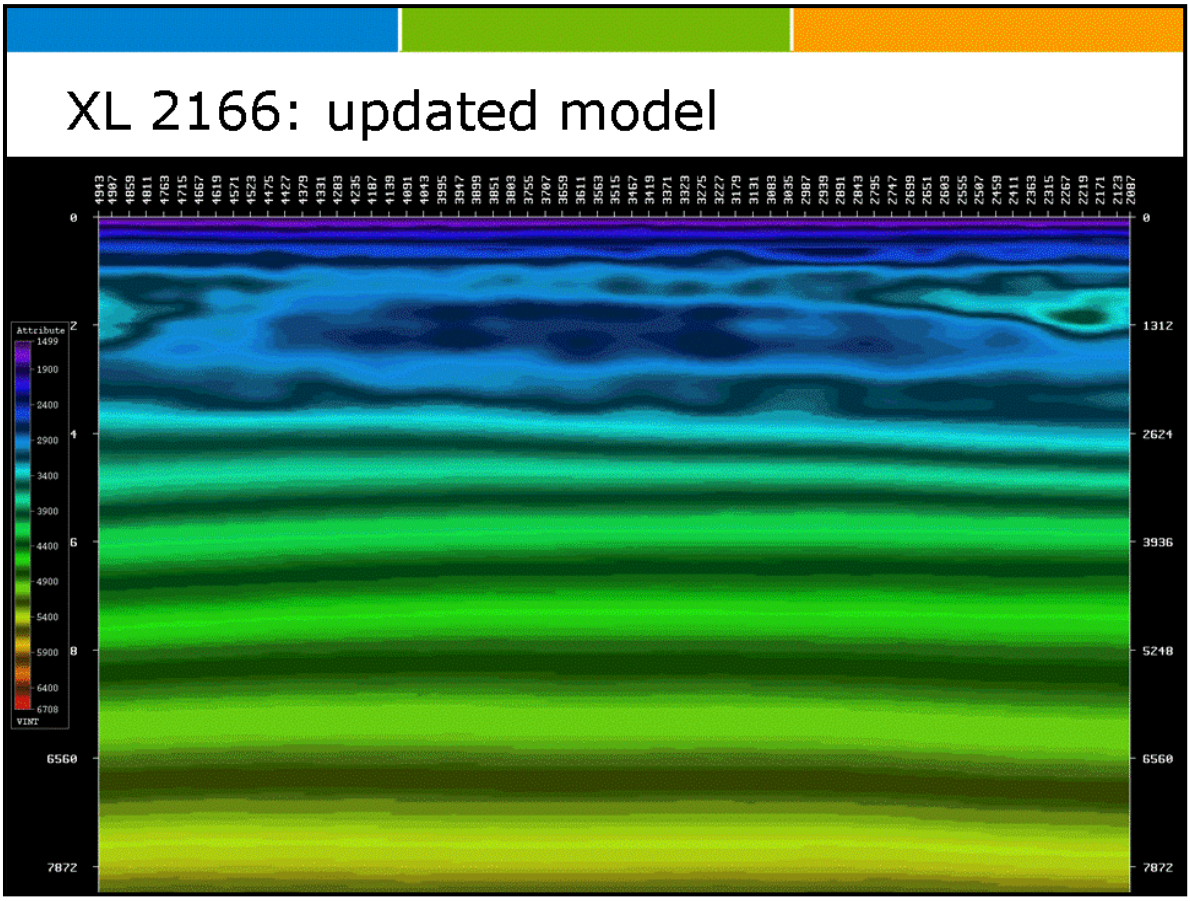
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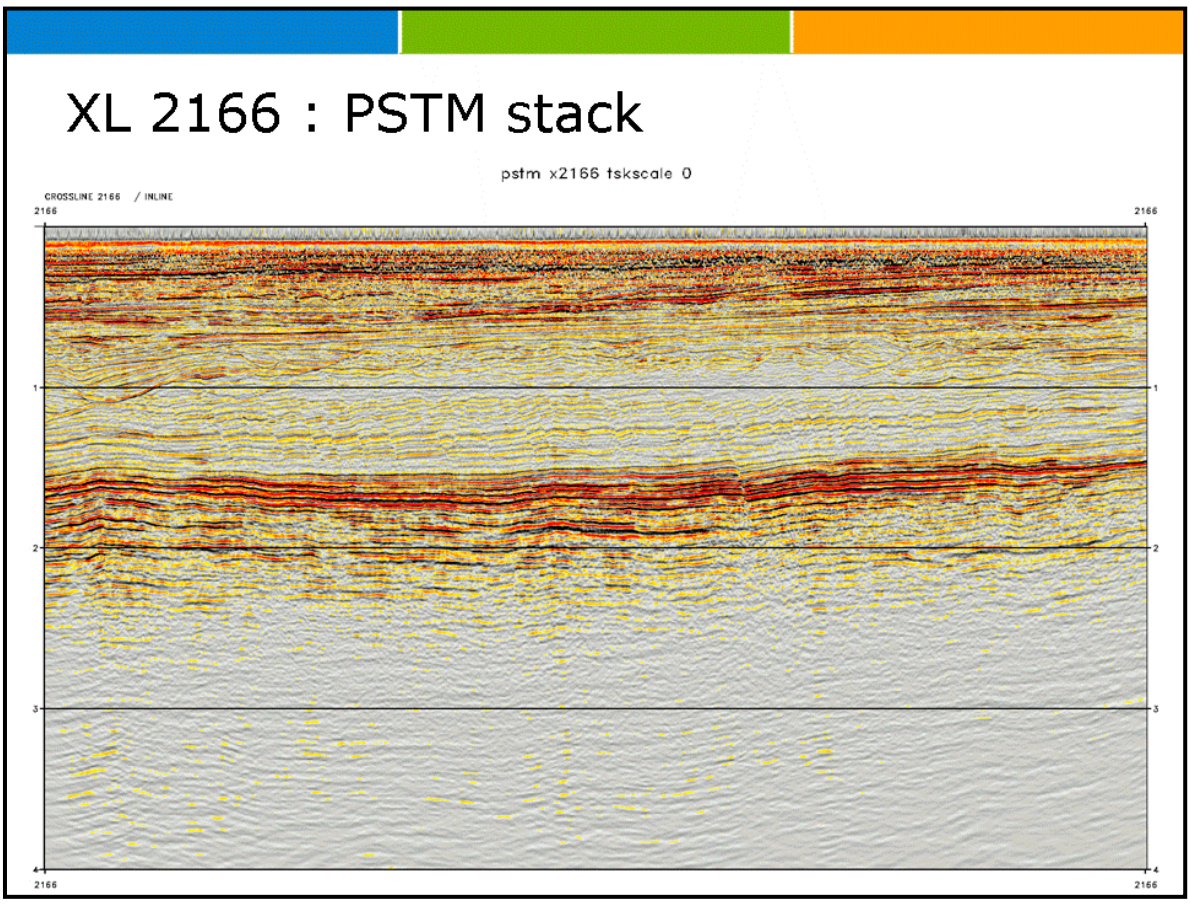
XL 2166 : PSTM stack



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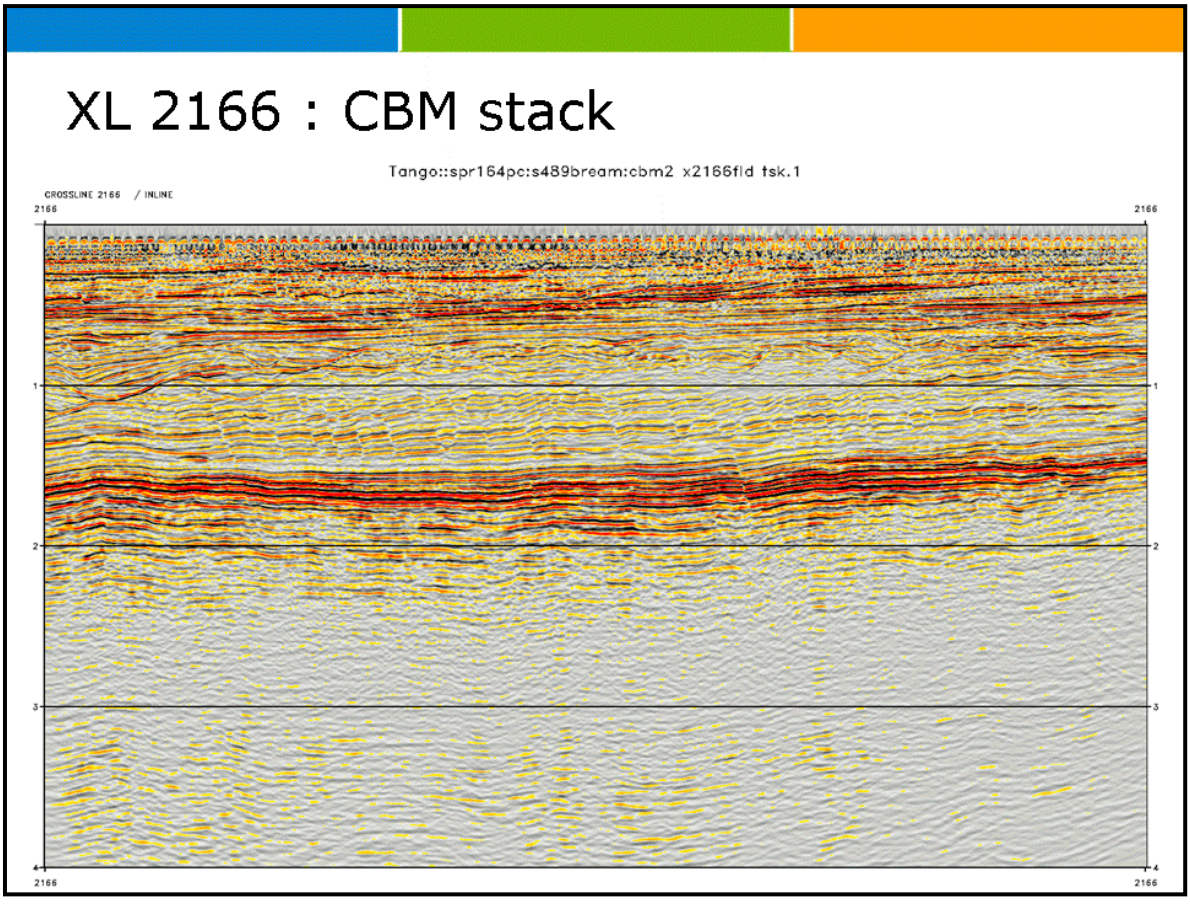

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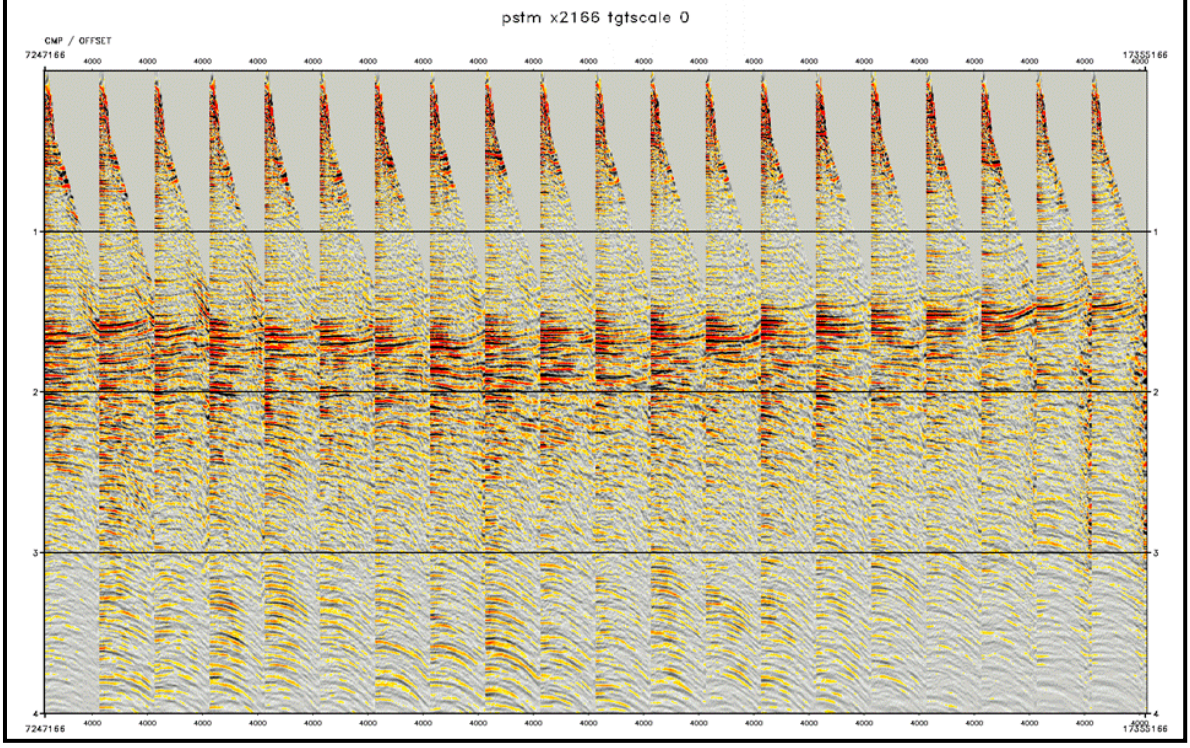

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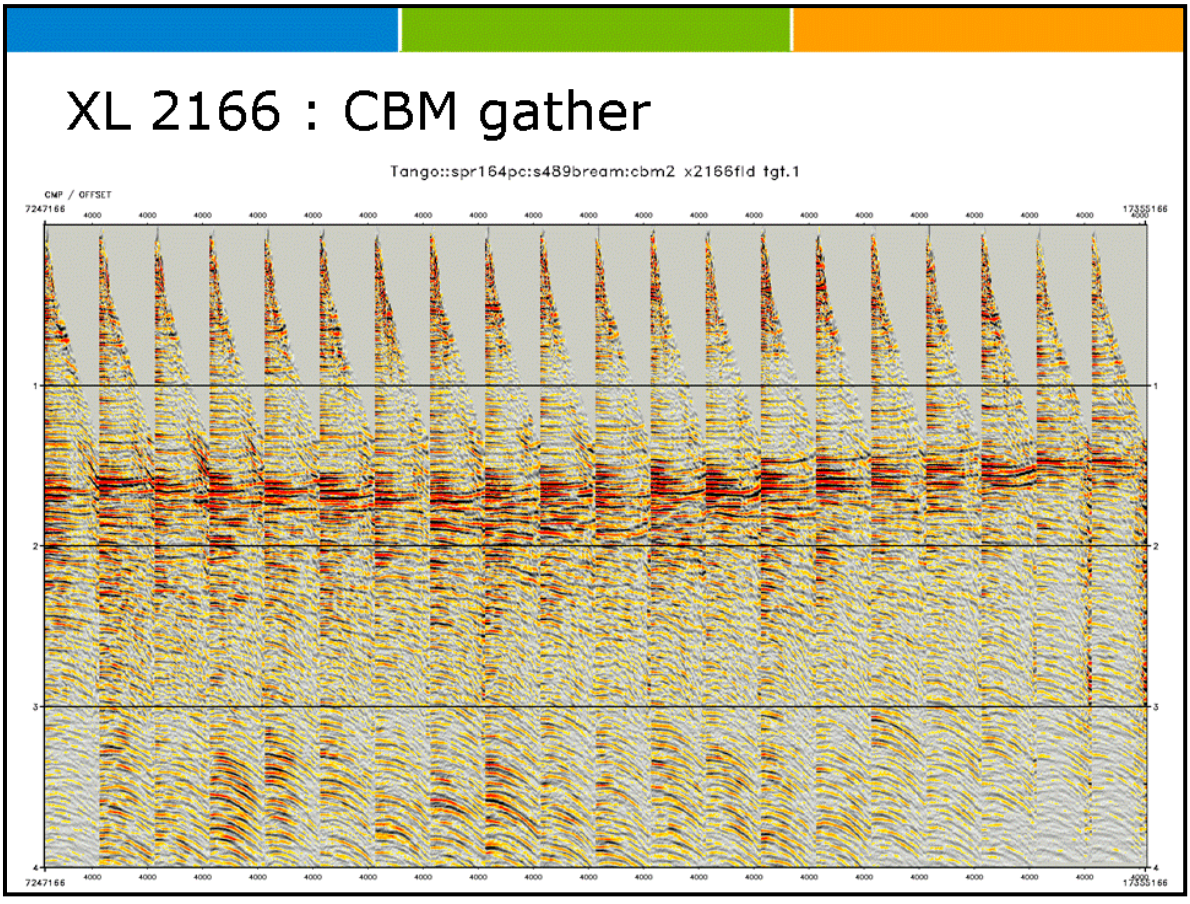

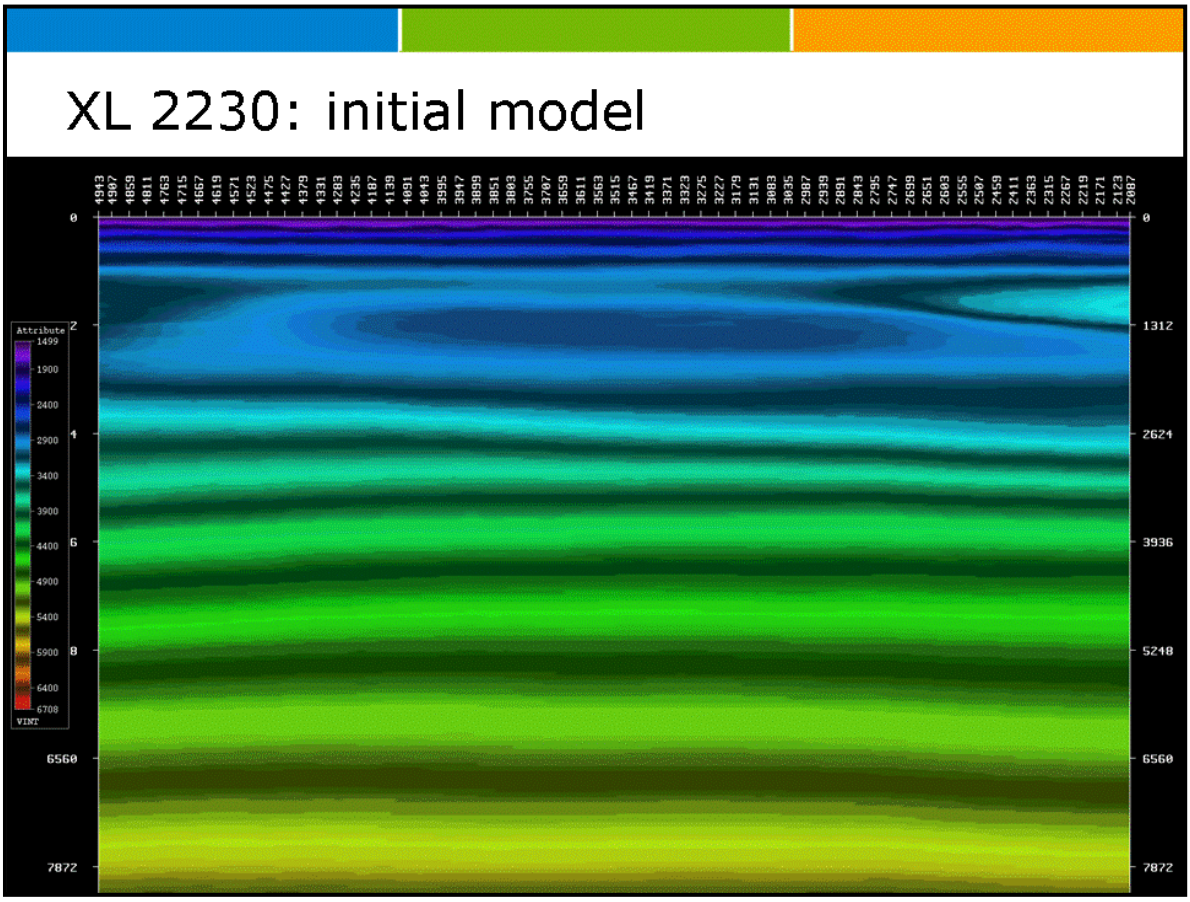
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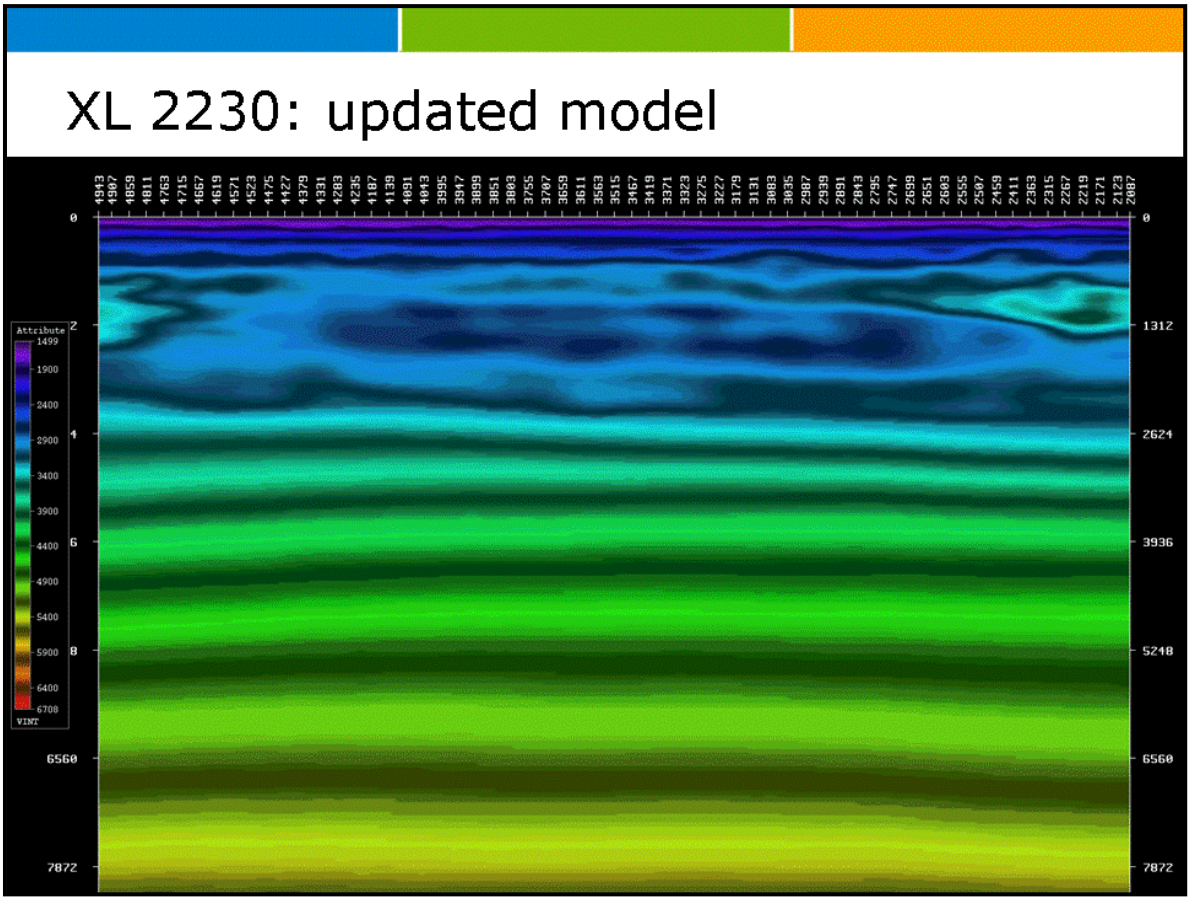
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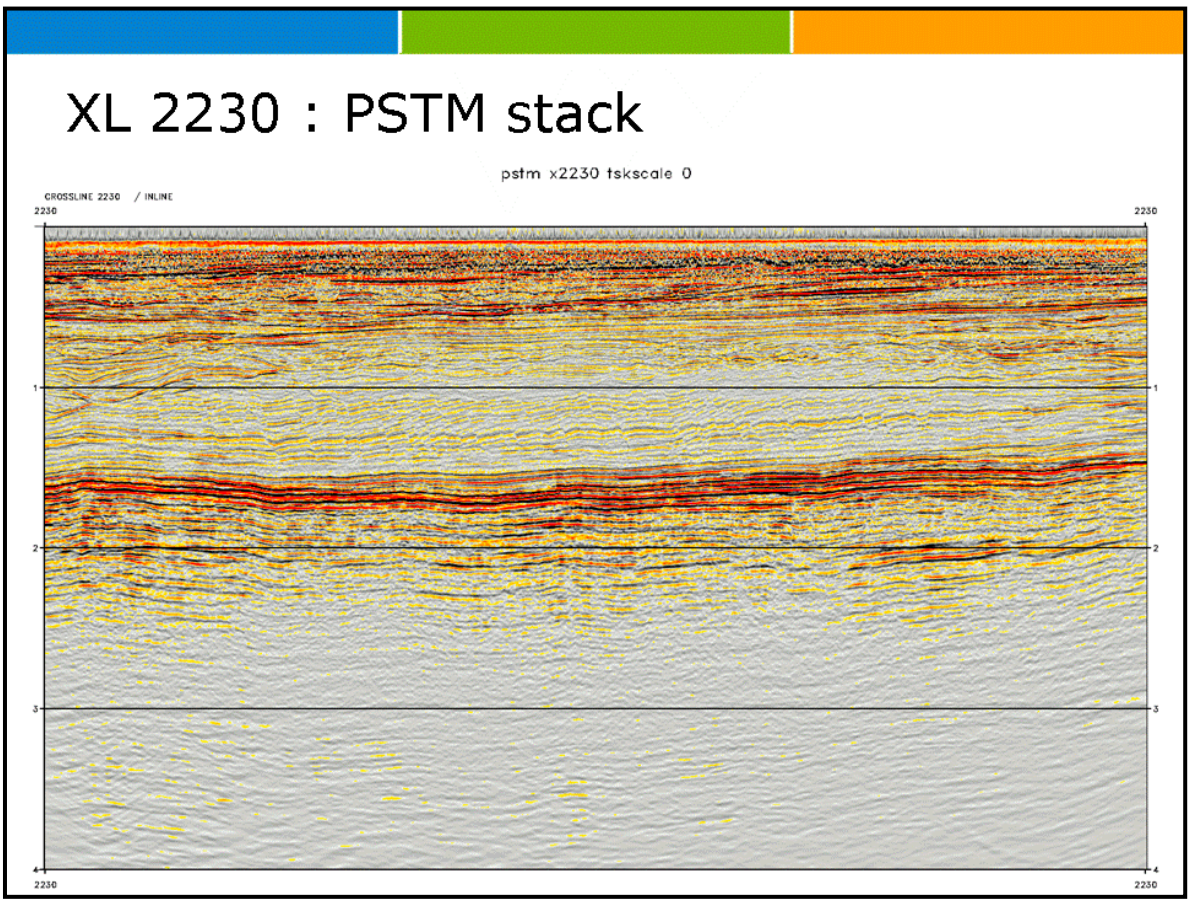
XL 2230 : PSTM stack



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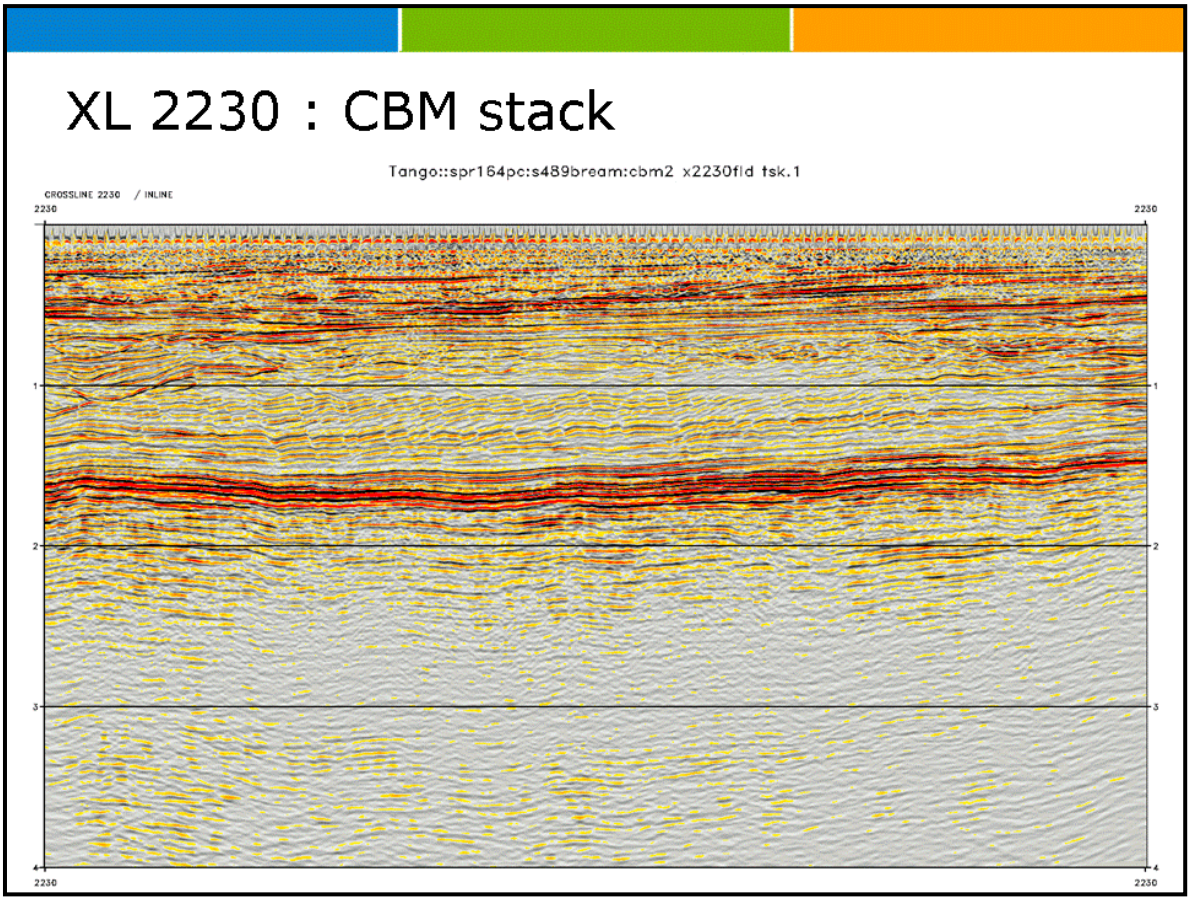

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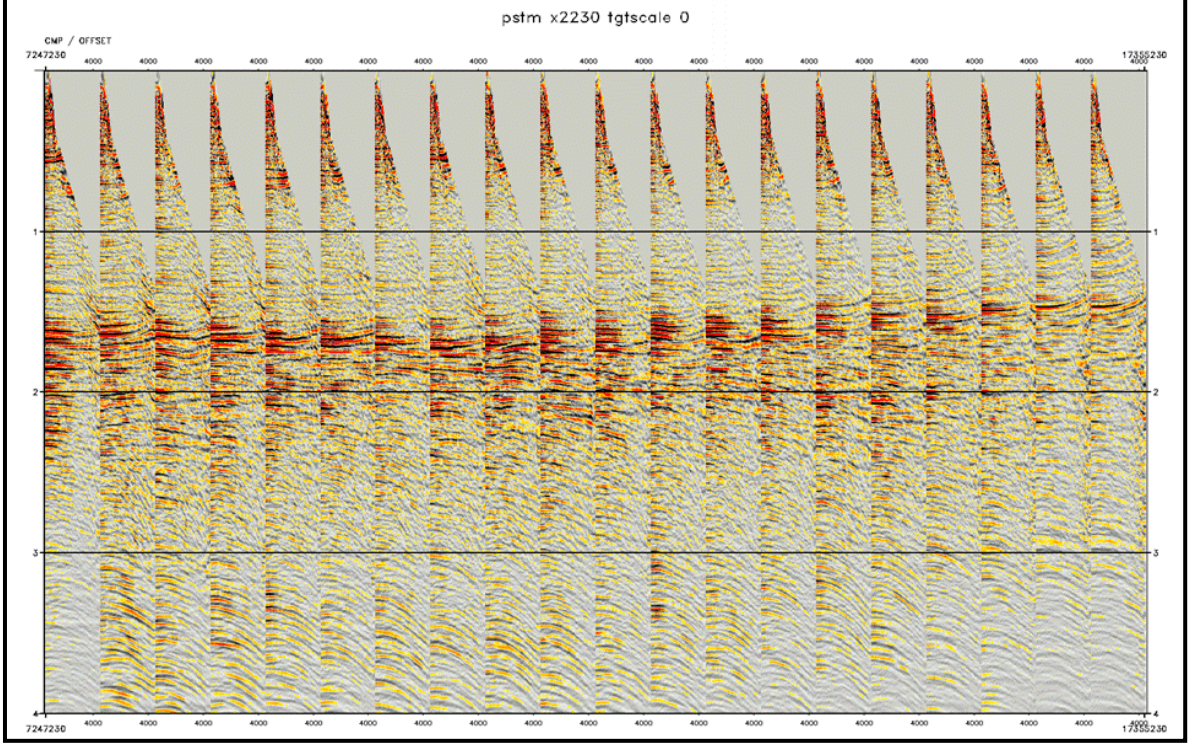

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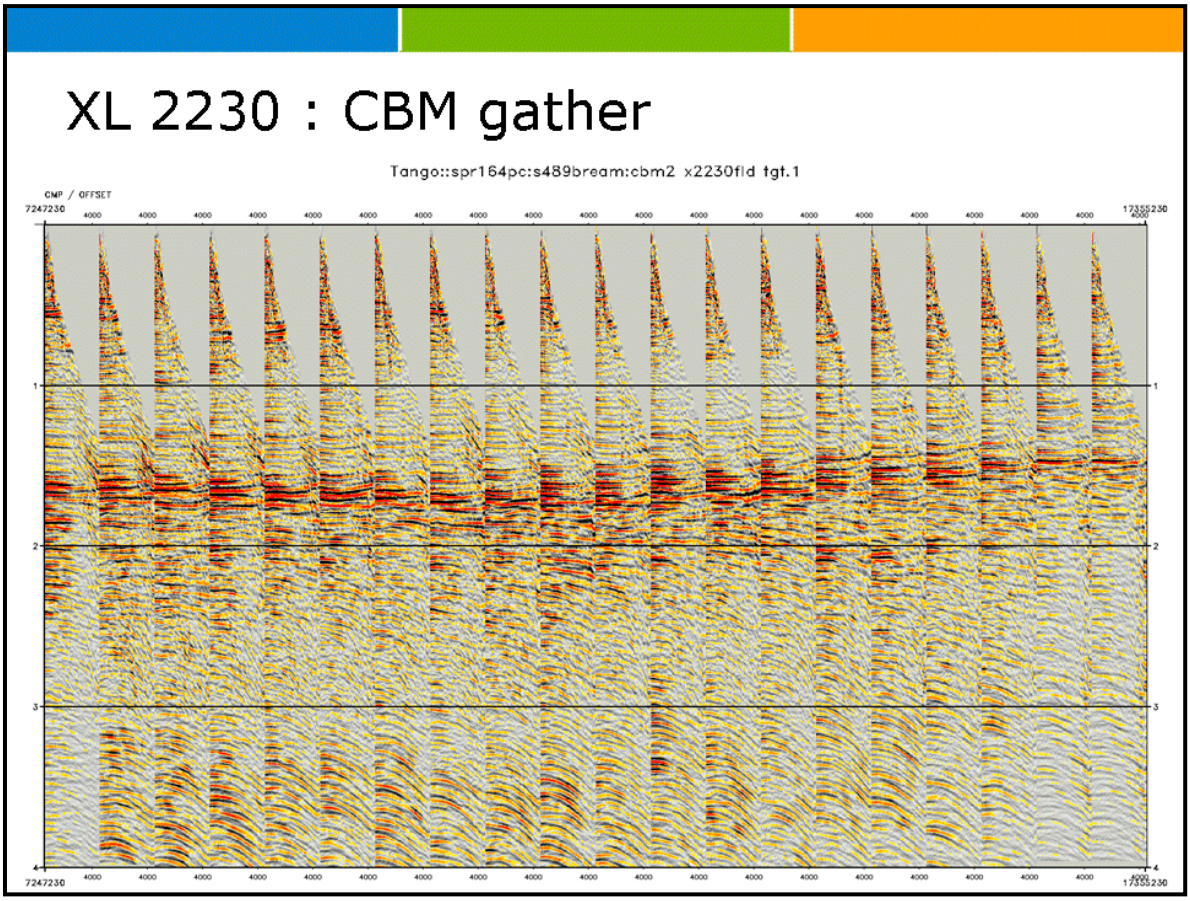

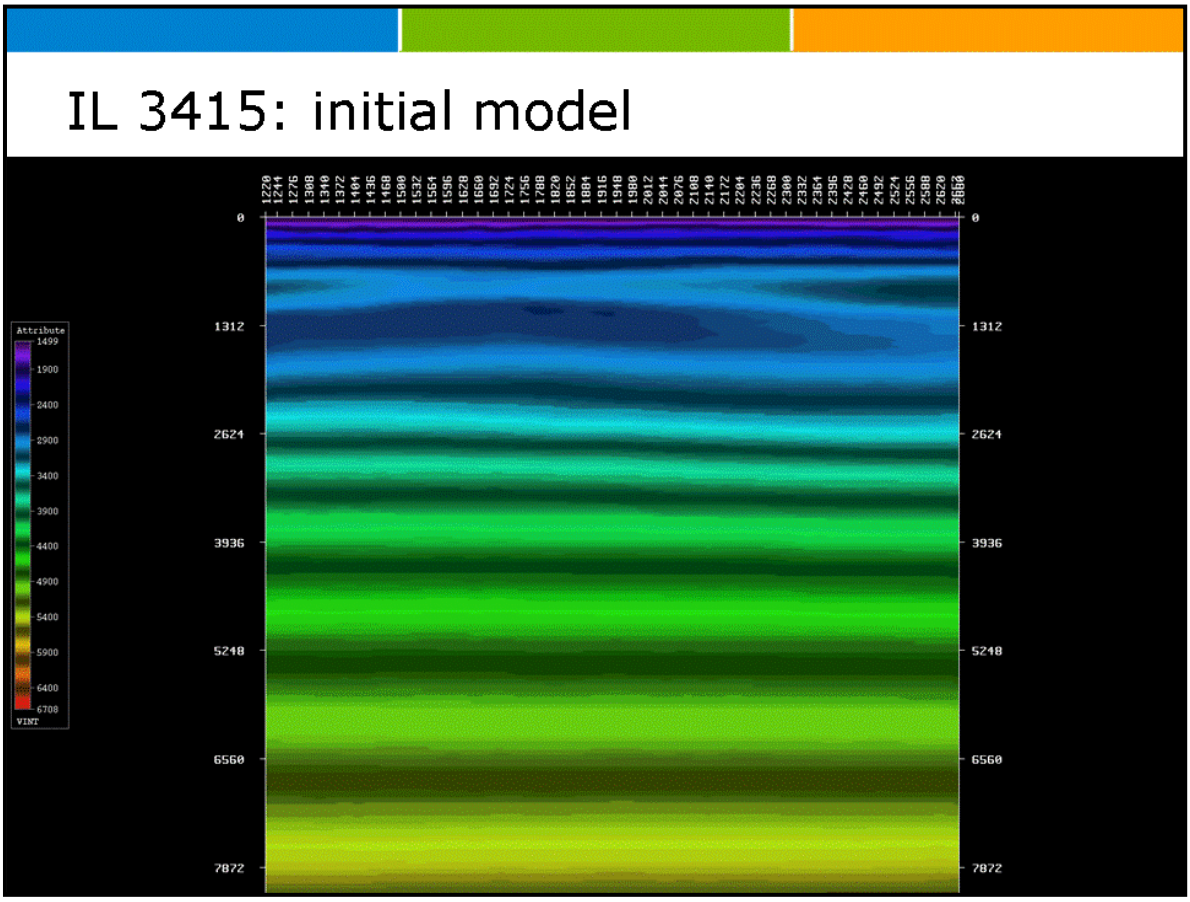
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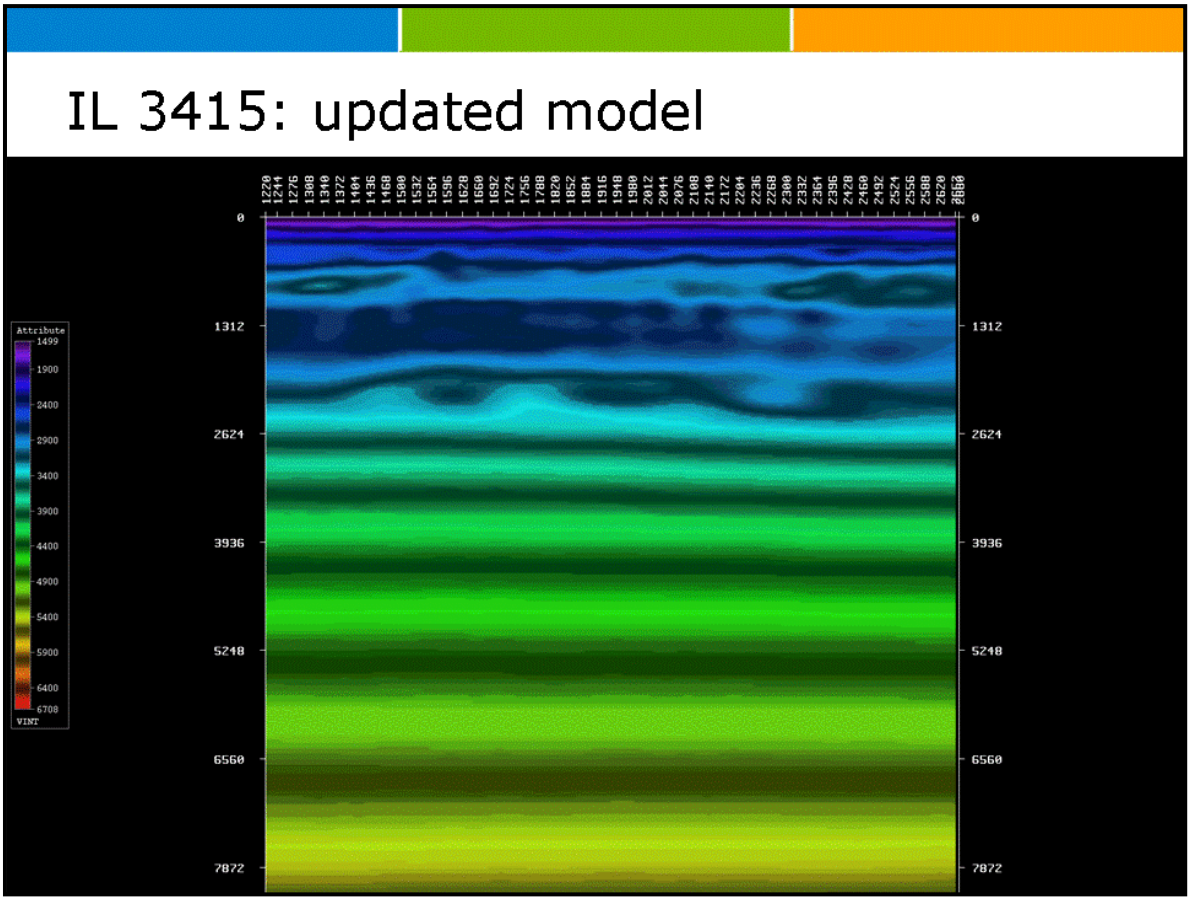
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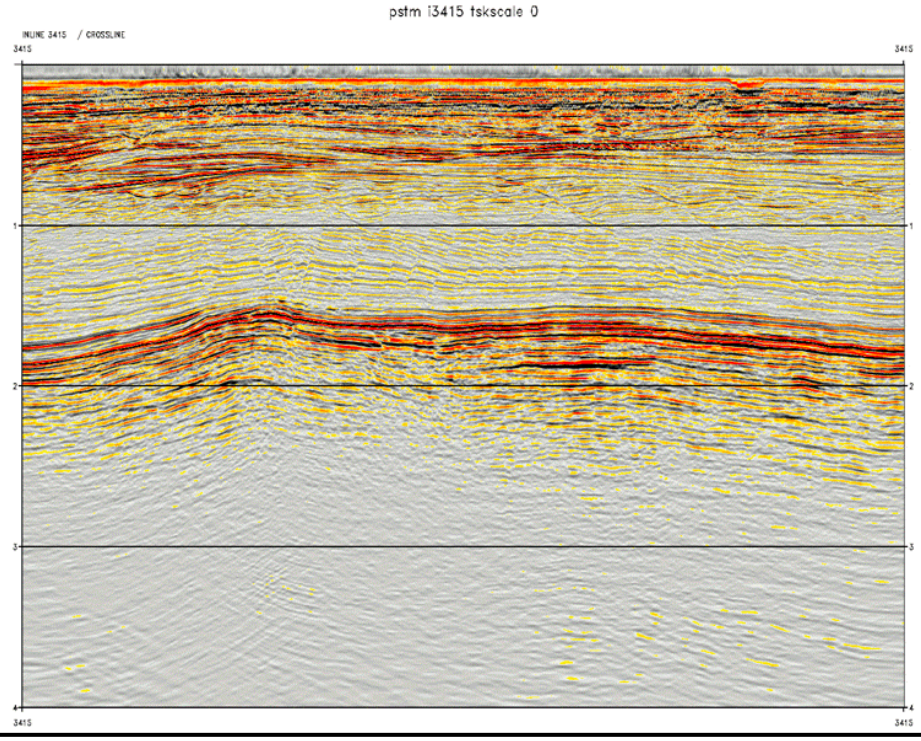
IL 3415: PSTM stack



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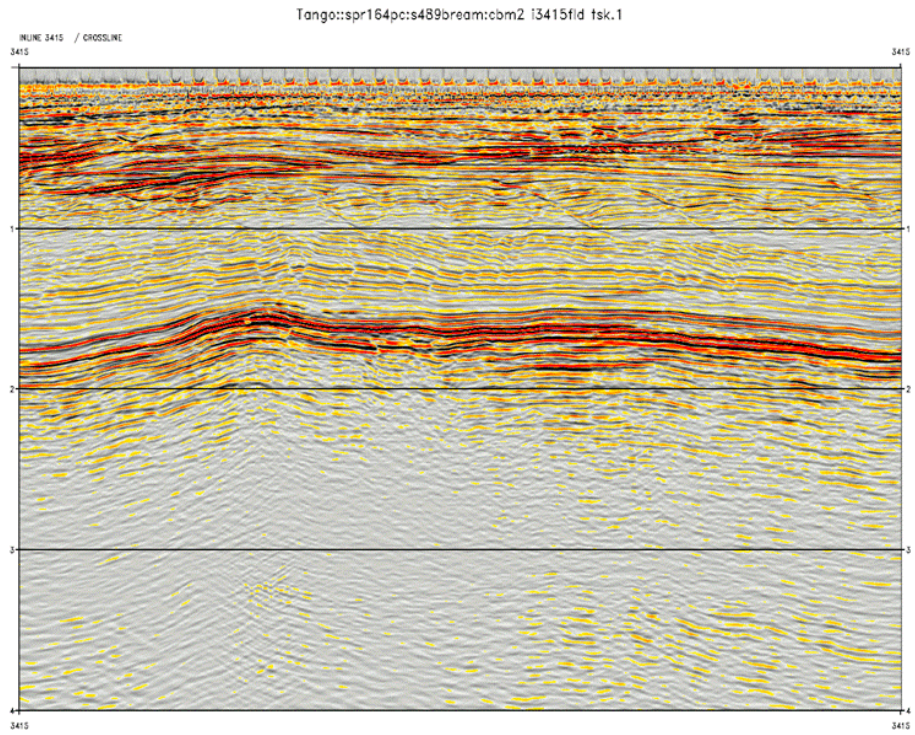

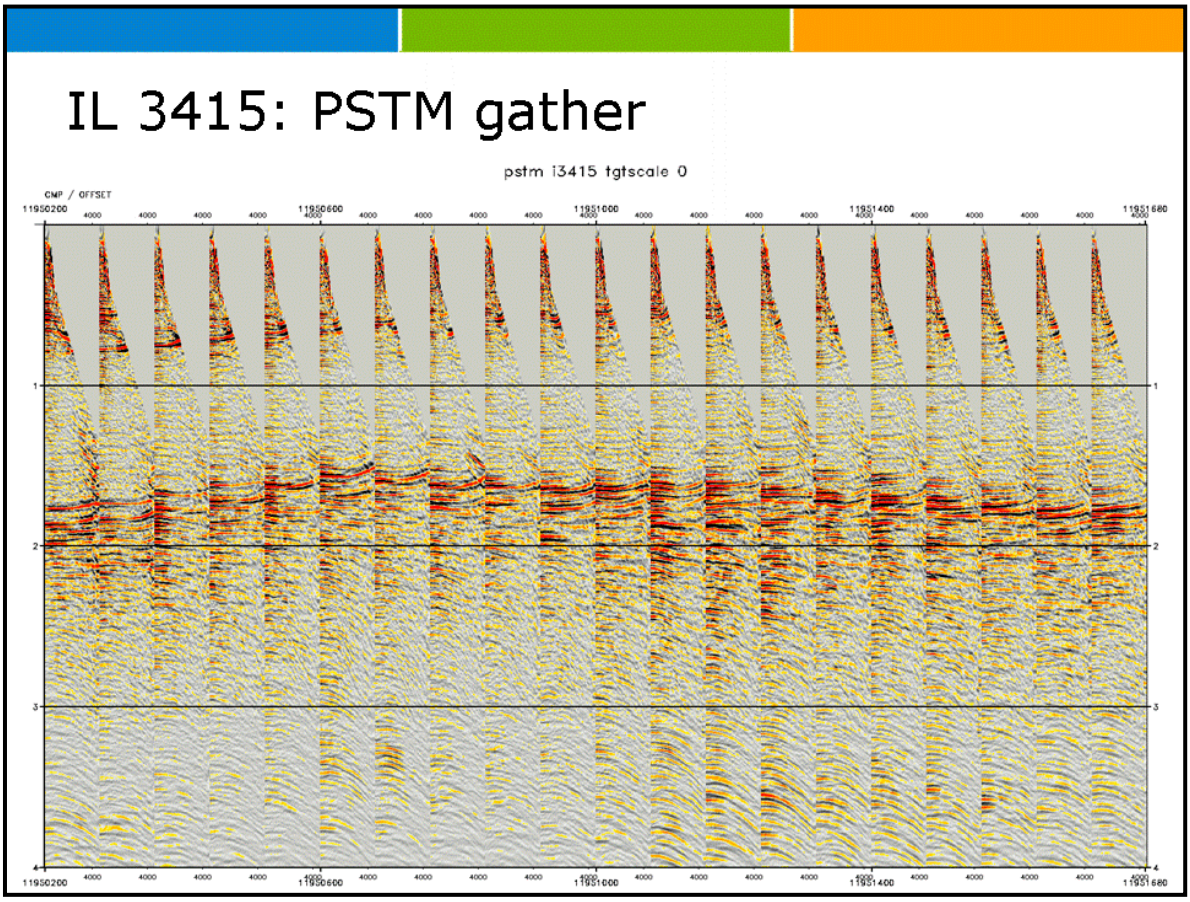
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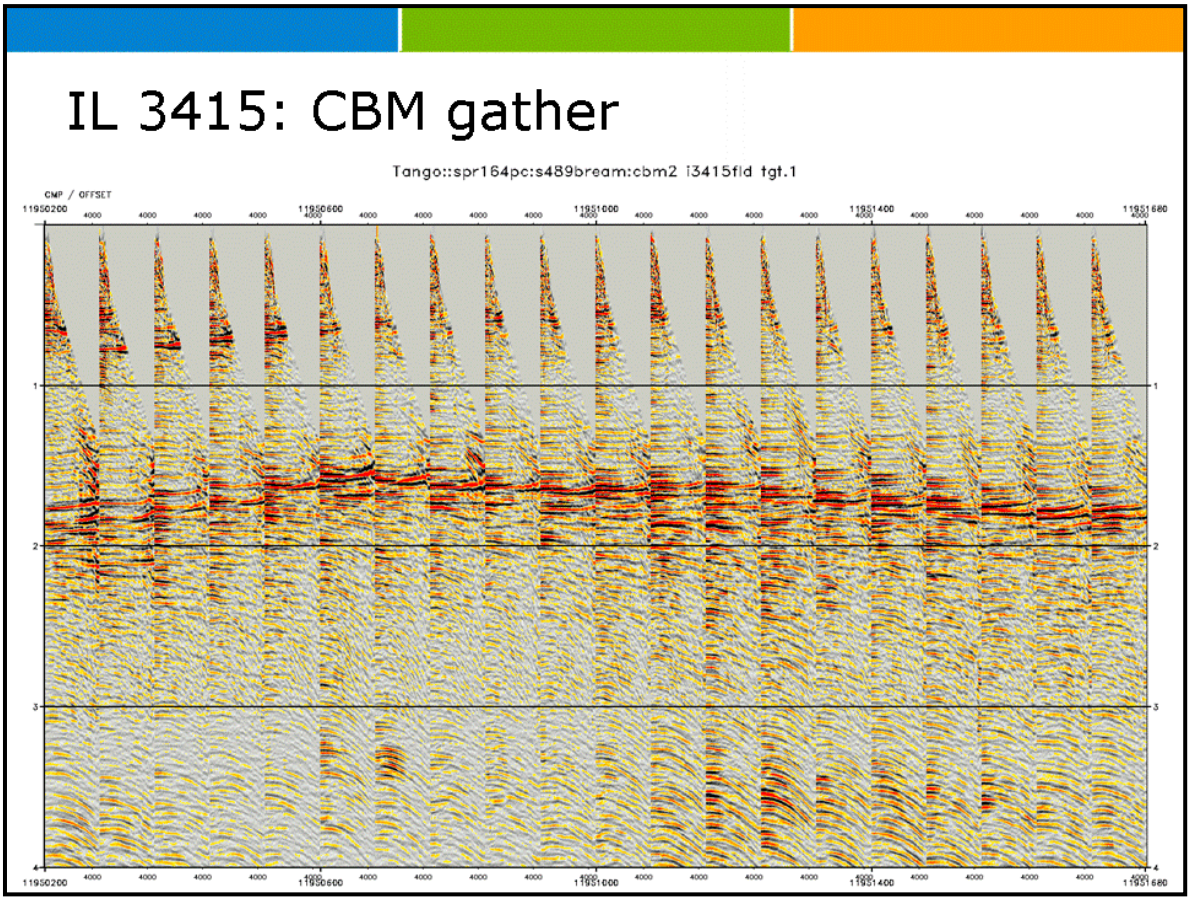
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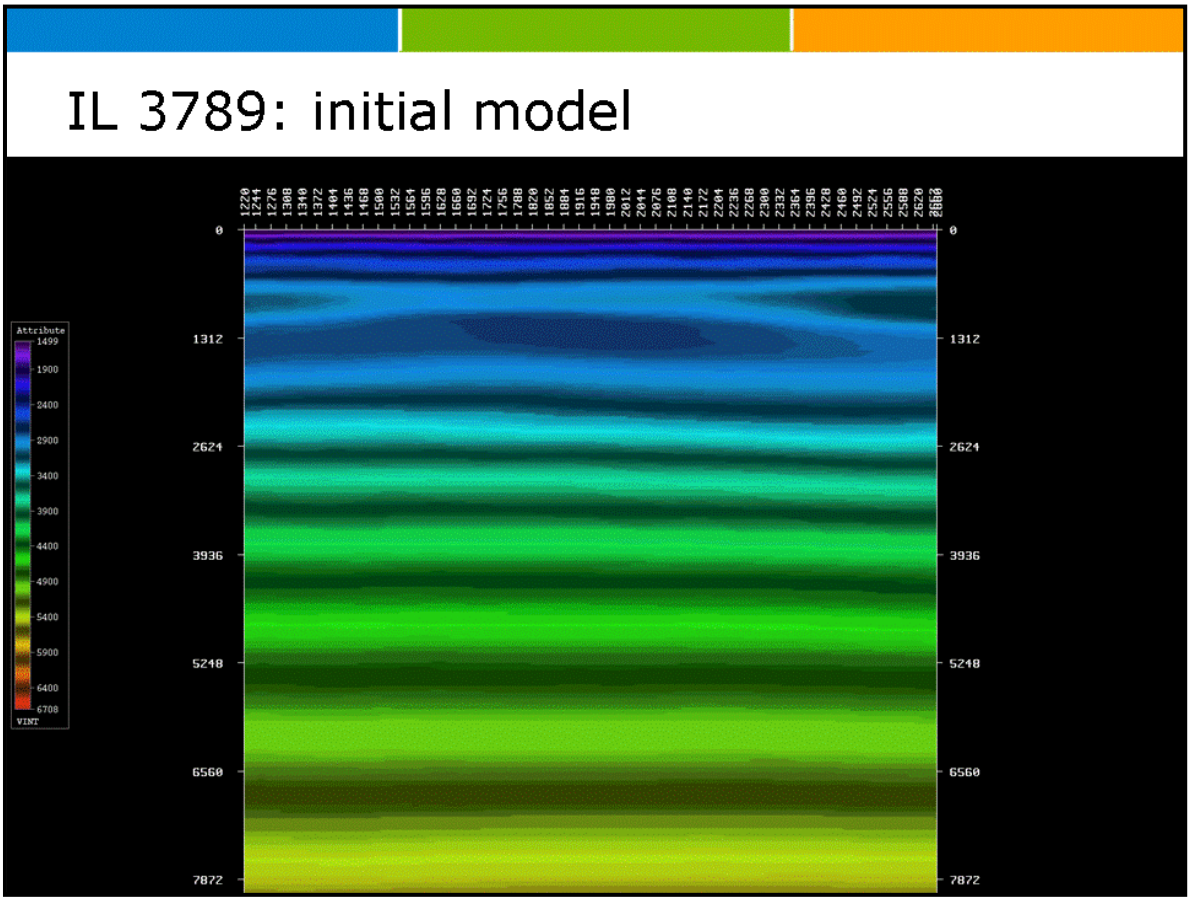
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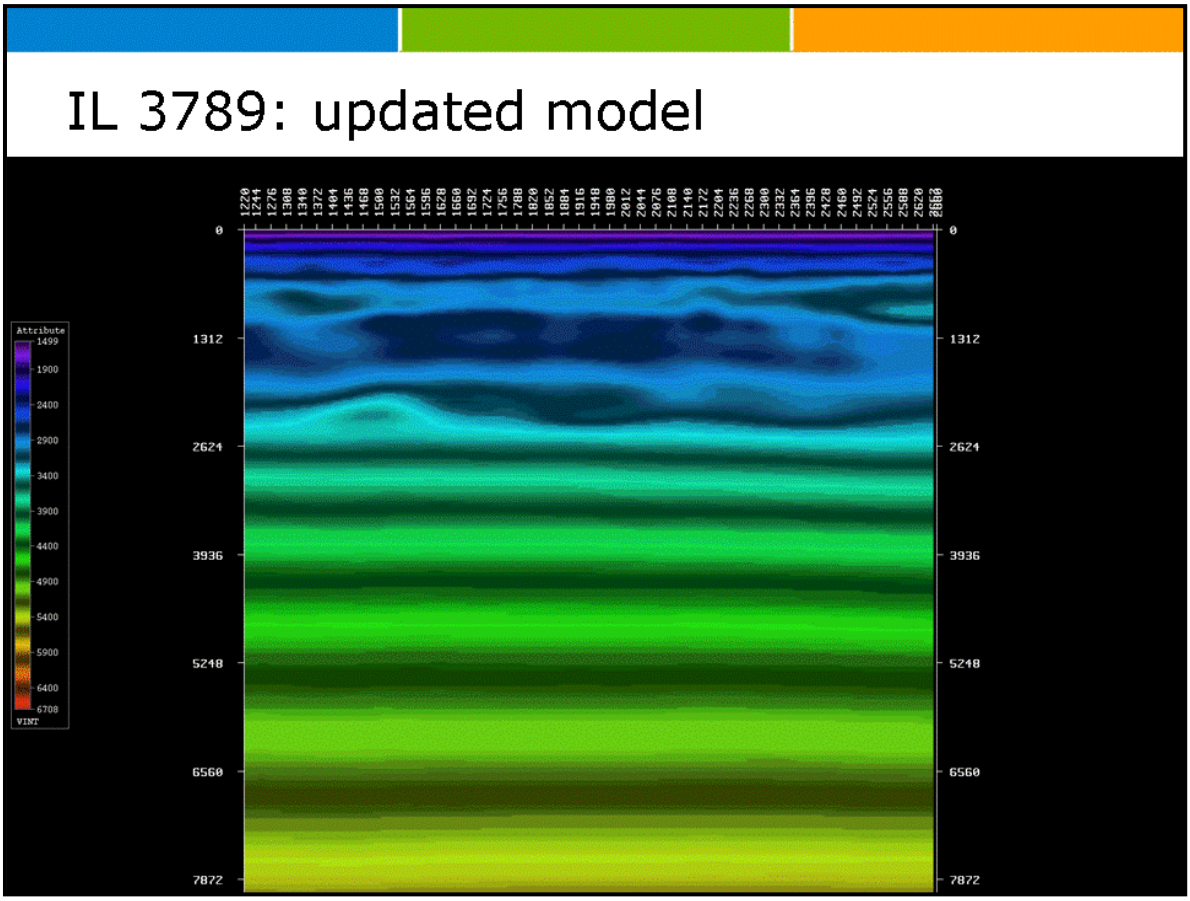
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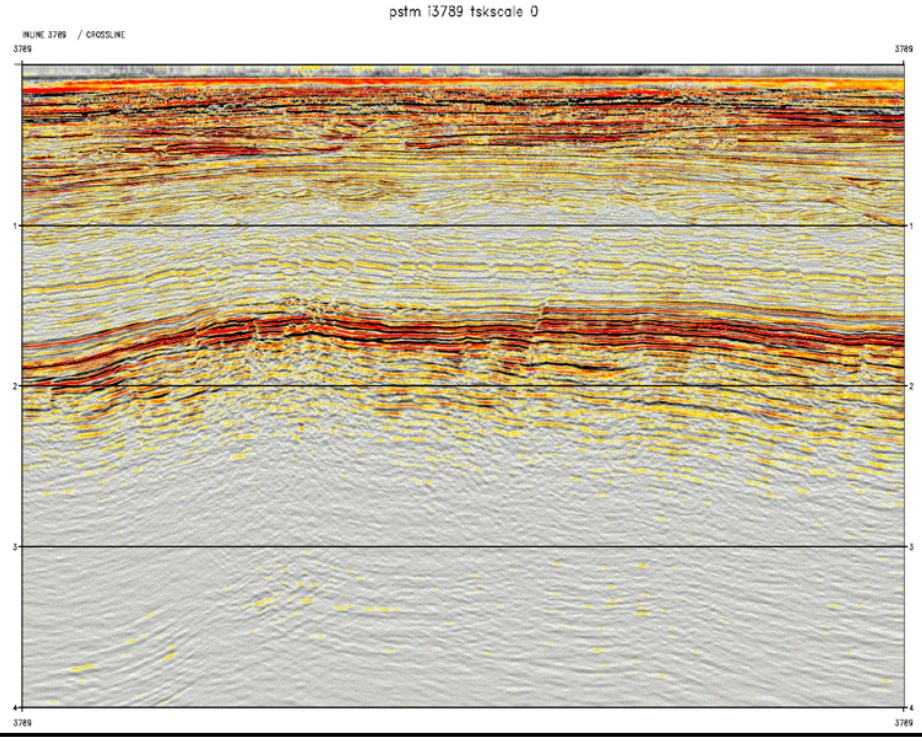
IL 3789: PSTM stack



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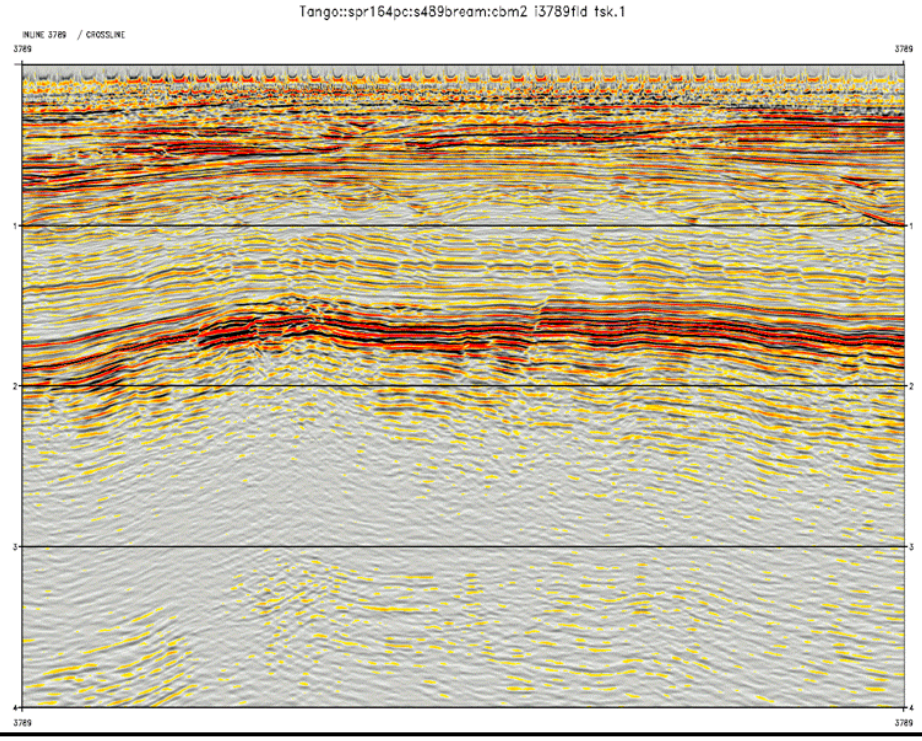

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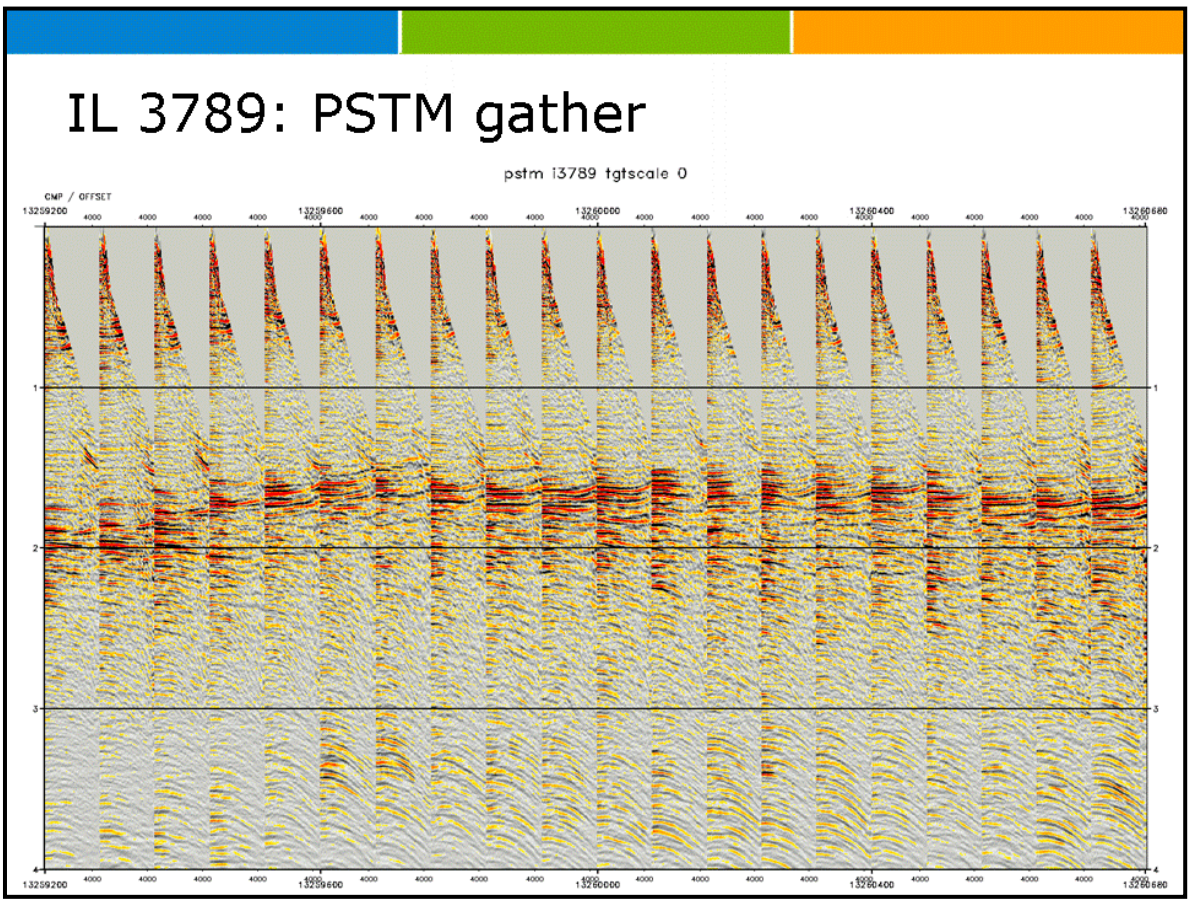

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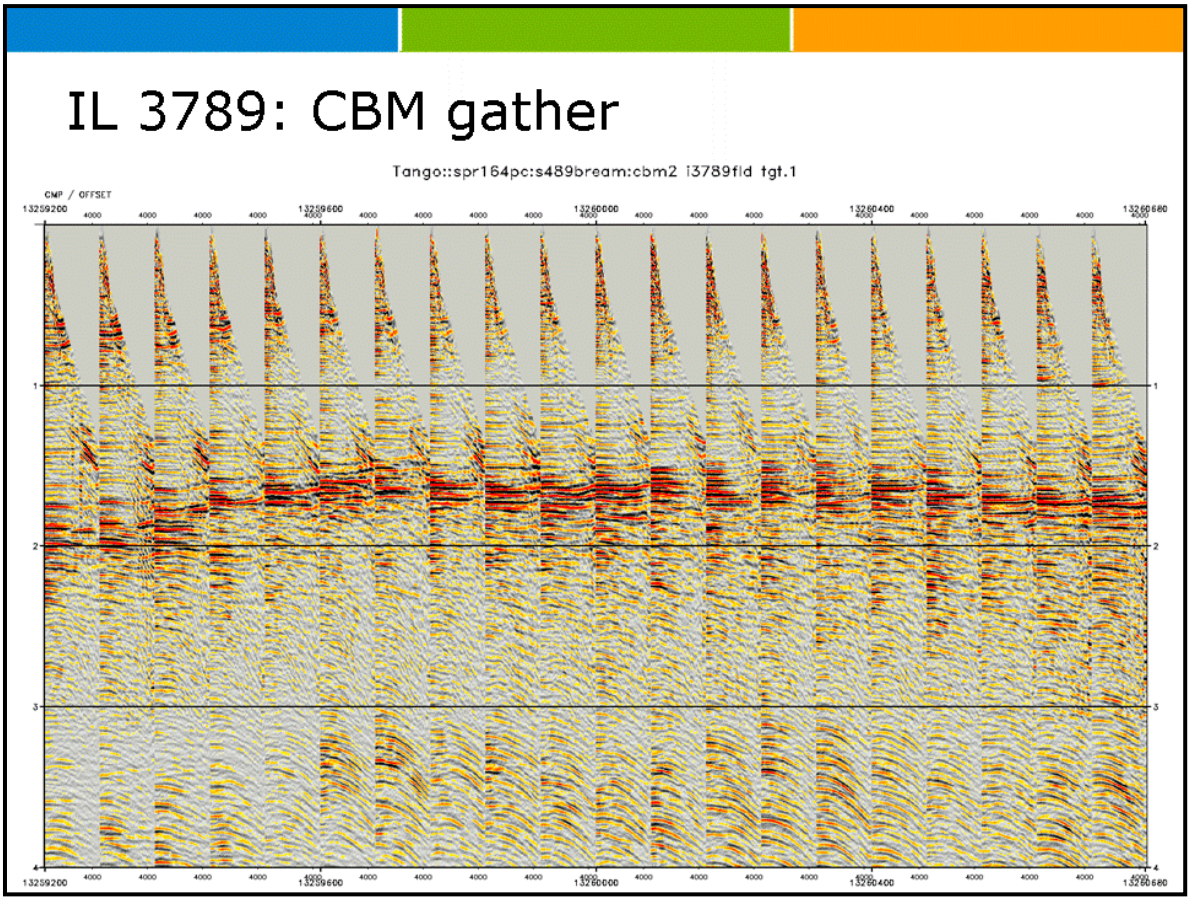

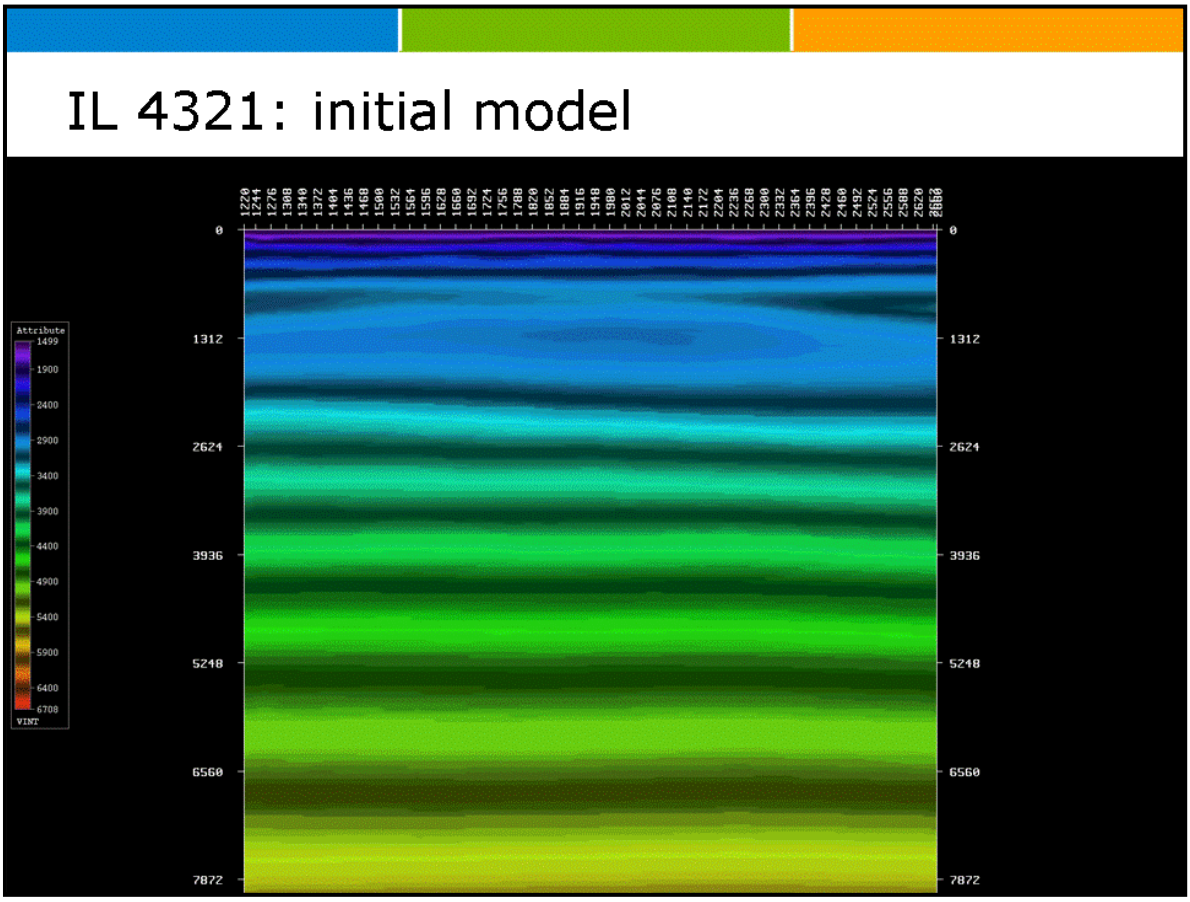
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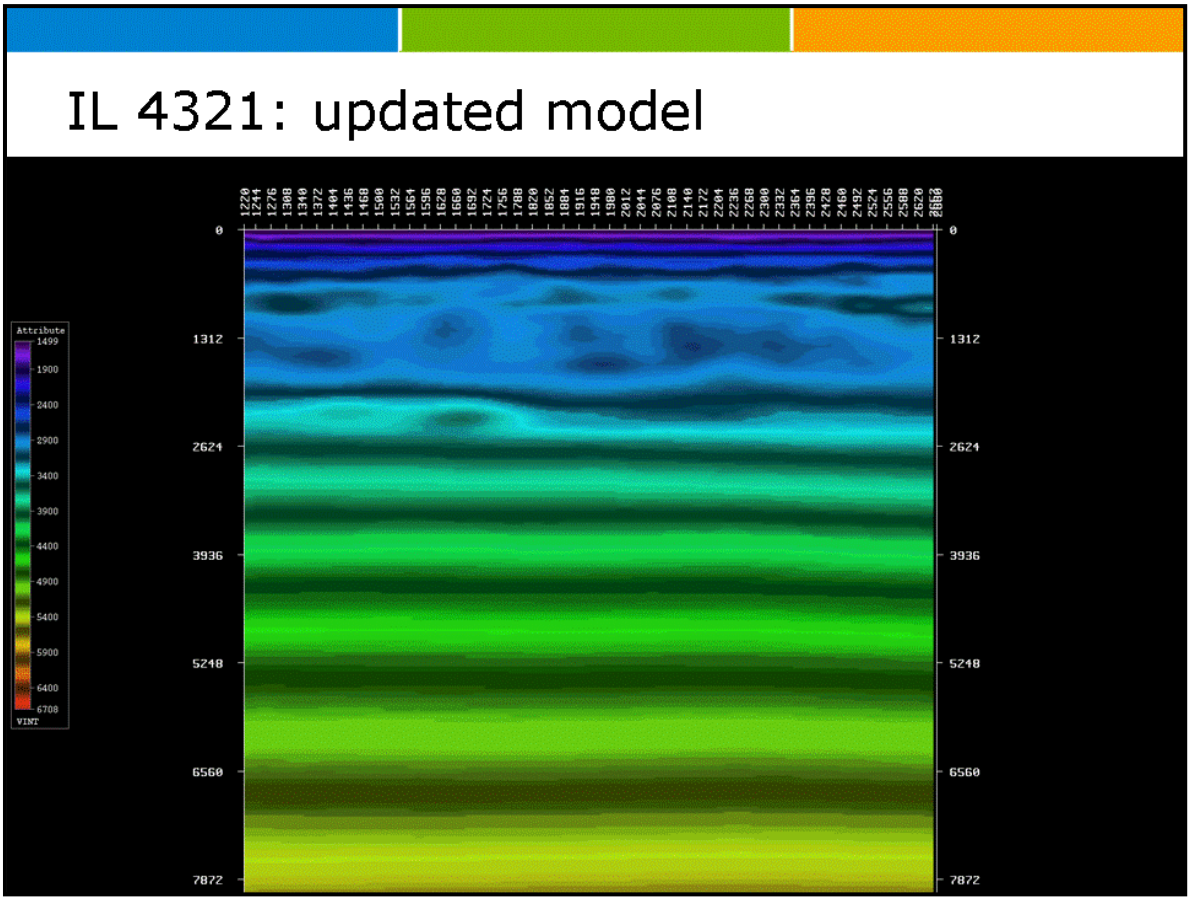
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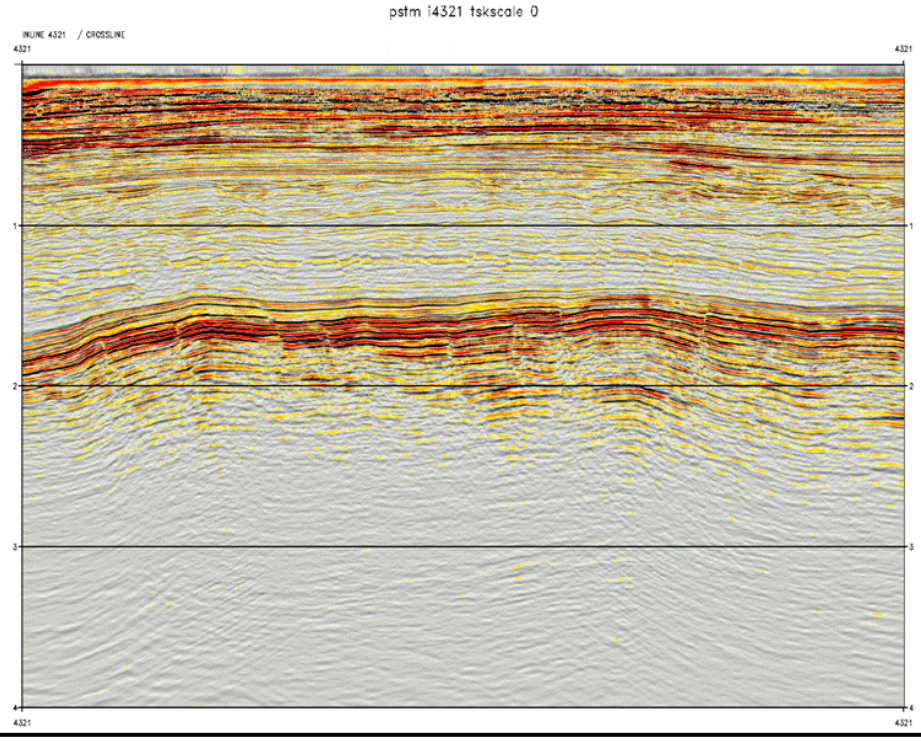
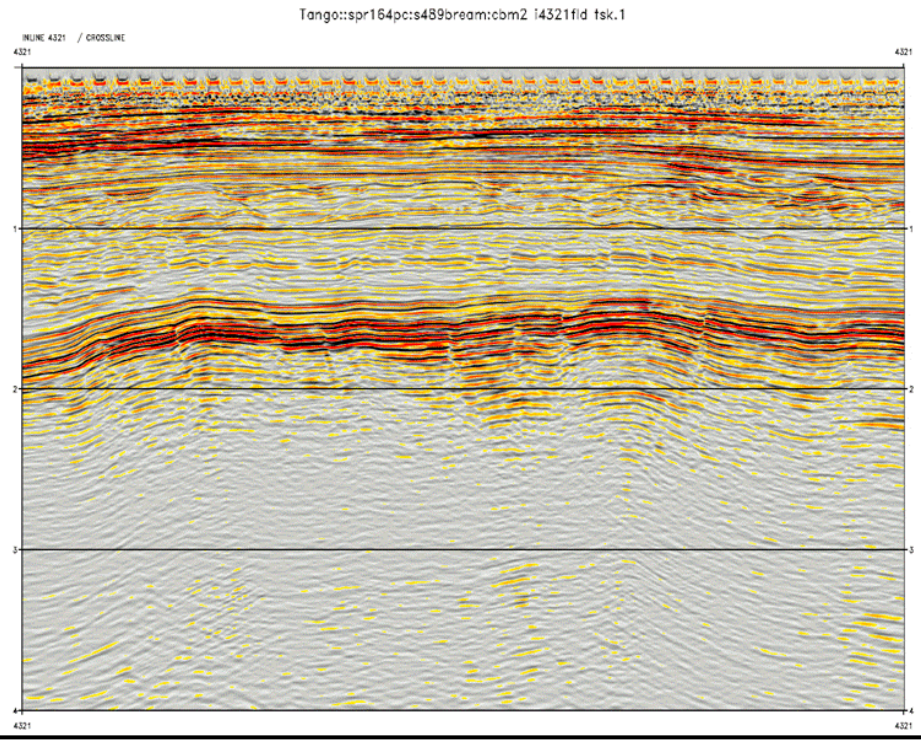
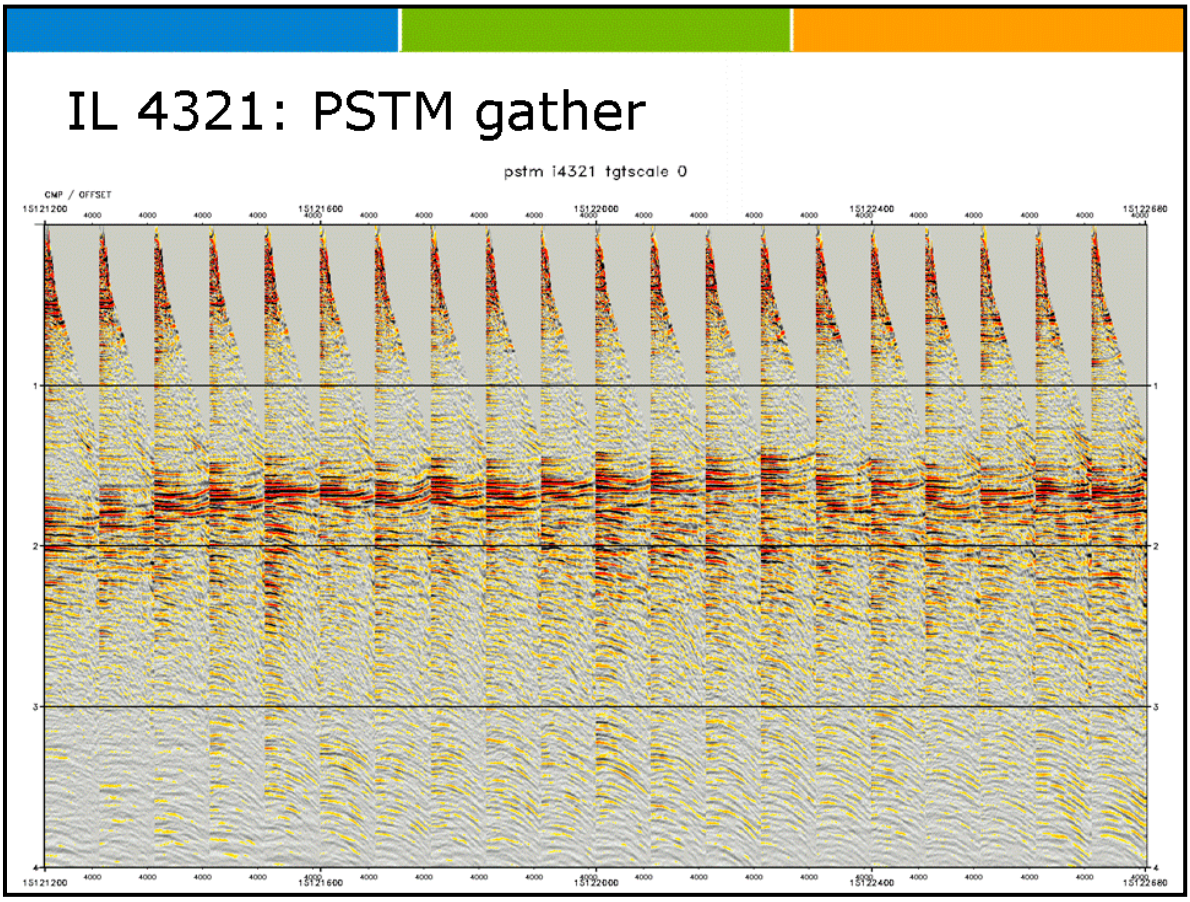
IL 4321: PSTM stack



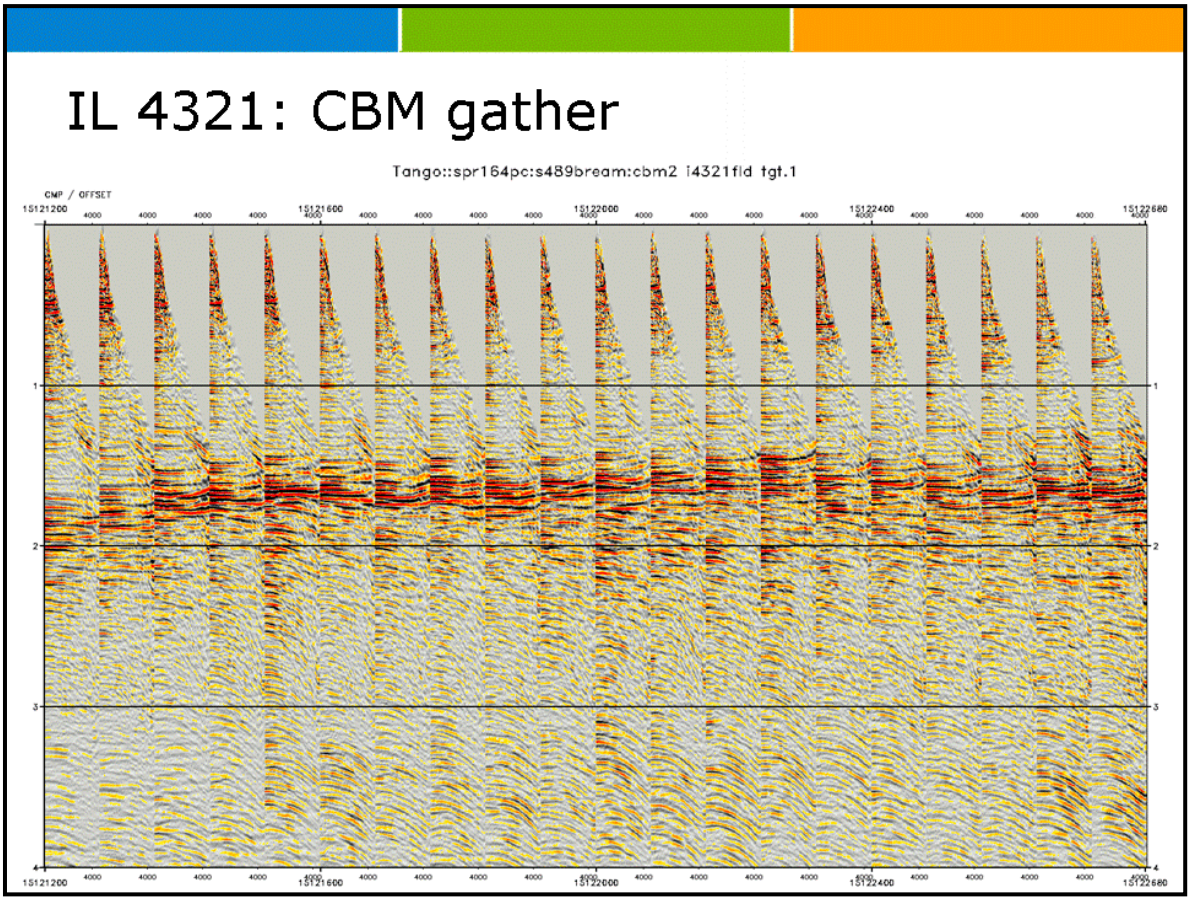
IL 4321: CBM stack



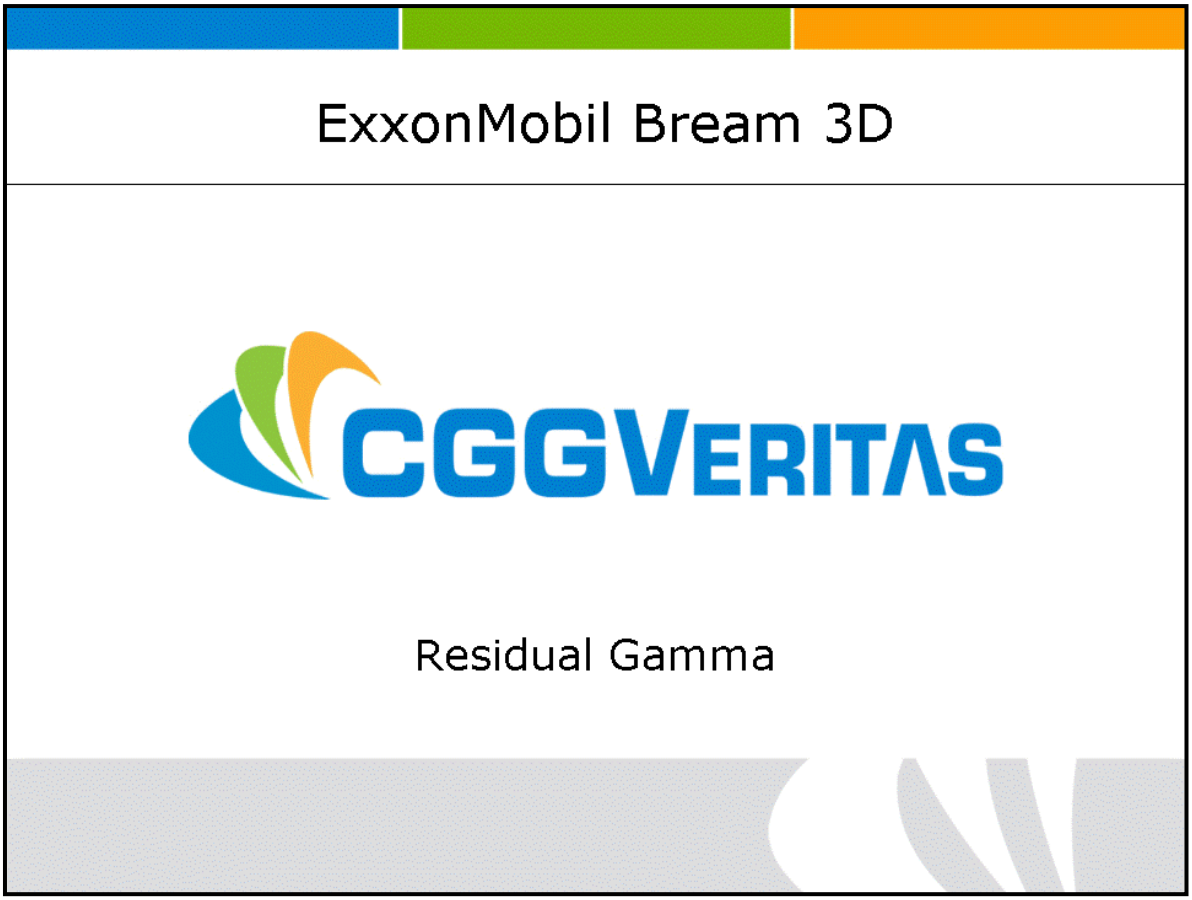
IL 4321: PSTM gather



IL 4321: CBM gather



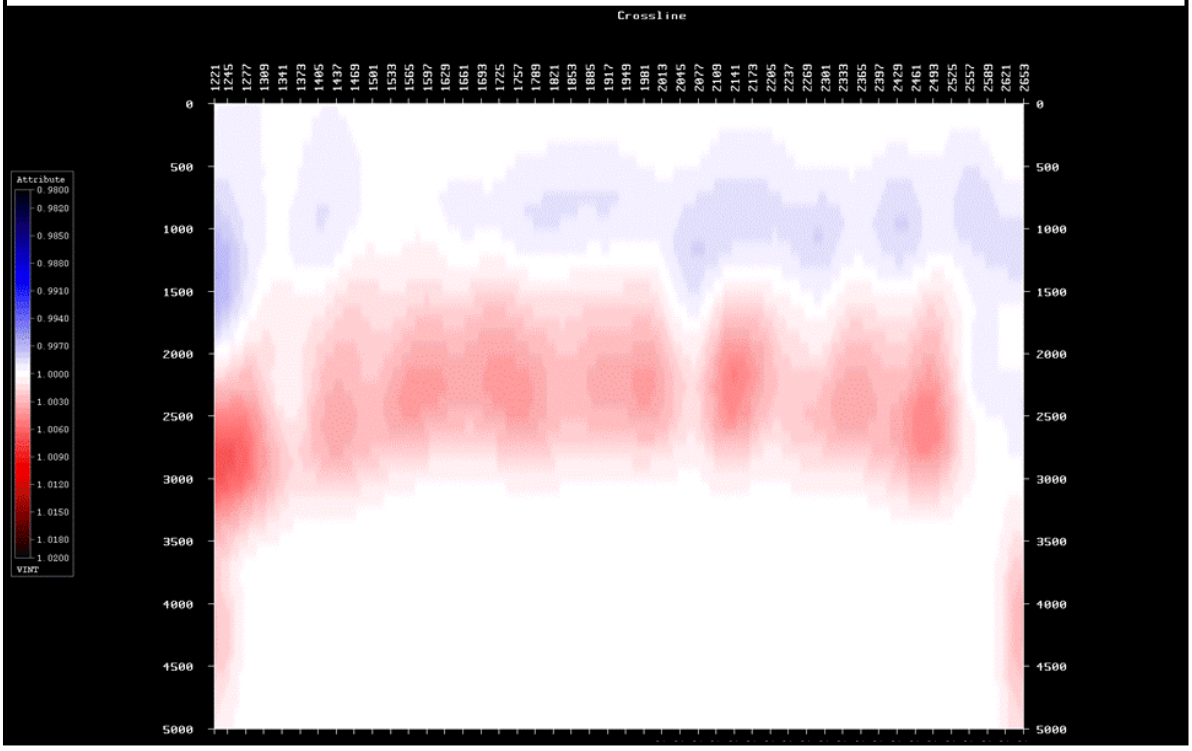
After two iterations of tomographic update, a little bit residual gamma still existed. However, it's limited.

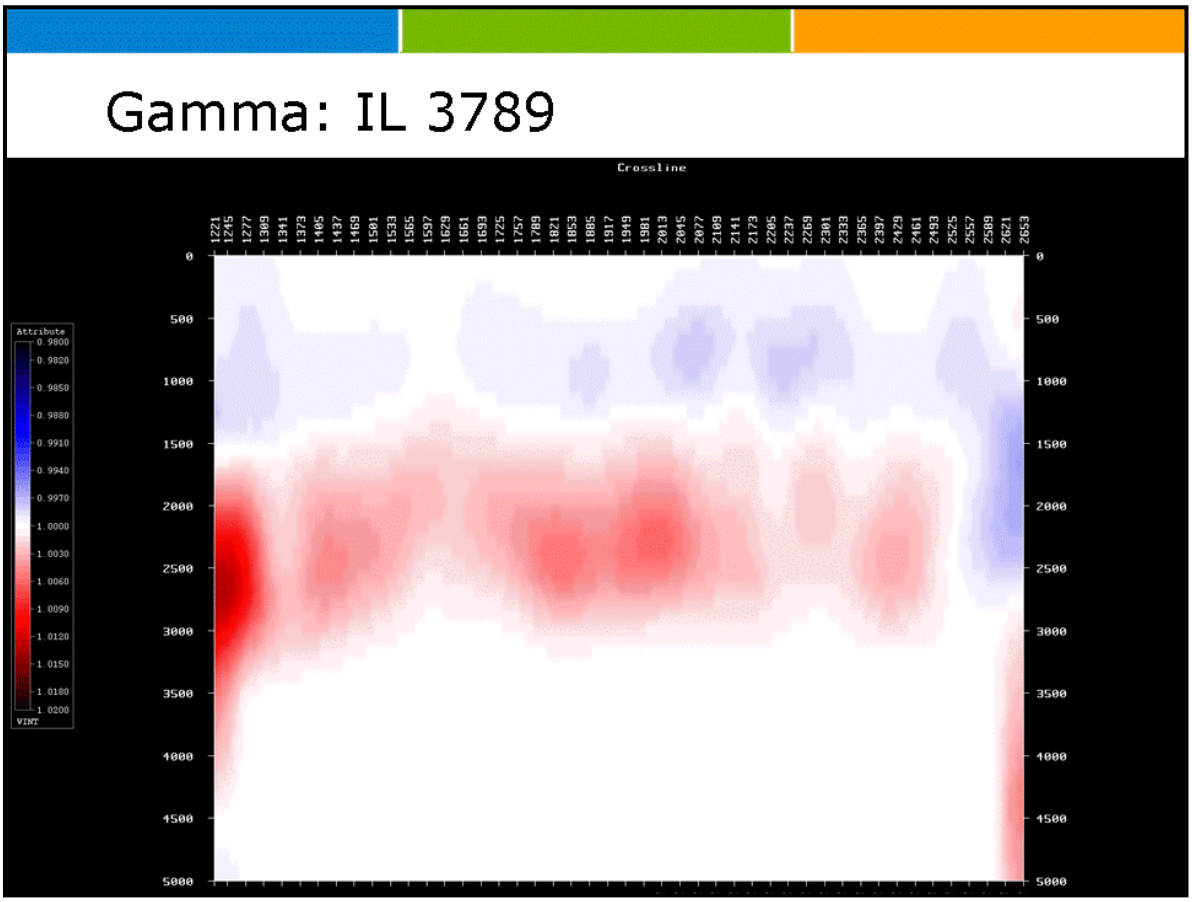


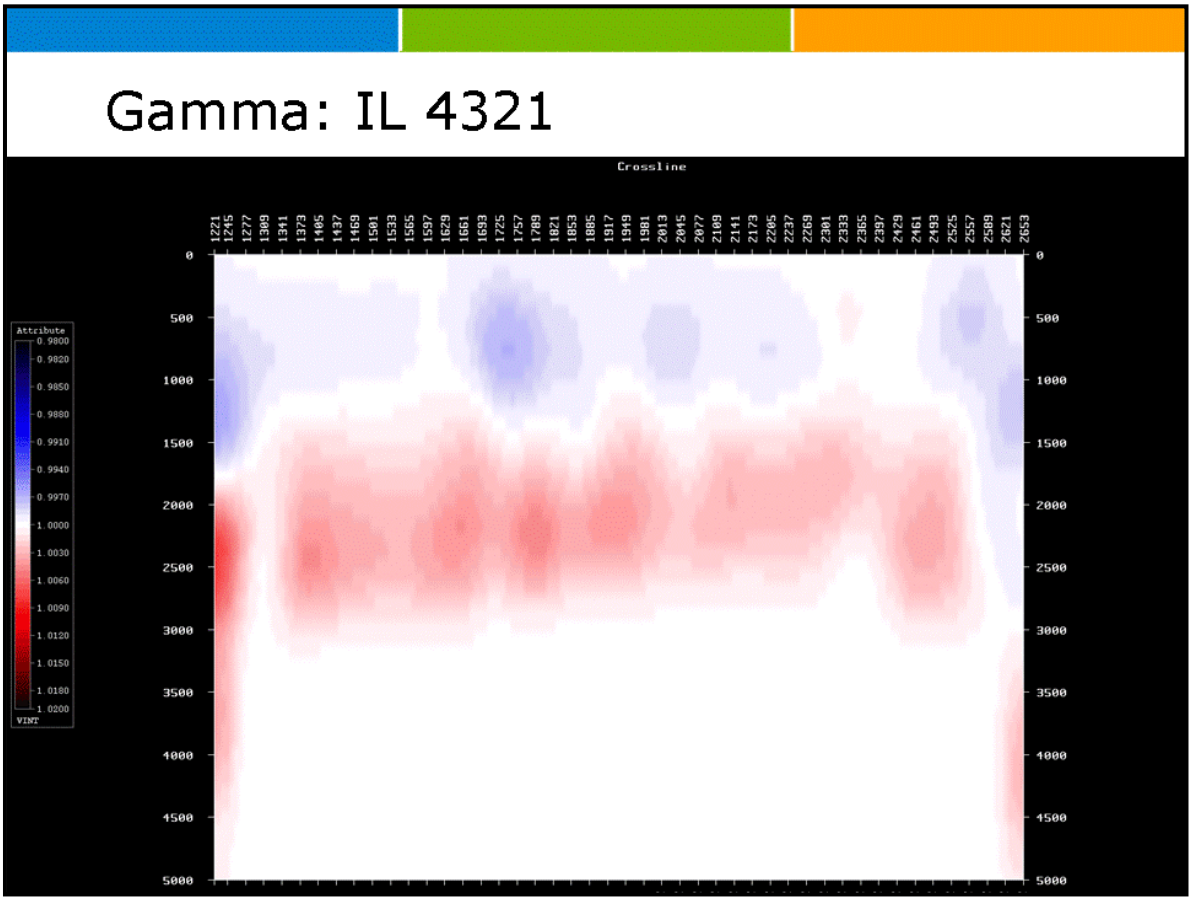
Outline

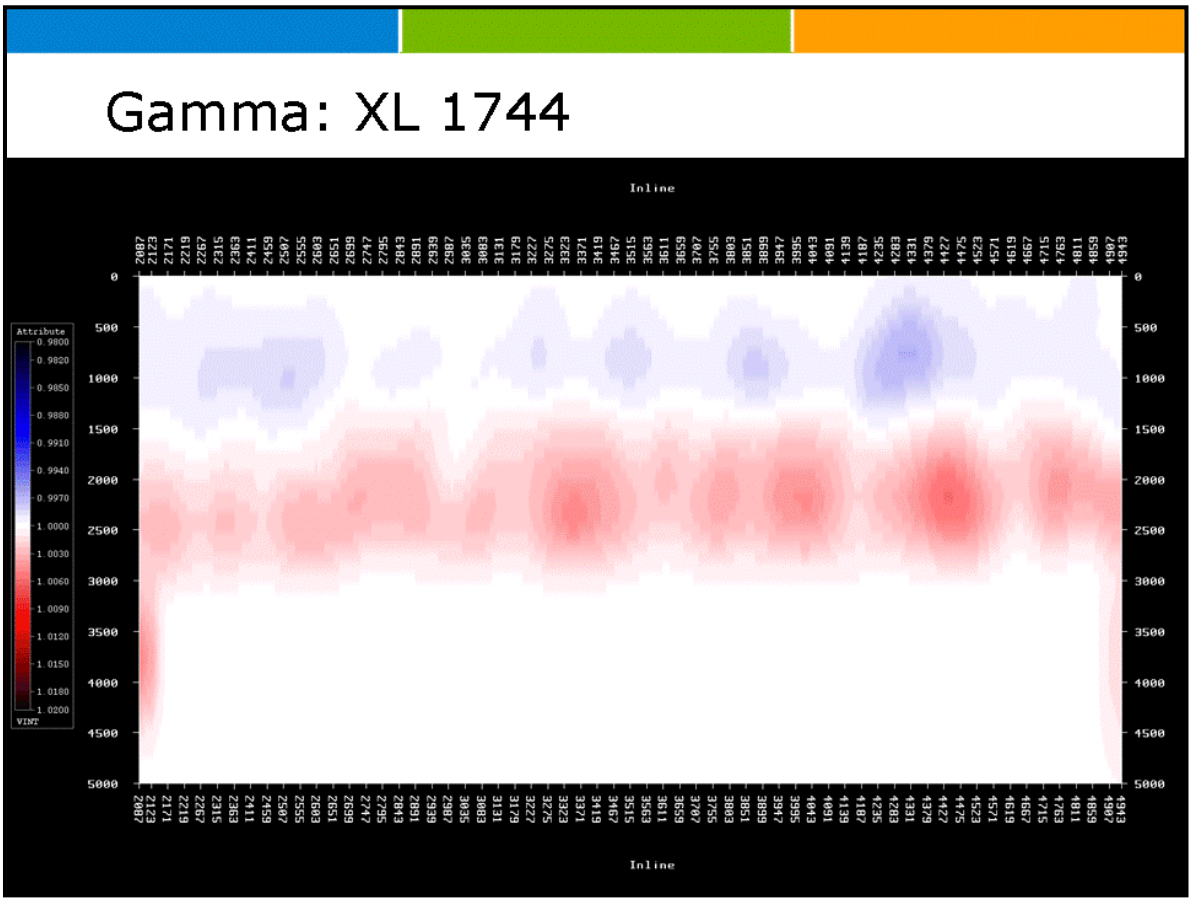
- The residual gamma at IL 3415, IL 3789, IL 4321, XL 1744, XL 2124, XL 2166, XL 2230 displayed
- The residual gamma overall is limited.

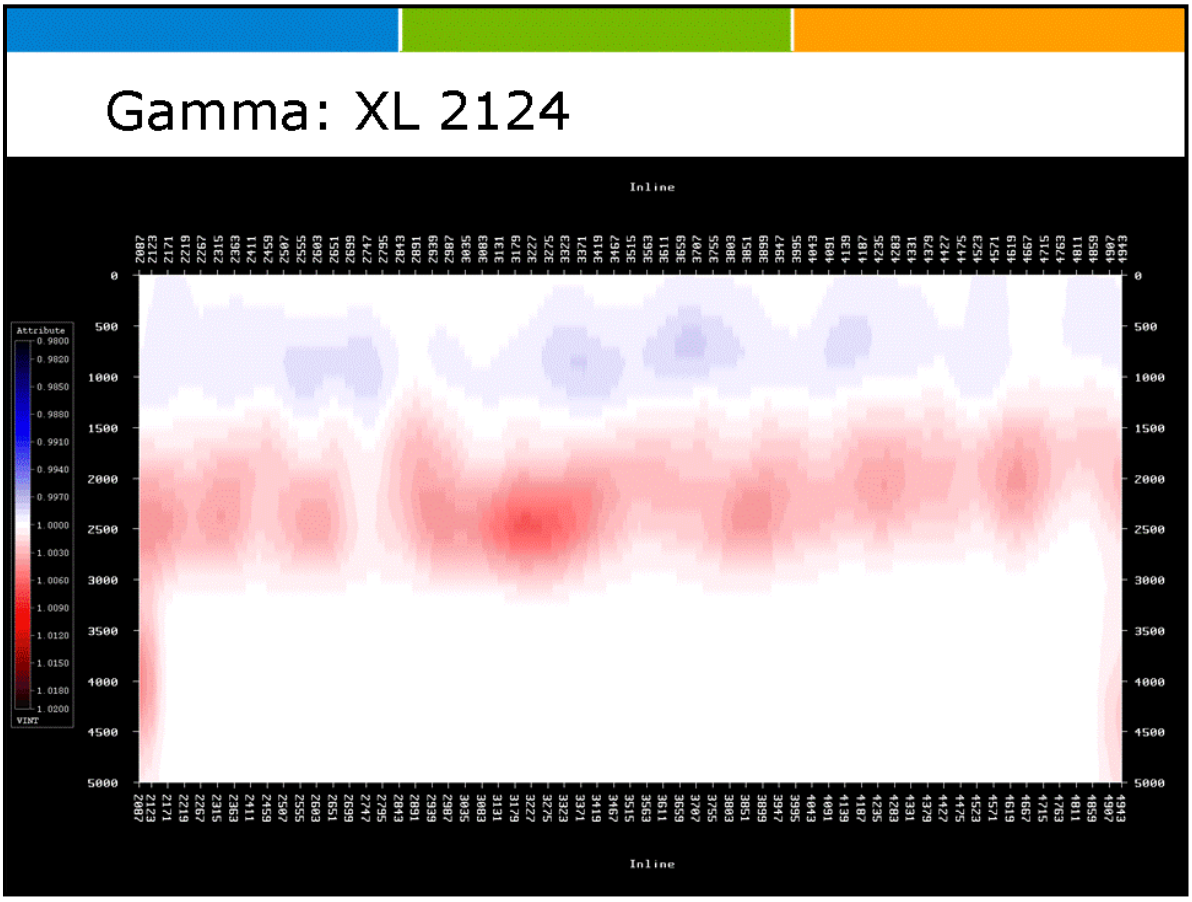
Gamma: IL 3415

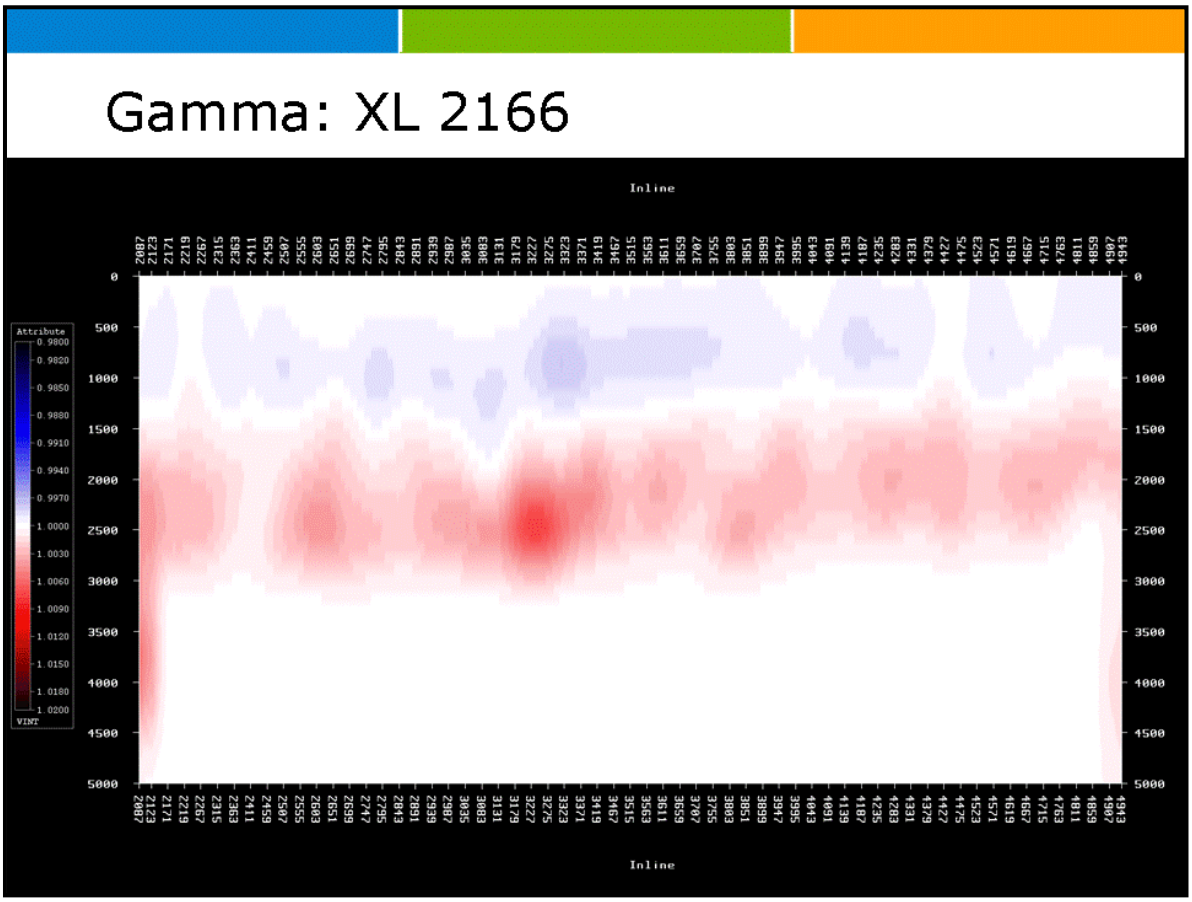


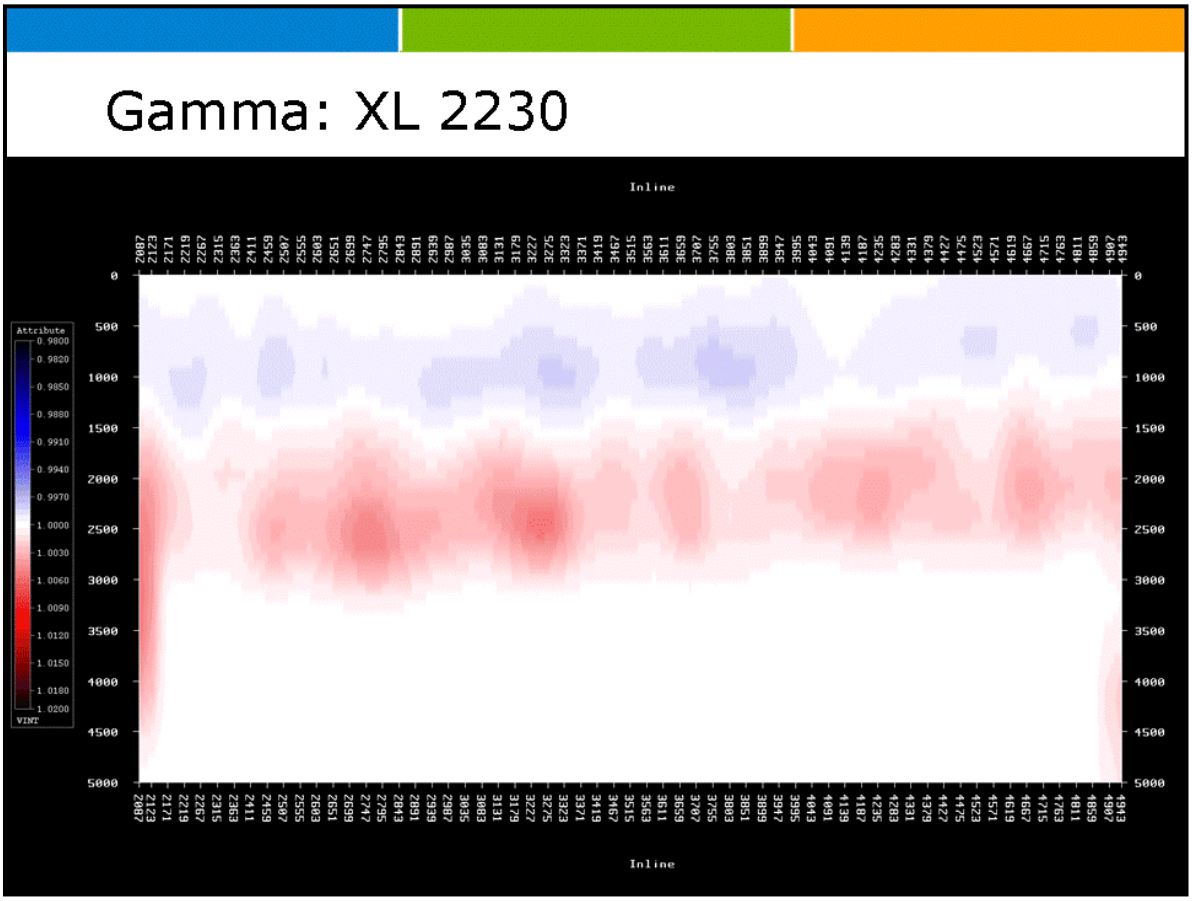

Gamma: IL 3789
Crossline
Attribute
VINT


Gamma: IL 4321
Crossline
Attribute
VINT


Gamma: XL 1744
Inline
Attribute
VINT
Inline


Gamma: XL 2124
Inline
Attribute
VINT
Inline


Gamma: XL 2166
Inline
Attribute
VINT
Inline


Gamma: XL 2230
Inline
Attribute
VINT
Inline

2.4 INPUT DATA

Input data come from the same input cube as PSTM (Please refer to Section 3.2.14 on page 10 of ***BREAM_REPORT***). We shift the data up 6ms in order to correct the time shift caused by the designation filter (14ms shift up) and SSD (8ms shift down). The final velocity model was also shifted up 6ms to match the data.

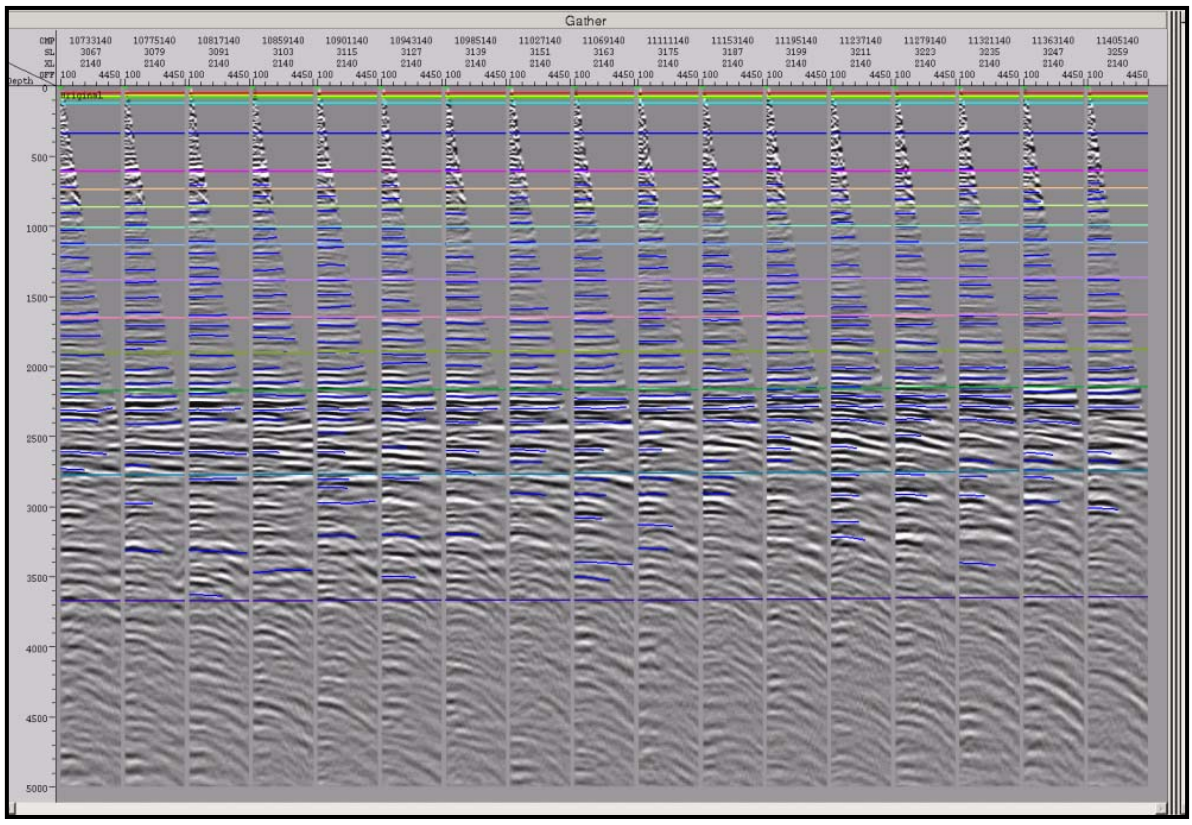
2.5 3D TOMOGRAPHY

RCA tomography was used to update velocities by analyzing residual curvature and structural dip values, and then globally determining the velocity perturbation along appropriate ray-paths required to reduce the curvatures. The model output from 1st iteration RCA was checked against the input initial velocity model to make sure that update was correct. The model output from the 2nd iteration RCA was also checked against the model output from 1st iteration RCA.

RCA tomography parameter:

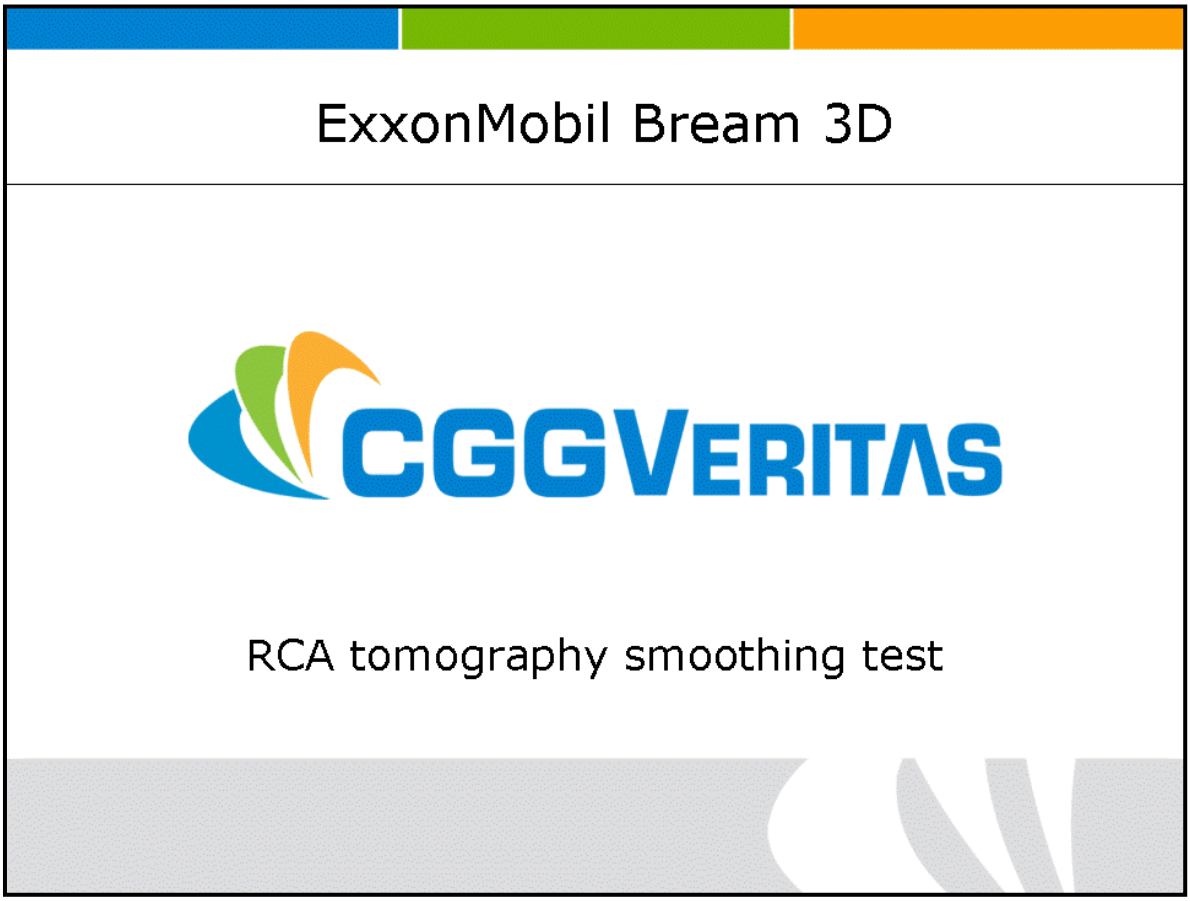
Migration input CMP grid for the tomographic update: 25x18.75m
Ray tracing grid: 100x112.5m
Velocity grid: 100x112.5x20m
CIG grid: 100x112.5m

The residual curvatures were picked on the Common Image Gathers (CIG). Below is the example showing the pick density.



Smoothing was required to regulate velocity update in RCA. The smoothing parameters were tested.

1500m smoothing was chosen.

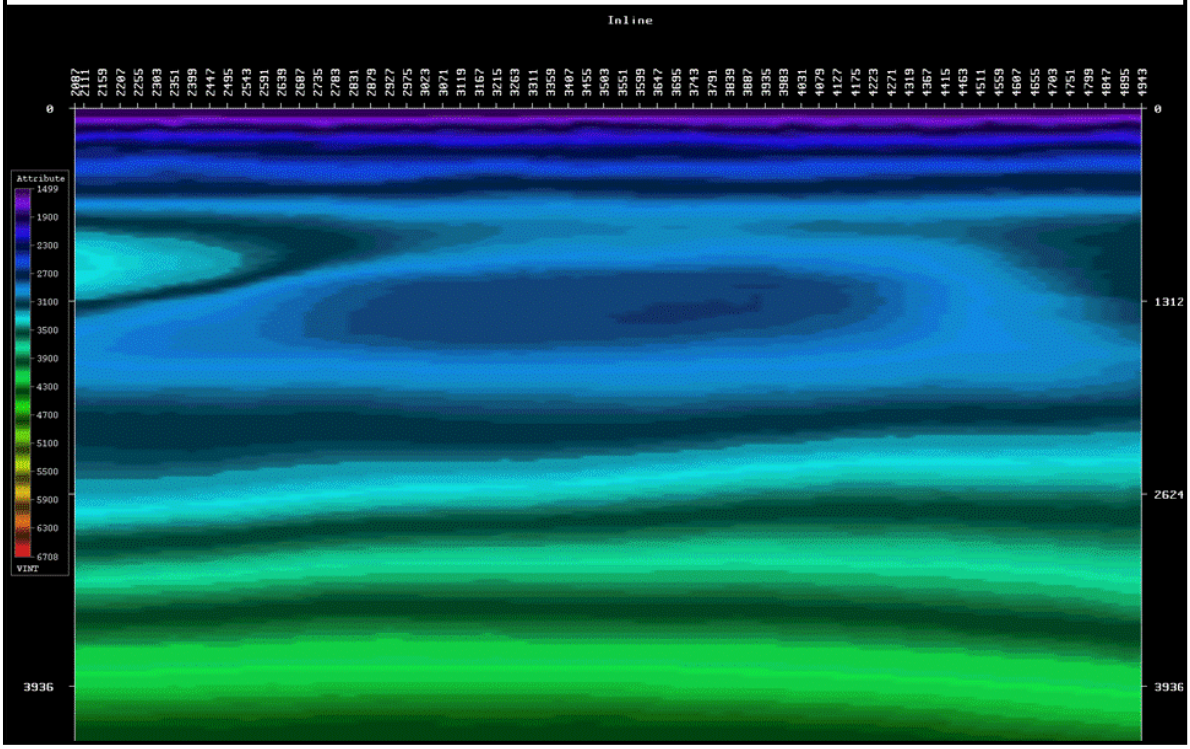


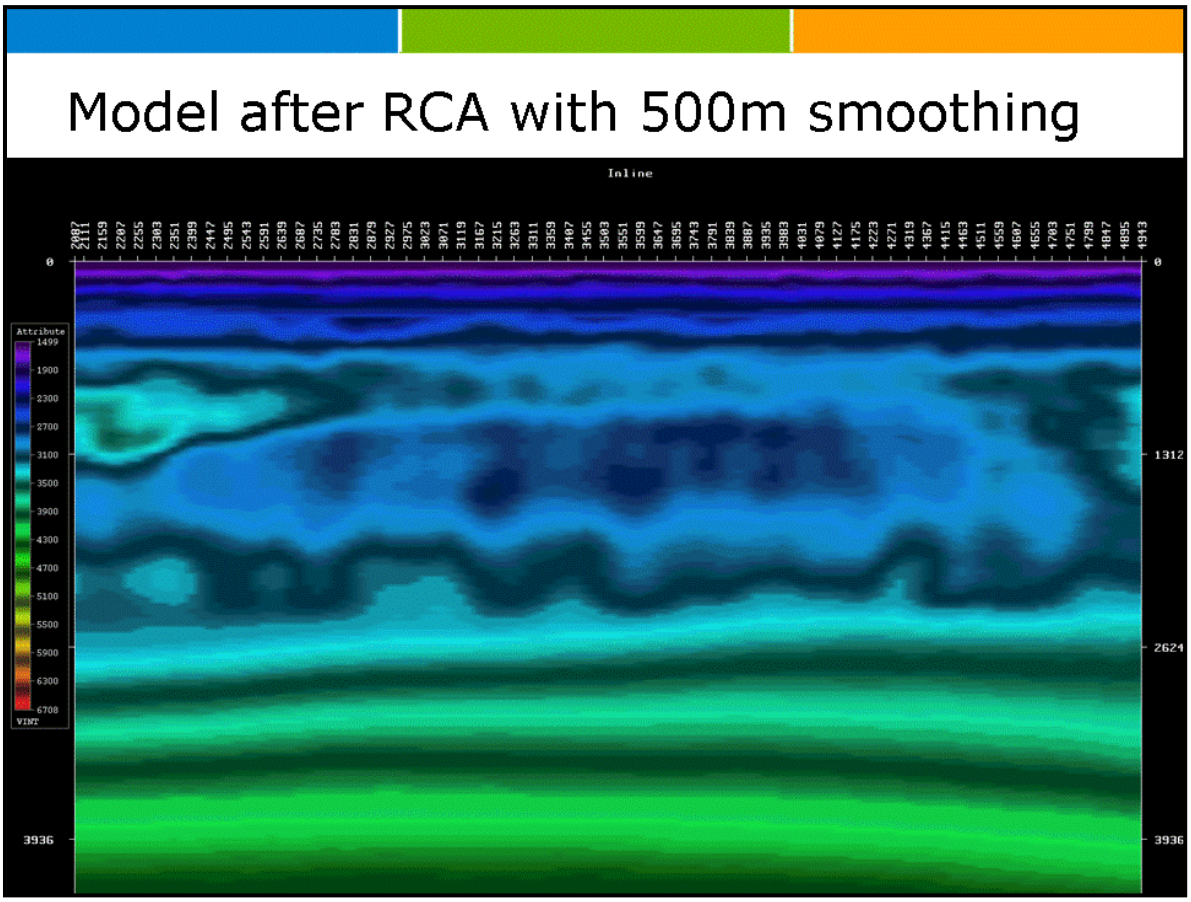
Outline

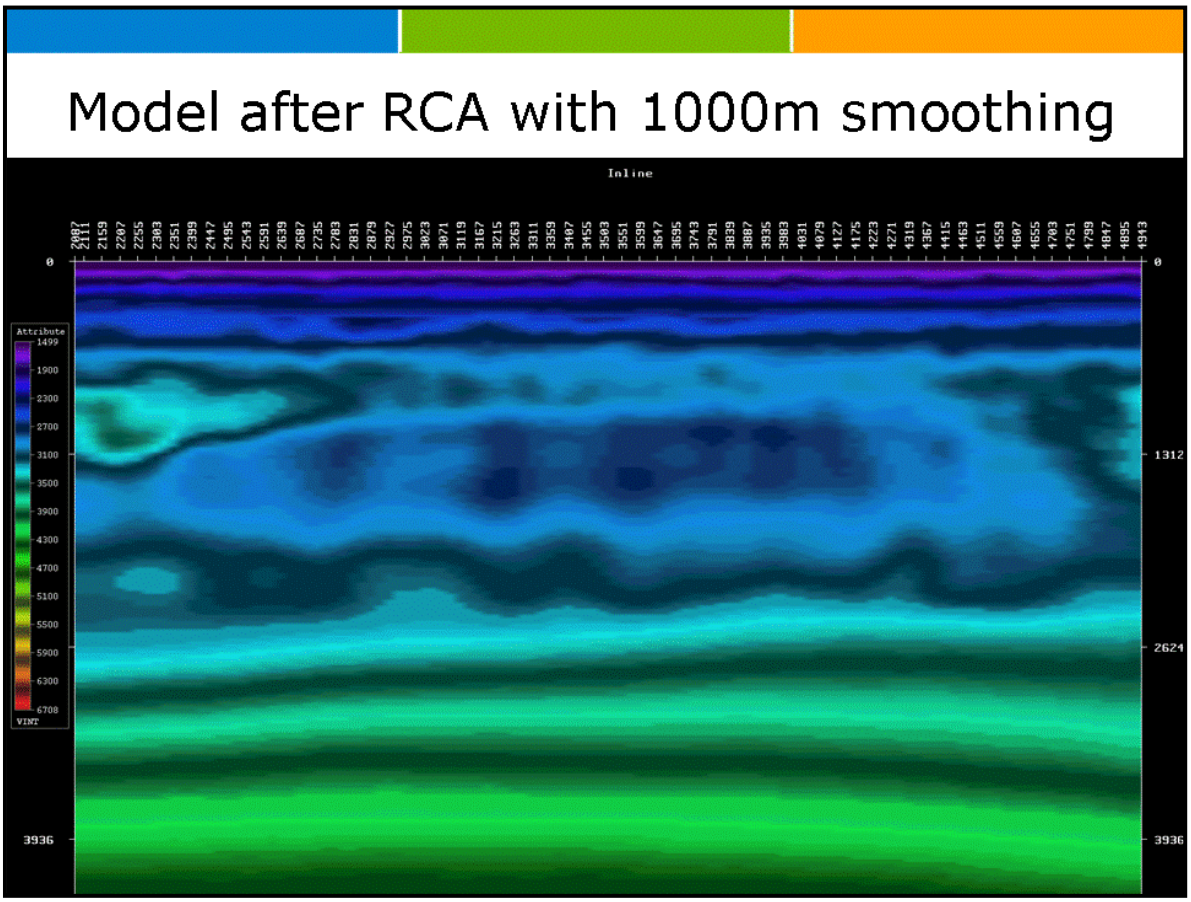
RCA tomography smoothing test:

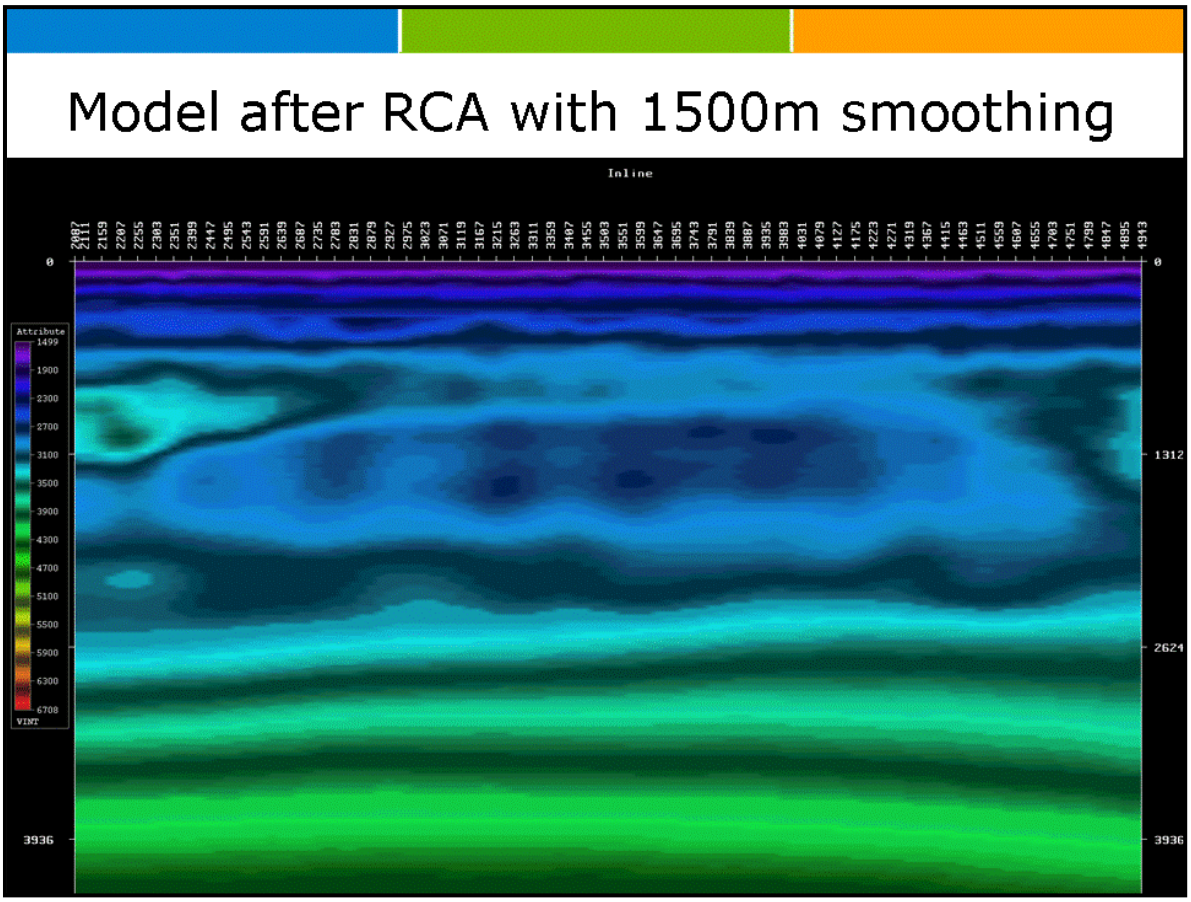
- 500m, 1000m, 1500m, 2000m smoothing.
- Display velocity field, stacks and gathers and gathers zoom in section of initial model and 4 models with different smoothing parameter.

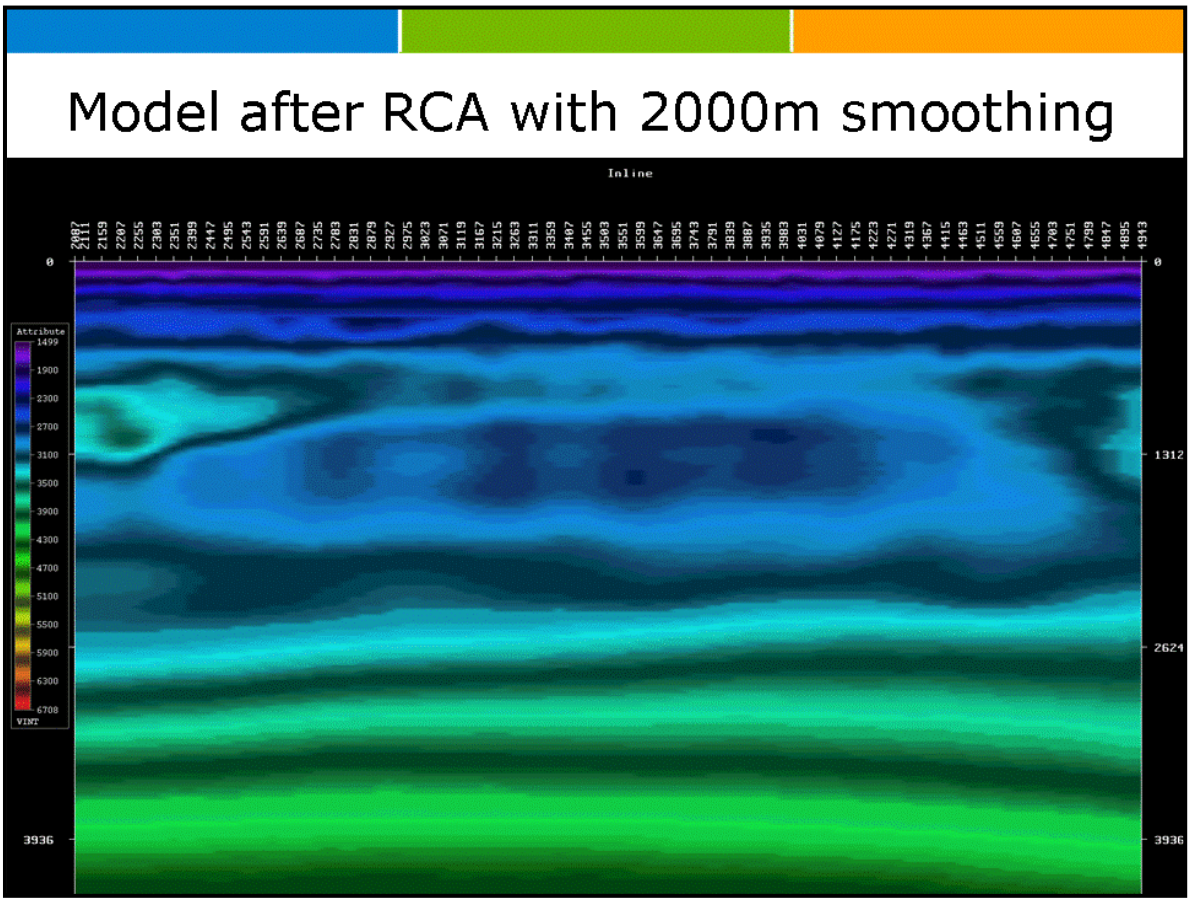
Initial model



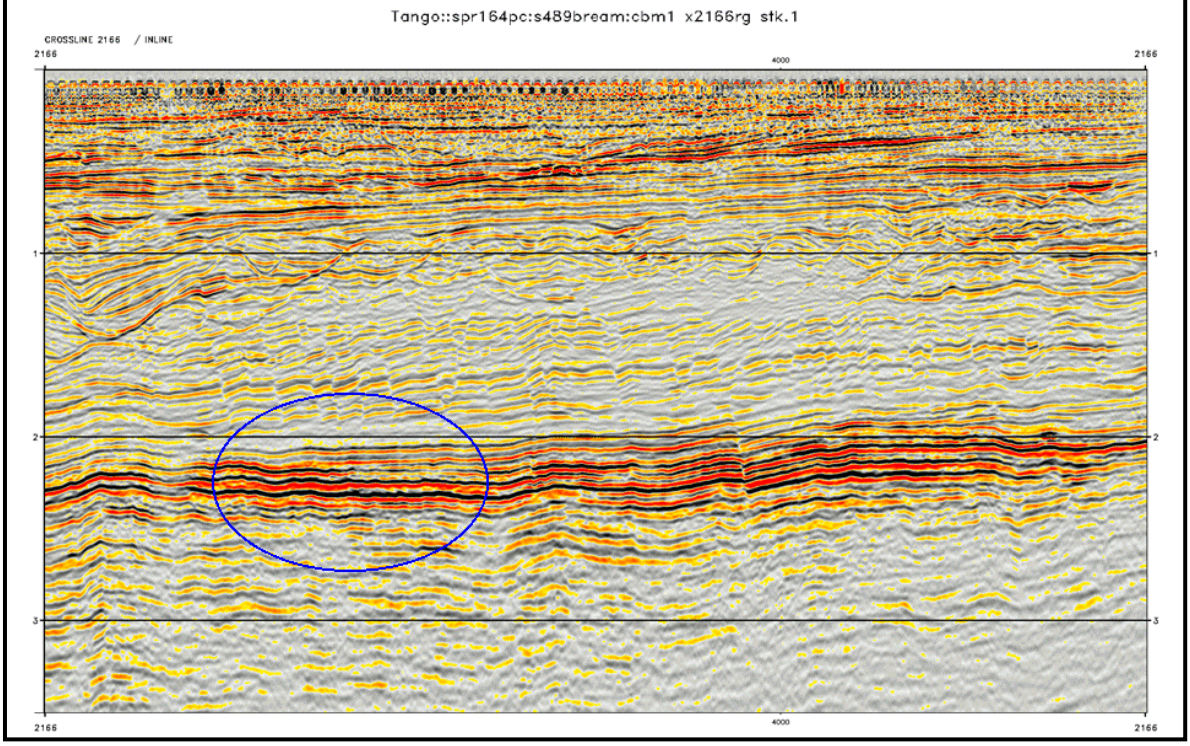

Model after RCA with 500m smoothing
Inline
Attribute
VINT
1312
2624
3936


Model after RCA with 1000m smoothing
Inline
Attribute
VINT
1312
2624
3936

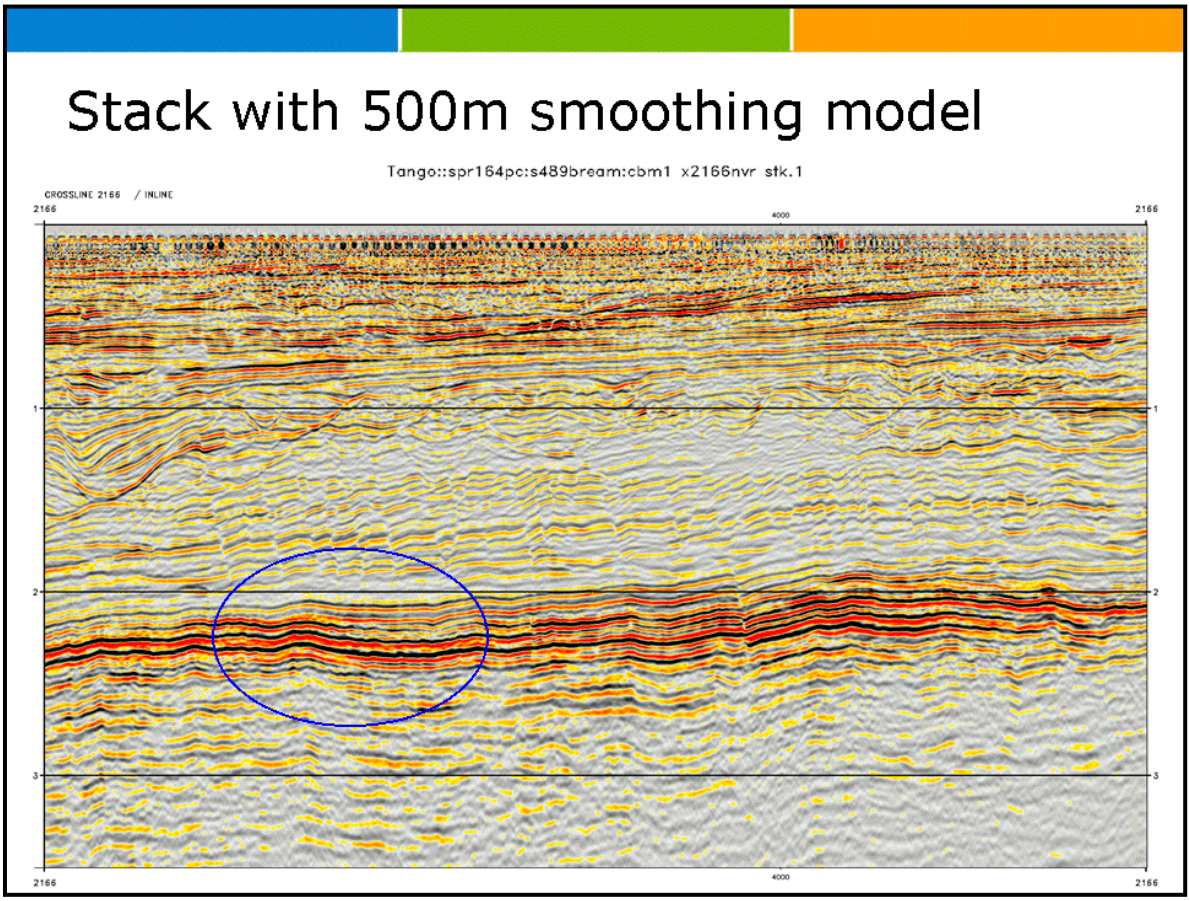

Model after RCA with 1500m smoothing
Inline
Attribute
1499
1900
2300
2700
3100
3500
3900
4300
4700
5100
5500
5900
6300
6708
VINT
0
1312
2624
3936


Model after RCA with 2000m smoothing
Inline
Attribute
1499
1900
2300
2700
3100
3500
3900
4300
4700
5100
5500
5900
6300
6708
VINT
0
1312
2624
3936

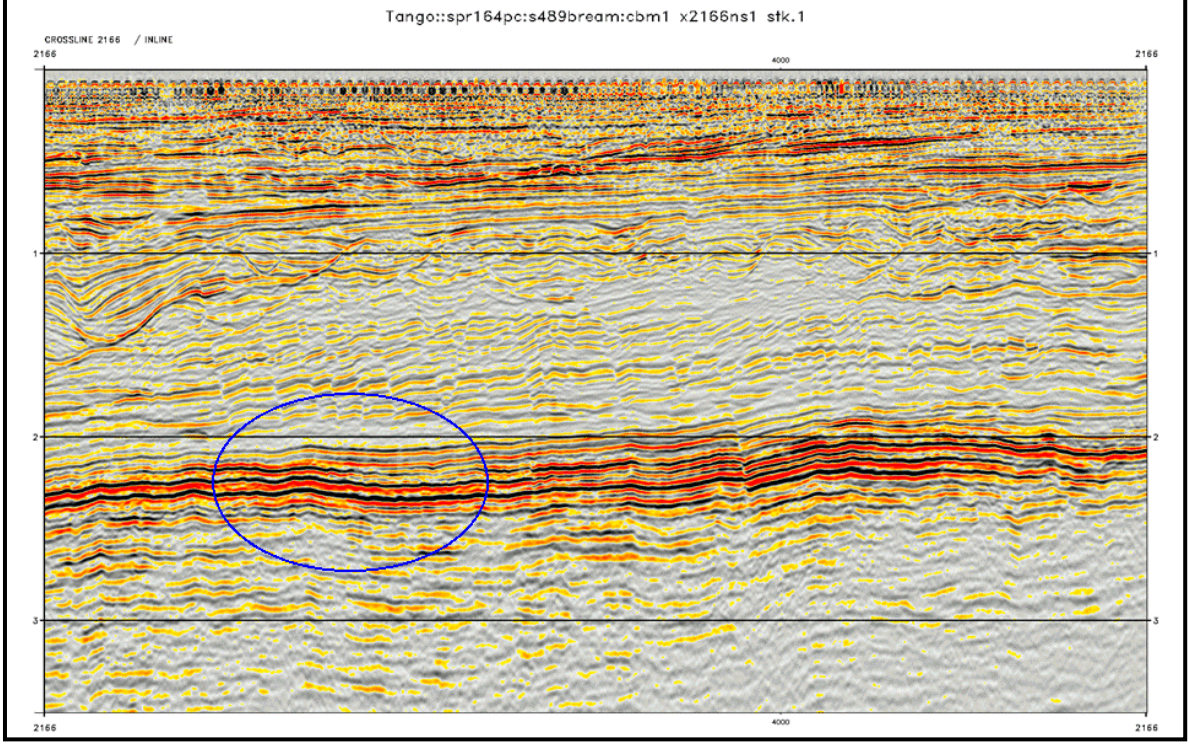
Stack with initial model



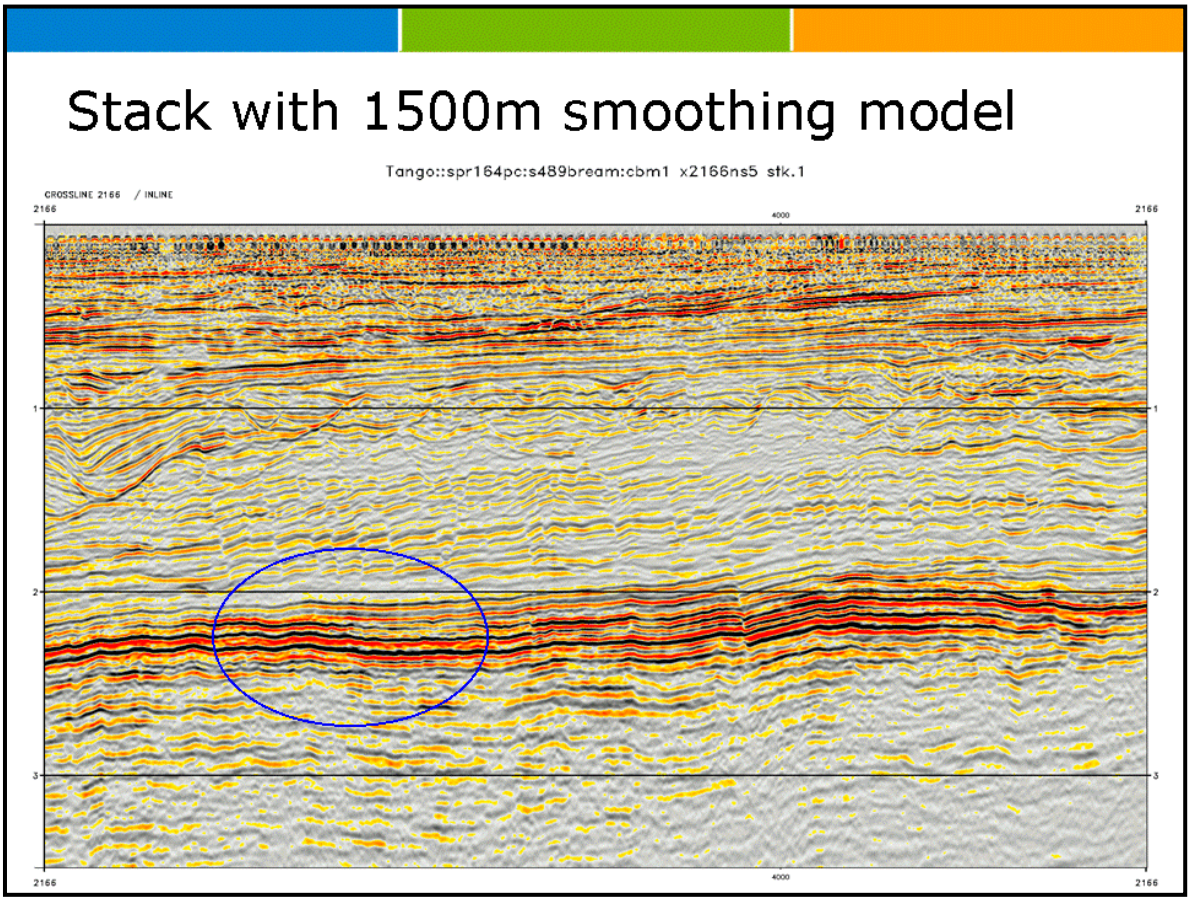
Stack with 500m smoothing model



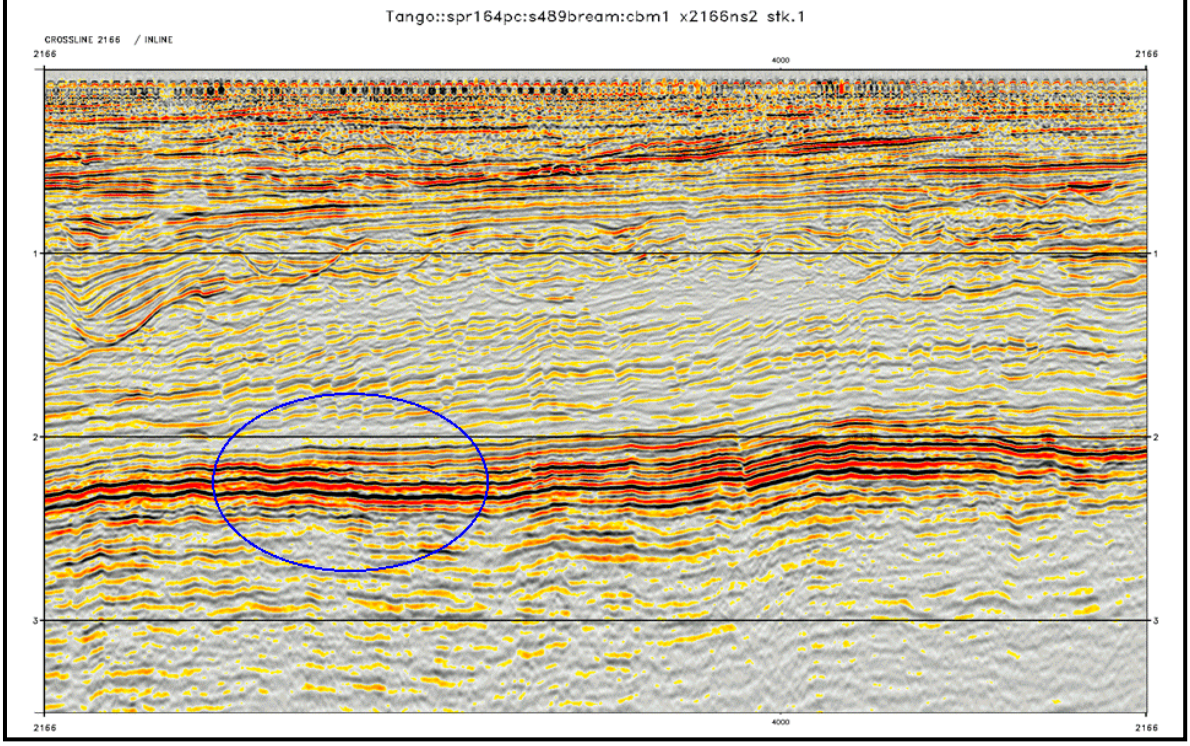
Stack with 1000m smoothing model



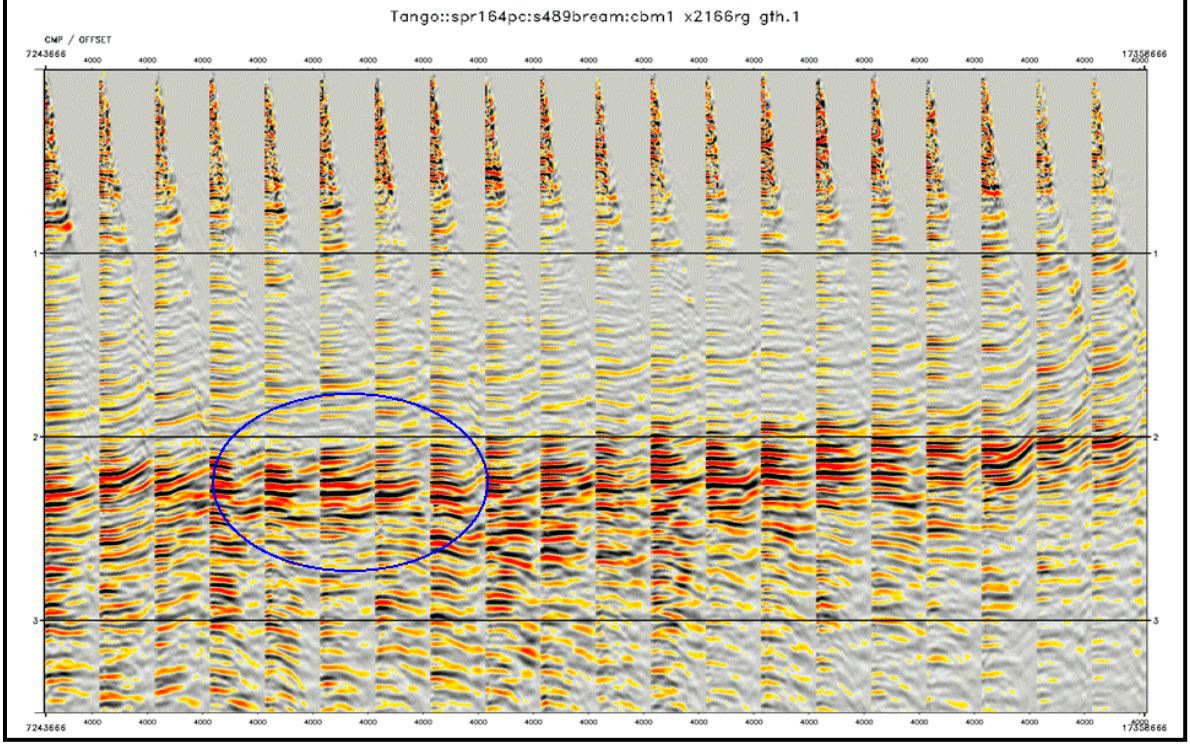
Stack with 1500m smoothing model



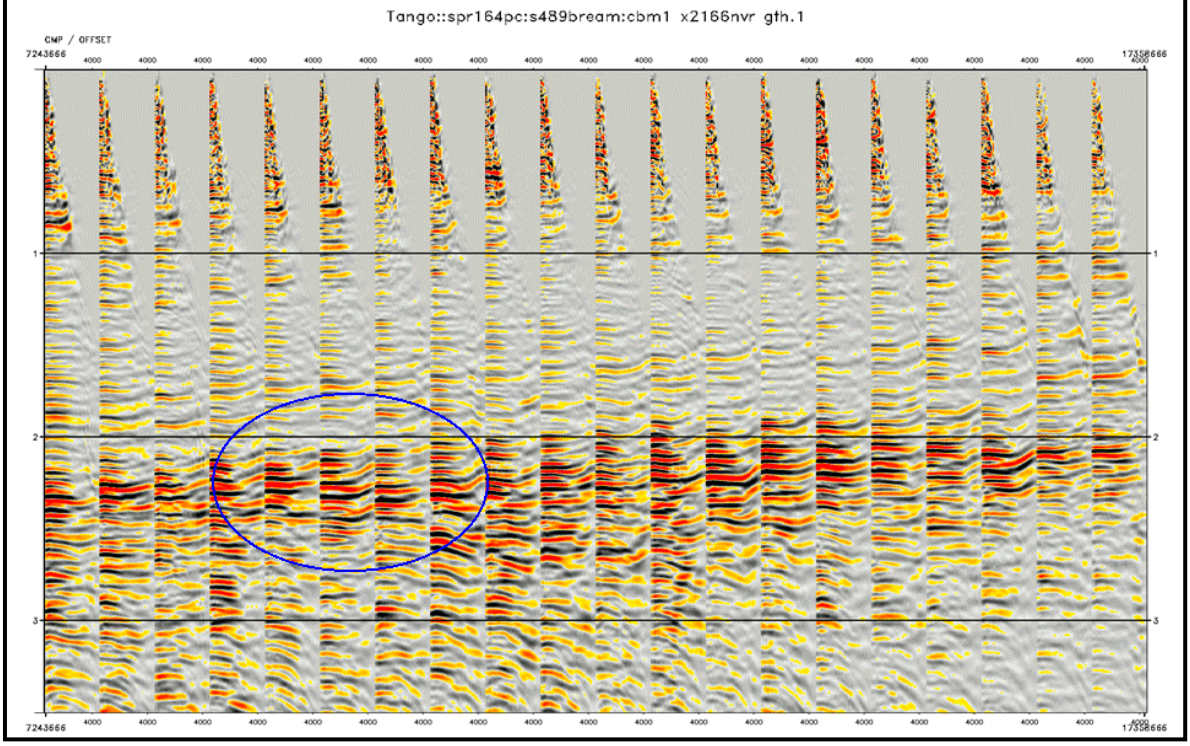
Stack with 2000m smoothing model



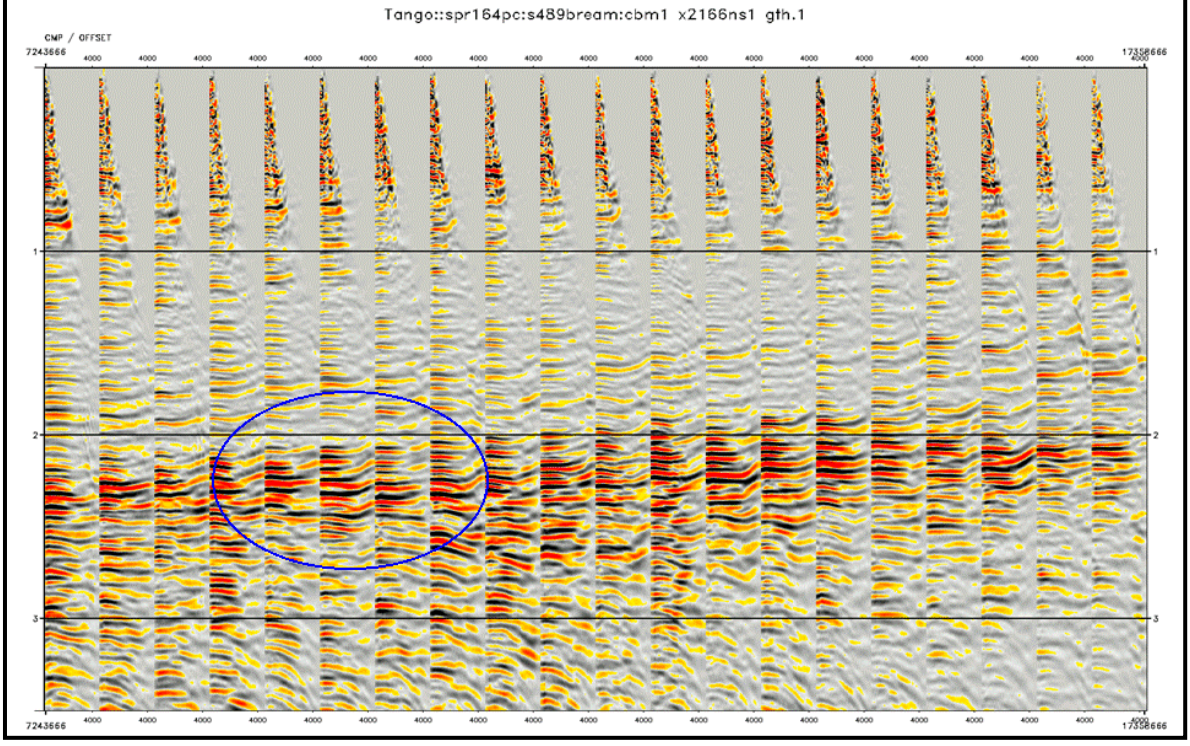
Gather with initial model



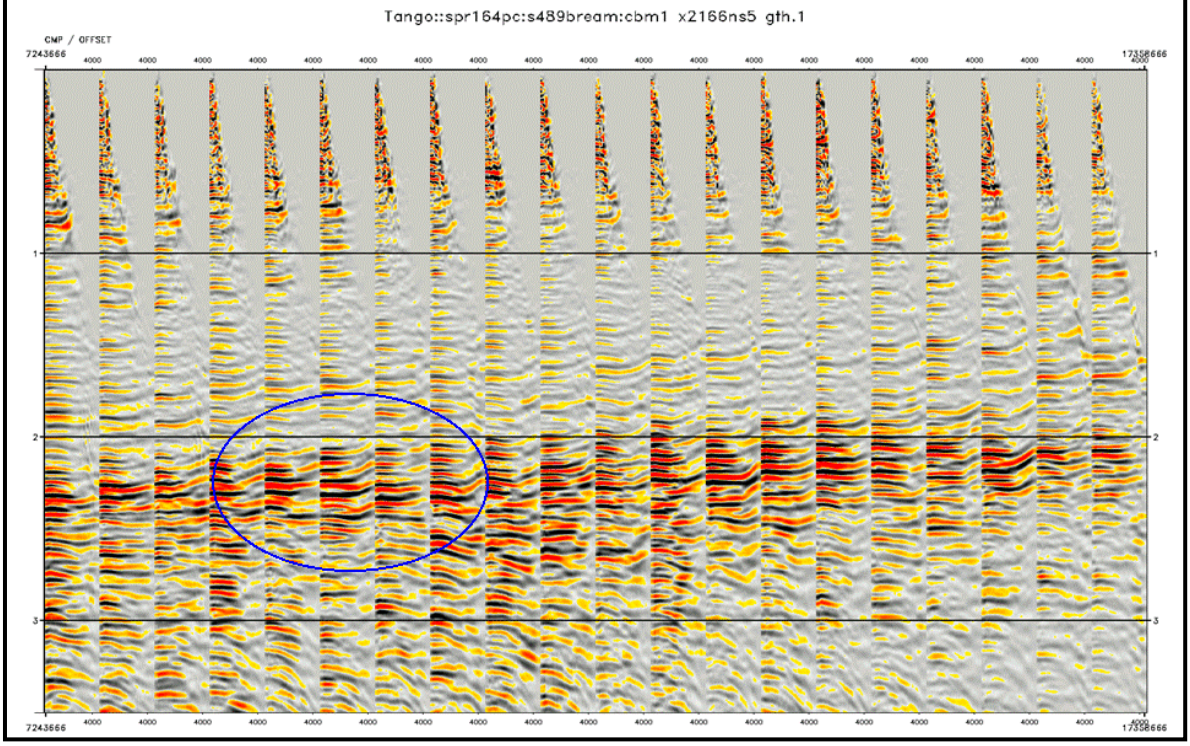
Gather with 500m smoothing model



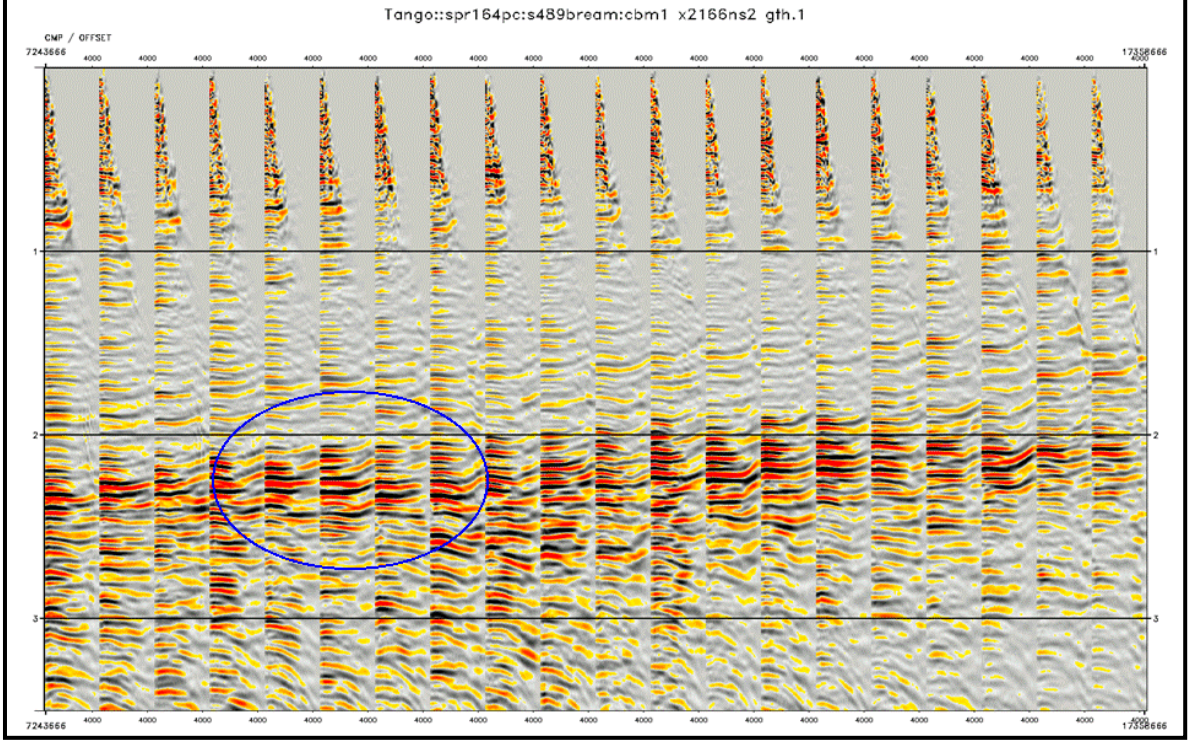
Gather with 1000m smoothing model



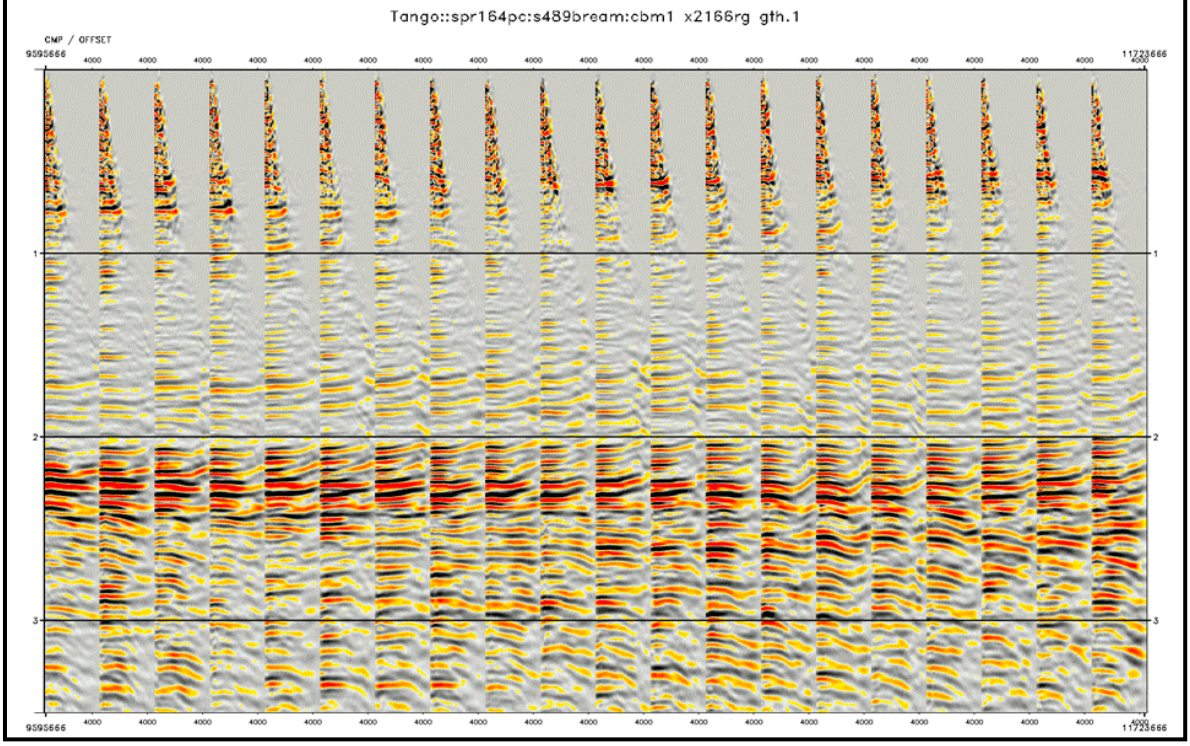
Gather with 1500m smoothing model



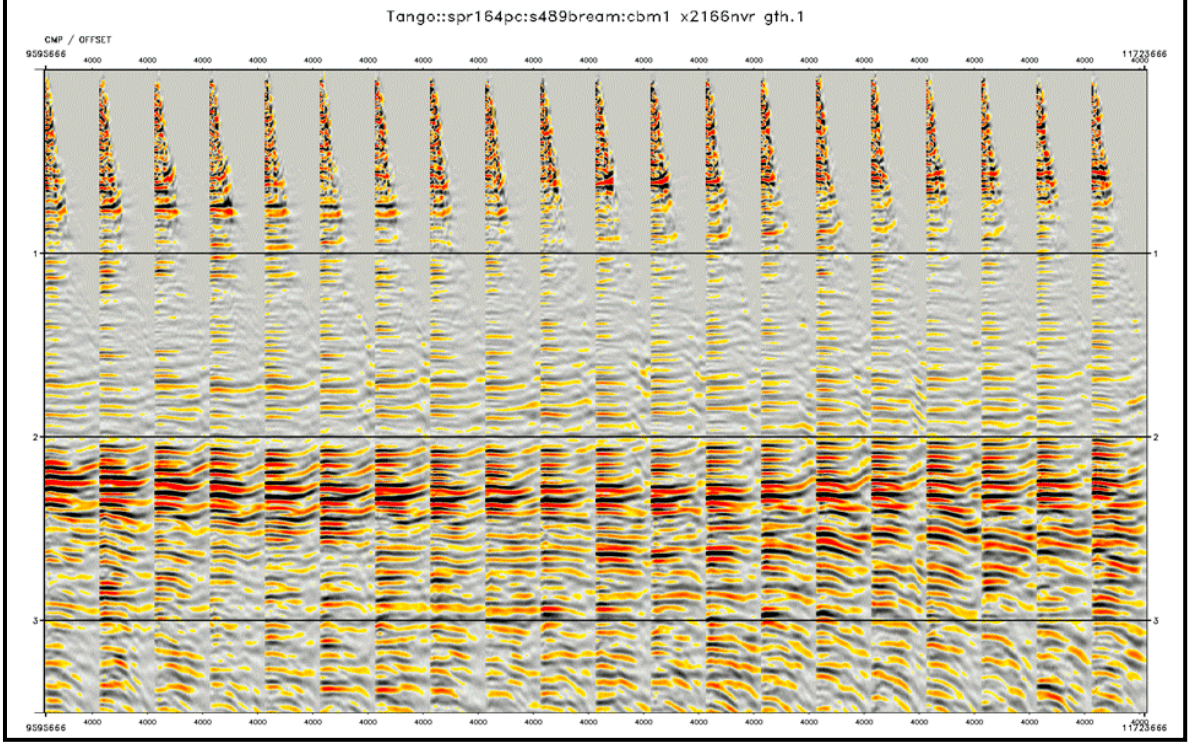
Gather with 2000m smoothing model



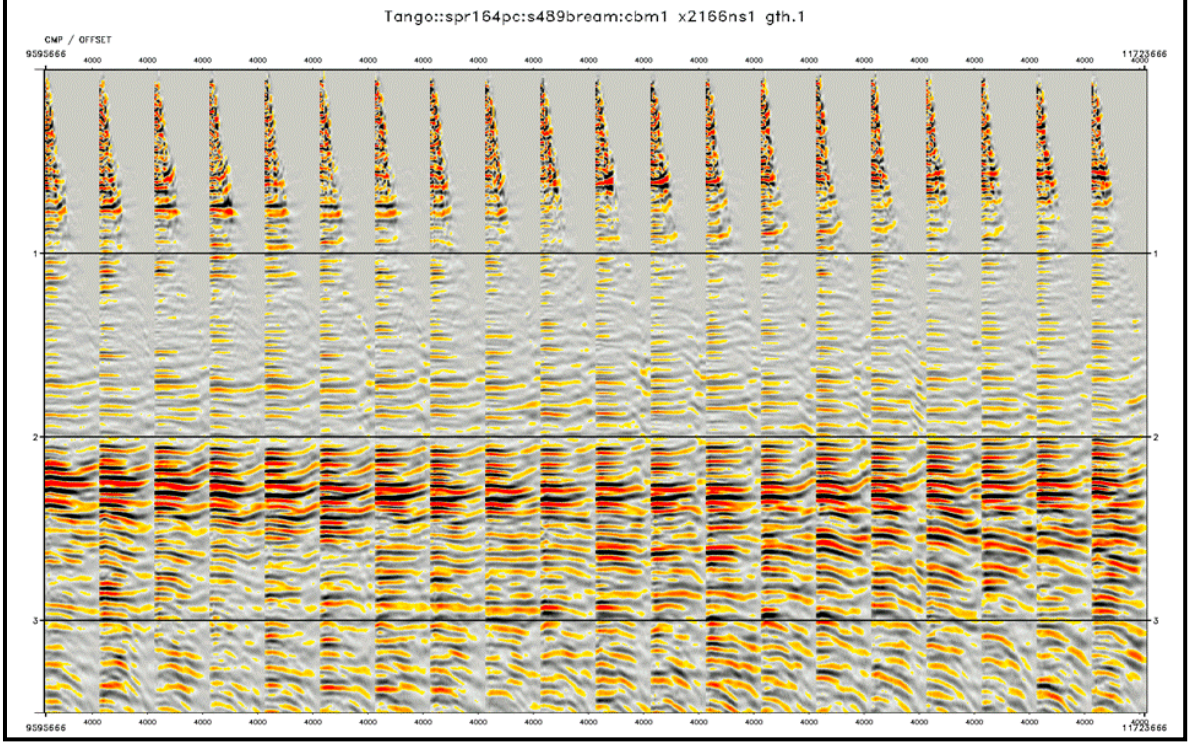
Zoom in of Gather with initial model



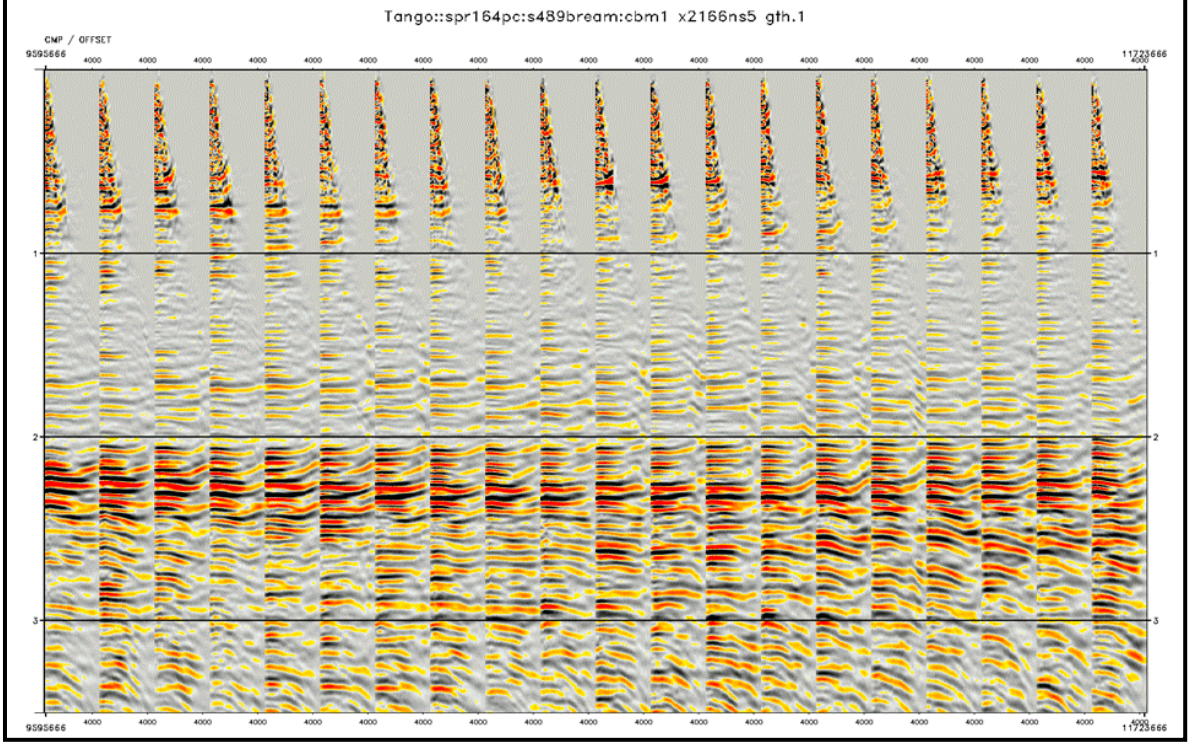
Zoom in of Gather with 500m smoothing model

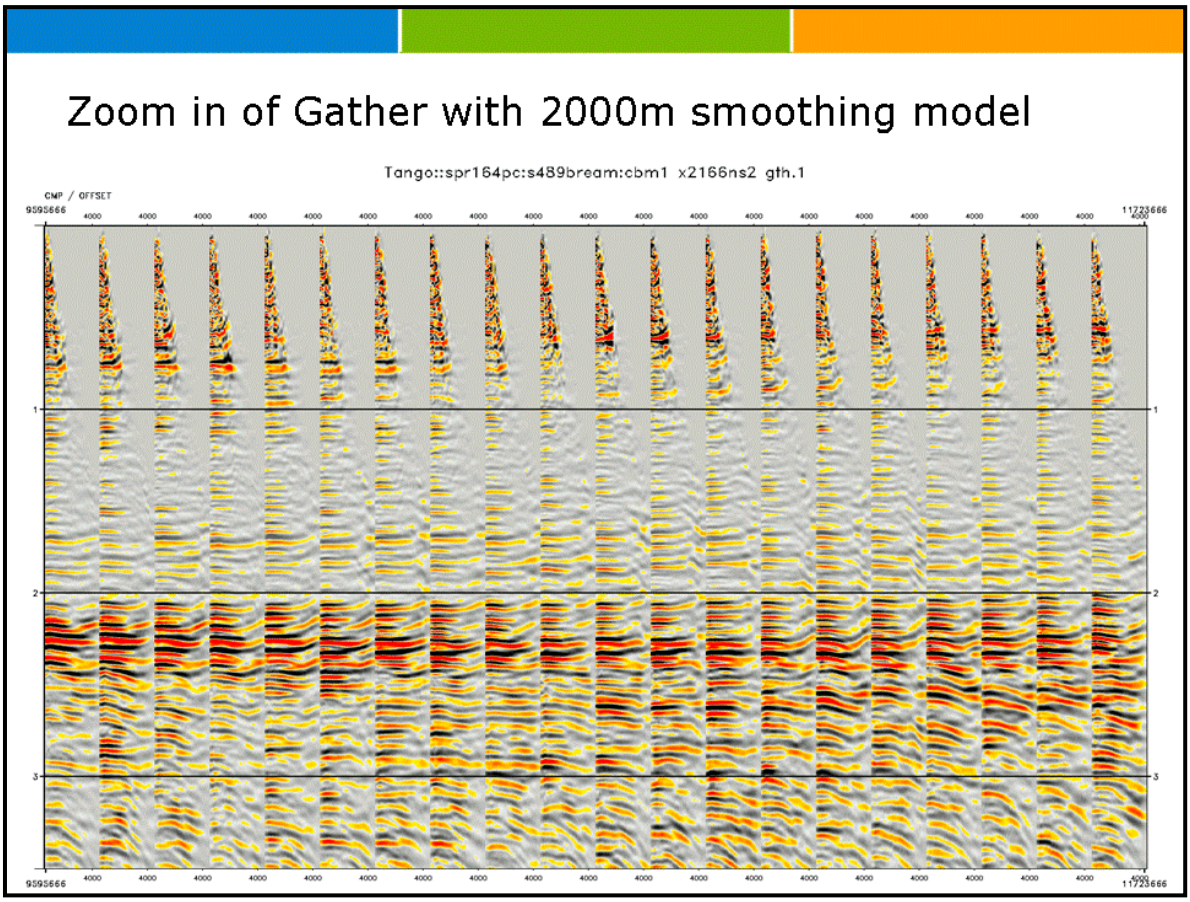


Zoom in of Gather with 1000m smoothing model



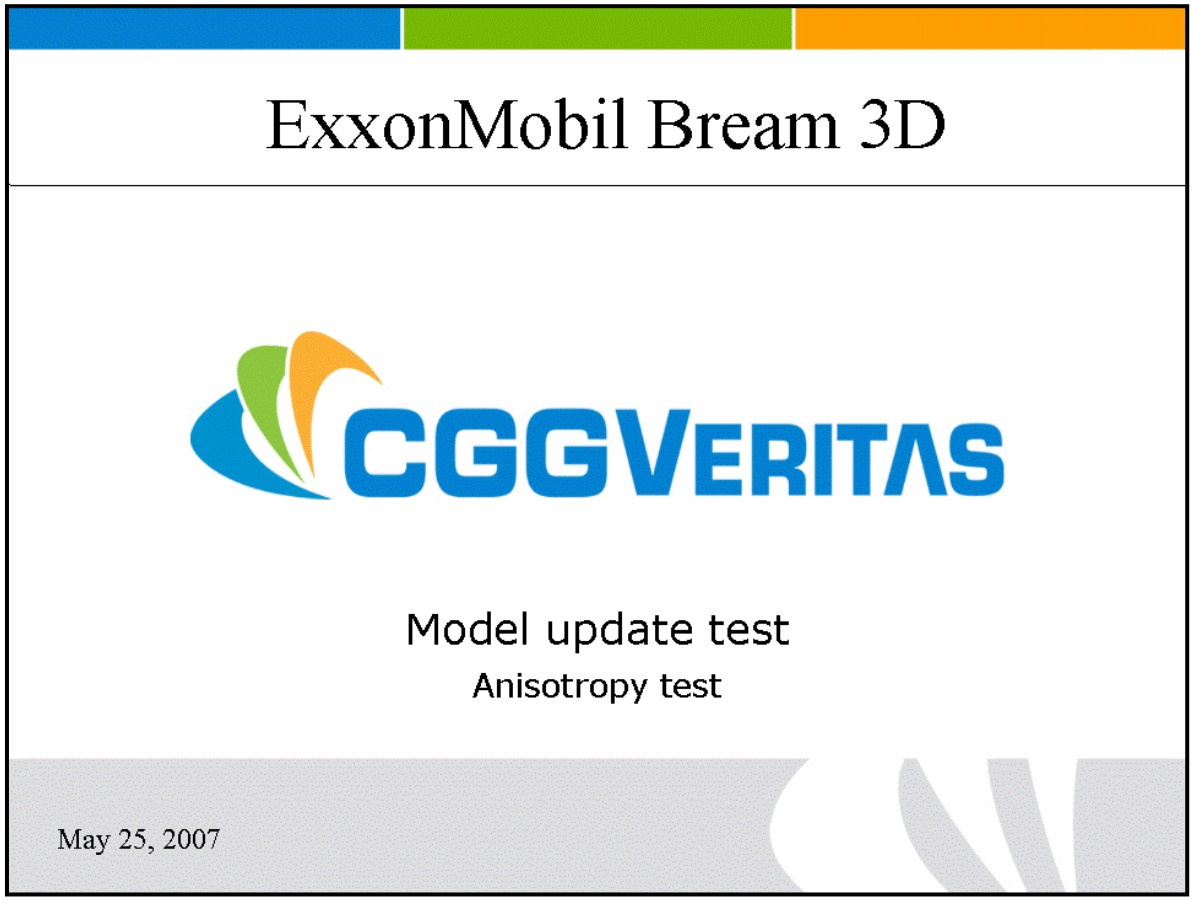
Zoom in of Gather with 1500m smoothing model




Zoom in of Gather with 2000m smoothing model
Tango::spr164pc:s489bream:cbm1 x2166ns2 gth.1
CMP / OFFSET
9595666
11723666
1
2
3

2.6 ANISOTROPY

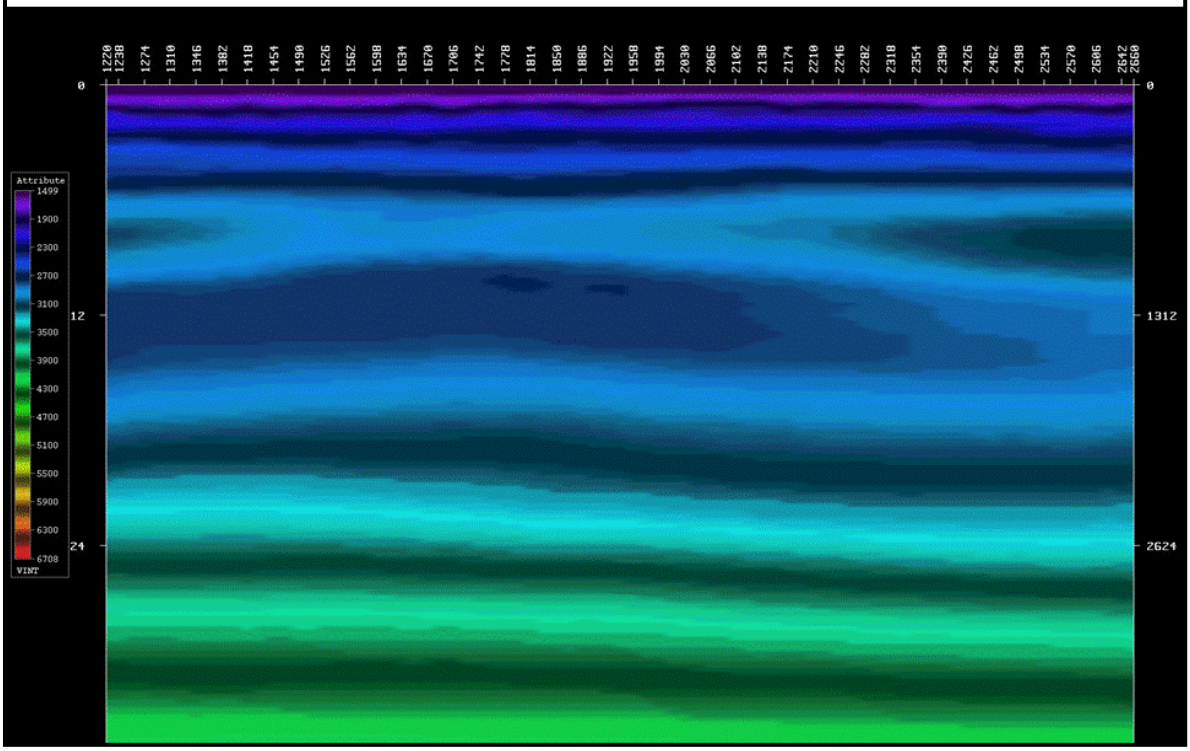
We observed the anisotropy effect on the gathers (hockey stick). 4% of Epsilon volume was introduced between reflectors 1000m above the top of the coal to top of coal horizon after the 1st iteration RCA.

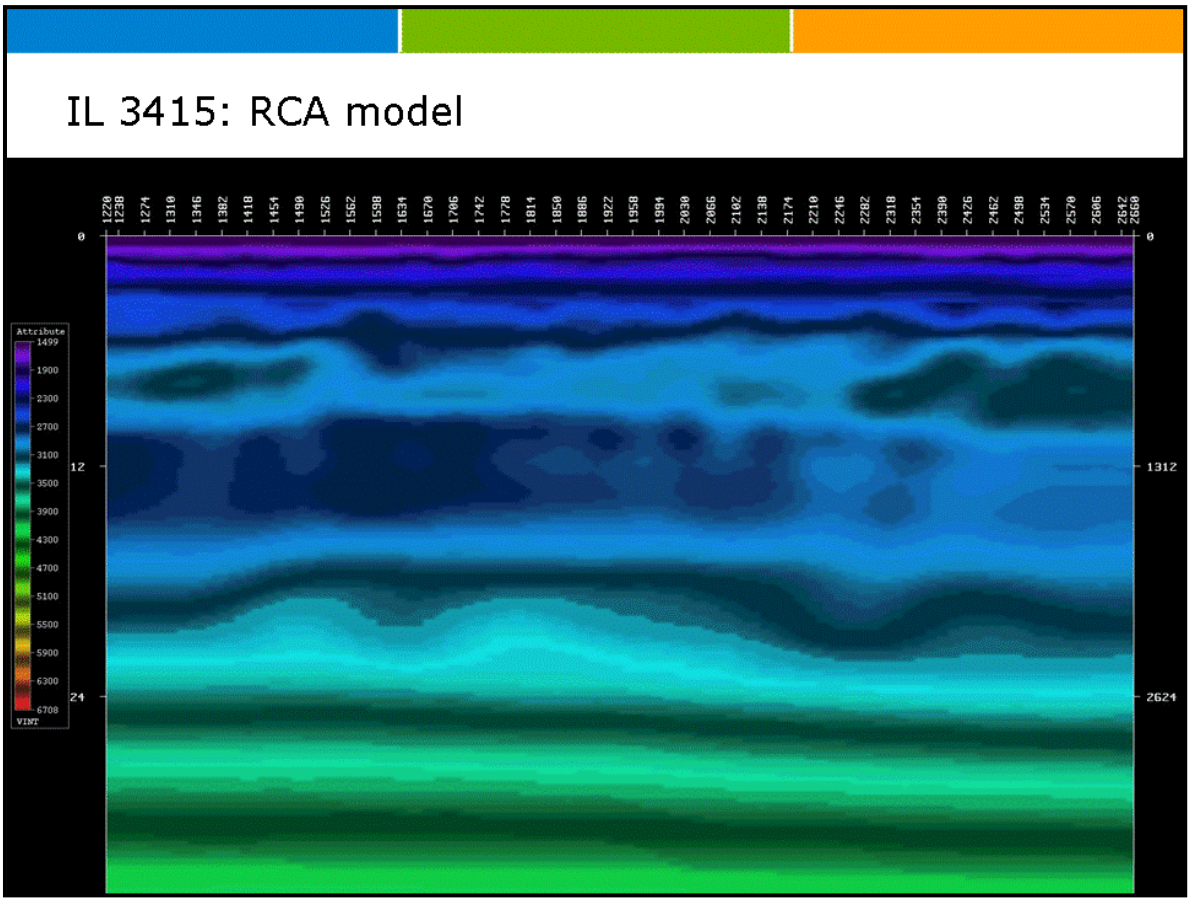


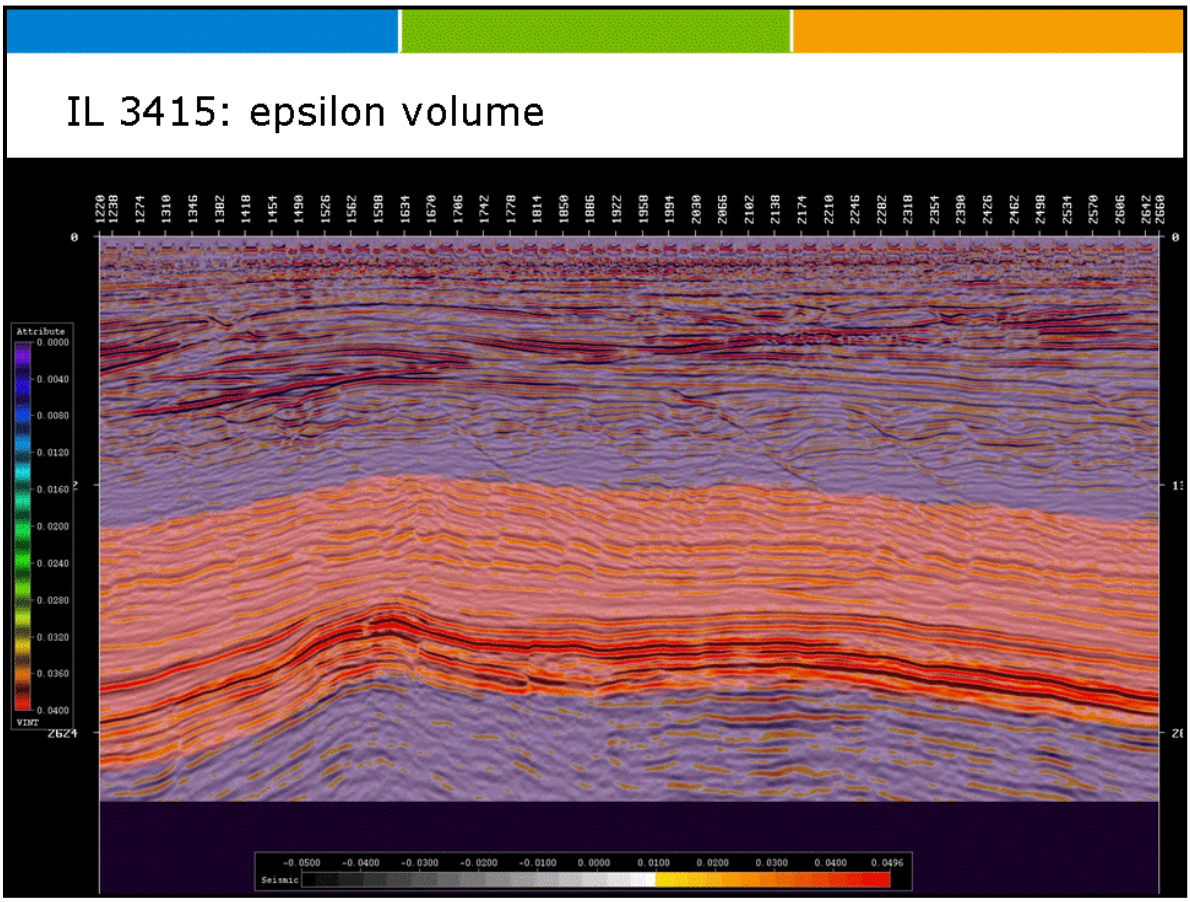
Outline

- Model:
  - Initial velocity model (from PSTM velocity field)
  - RCA model: RCA smoothing distance 1500mx1500m.
  - RCA model with 0.04 anisotropy introduced, delta set to zero.
- Target inline 3415, 3789 CBM gather and stack comparison.

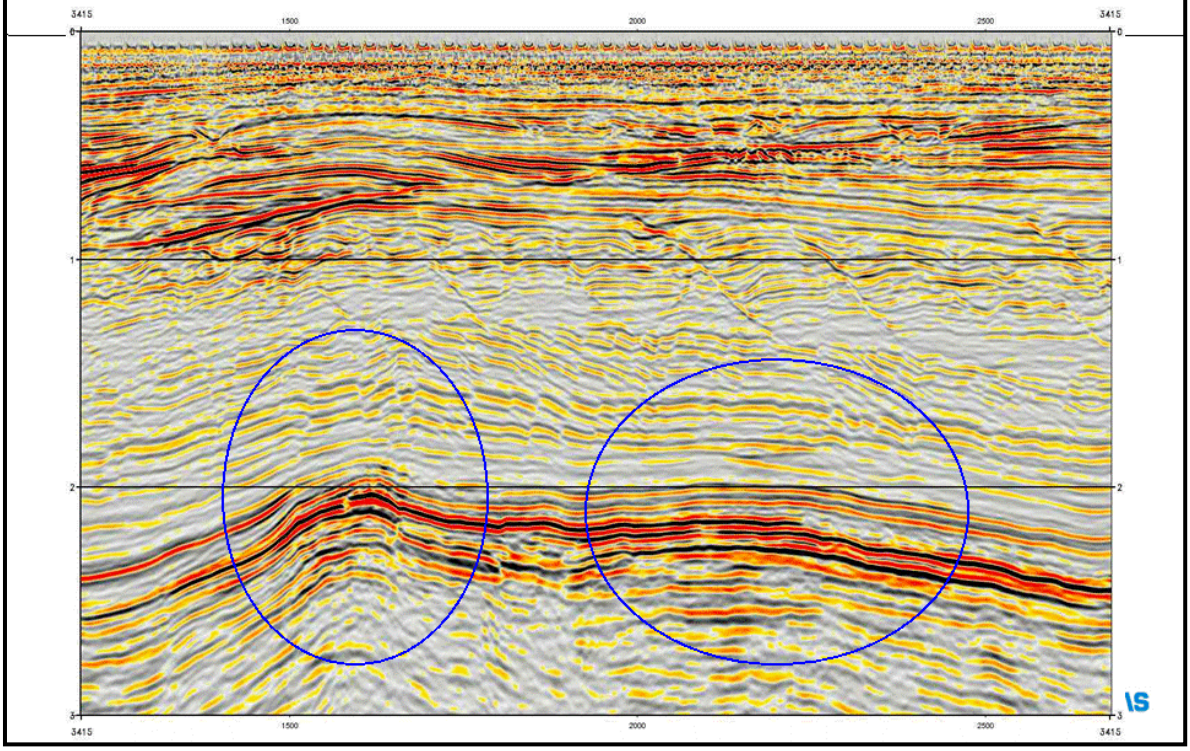
IL 3415: initial model



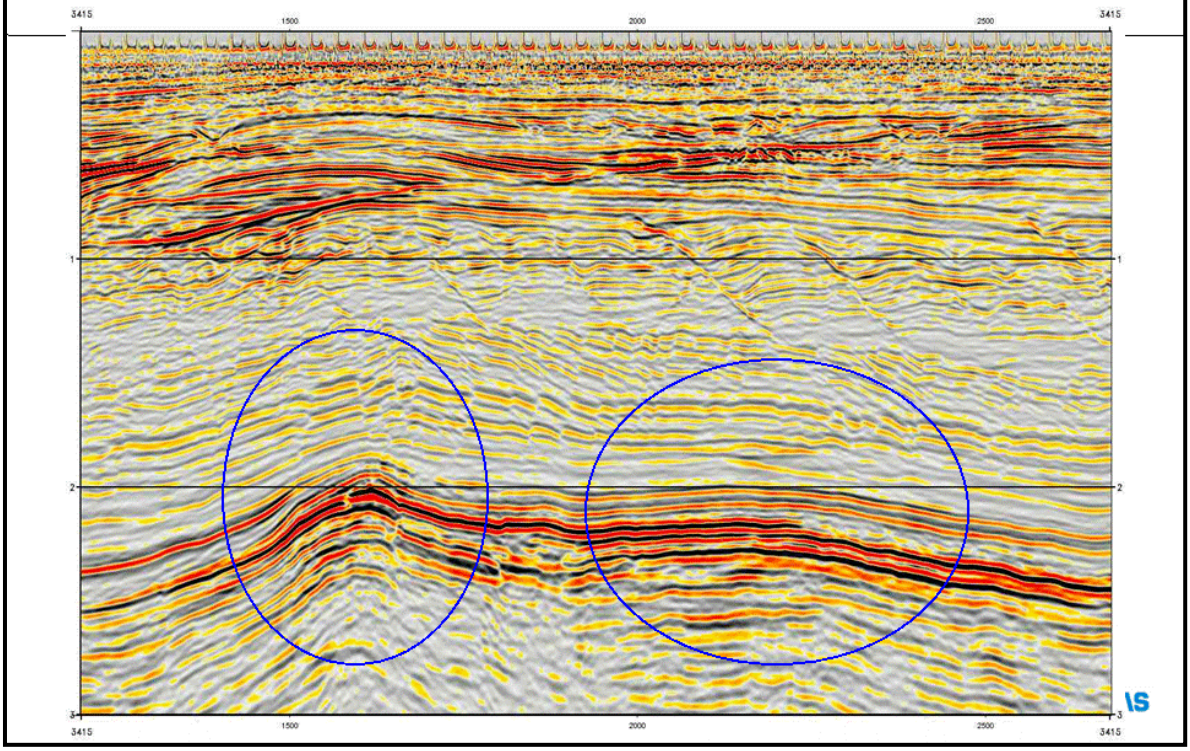

IL 3415: RCA model
1220 1238 1274 1310 1346 1382 1418 1454 1490 1526 1562 1598 1634 1670 1706 1742 1778 1814 1850 1886 1922 1958 1994 2030 2066 2102 2138 2174 2210 2246 2282 2318 2354 2390 2426 2462 2498 2534 2570 2606 2642 2660
0
0
Attribute
1499
1900
2300
2700
3100
3500
3900
4300
4700
5100
5500
5900
6300
6708
VINT
12
24
1312
2624


IL 3415: epsilon volume
1220 1238 1274 1310 1346 1382 1418 1454 1490 1526 1562 1598 1634 1670 1706 1742 1778 1814 1850 1886 1922 1958 1994 2030 2066 2102 2138 2174 2210 2246 2282 2318 2354 2390 2426 2462 2498 2534 2570 2606 2642 2660
0
0
Attribute
0.0000
0.0040
0.0080
0.0120
0.0160
0.0200
0.0240
0.0280
0.0320
0.0360
0.0400
VINT
2624
-0.0500 -0.0400 -0.0300 -0.0200 -0.0100 0.0000 0.0100 0.0200 0.0300 0.0400 0.0496
Seismic

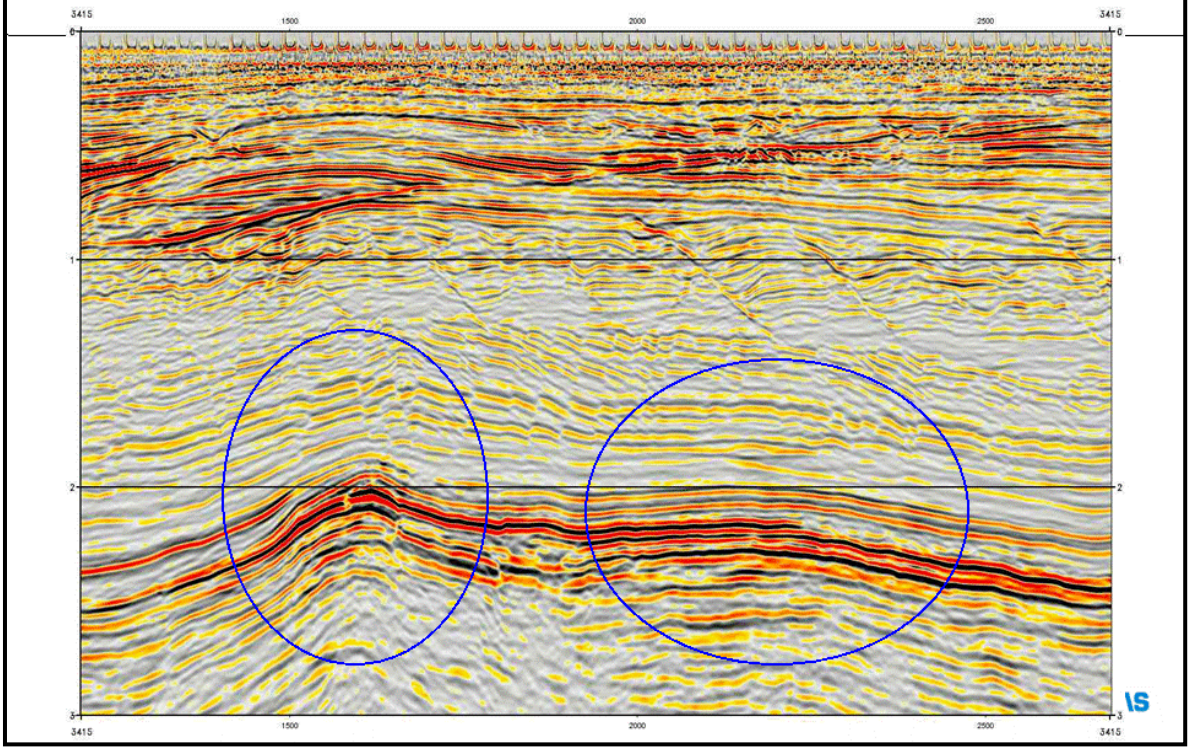
IL 3415: CBM stack with initial model



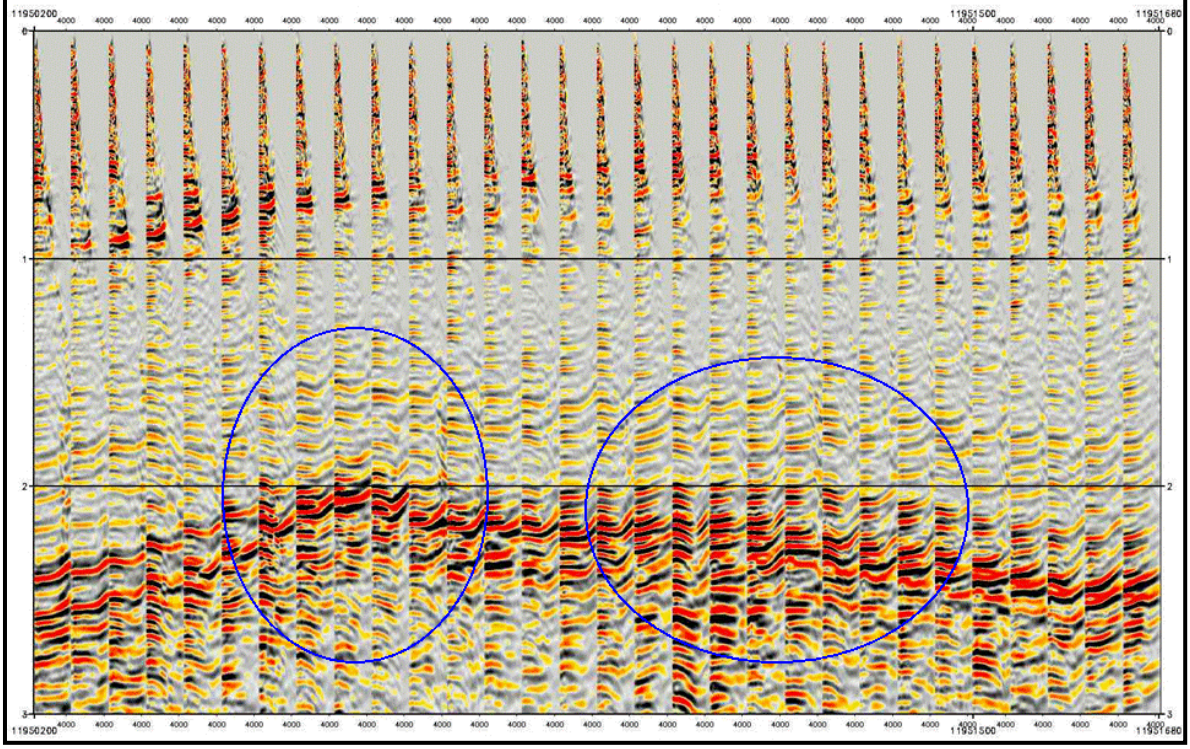
IL 3415: CBM stack with RCA model



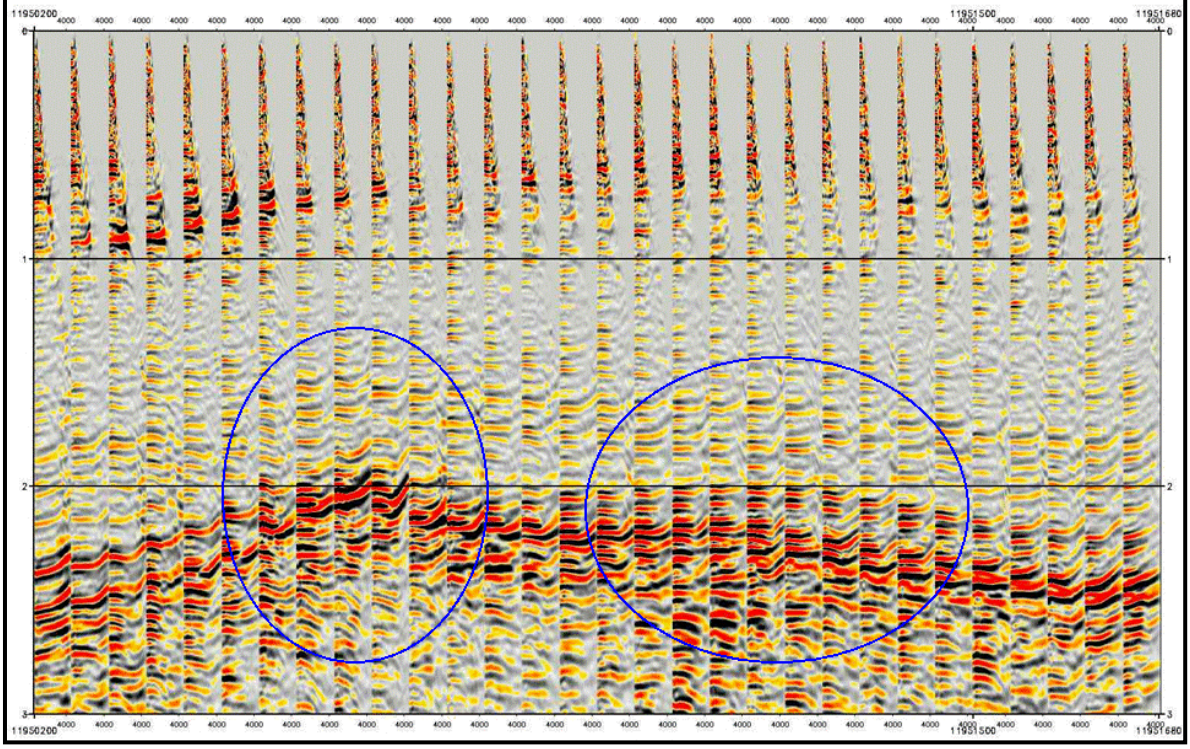
IL 3415: CBM stack with anisotropy model



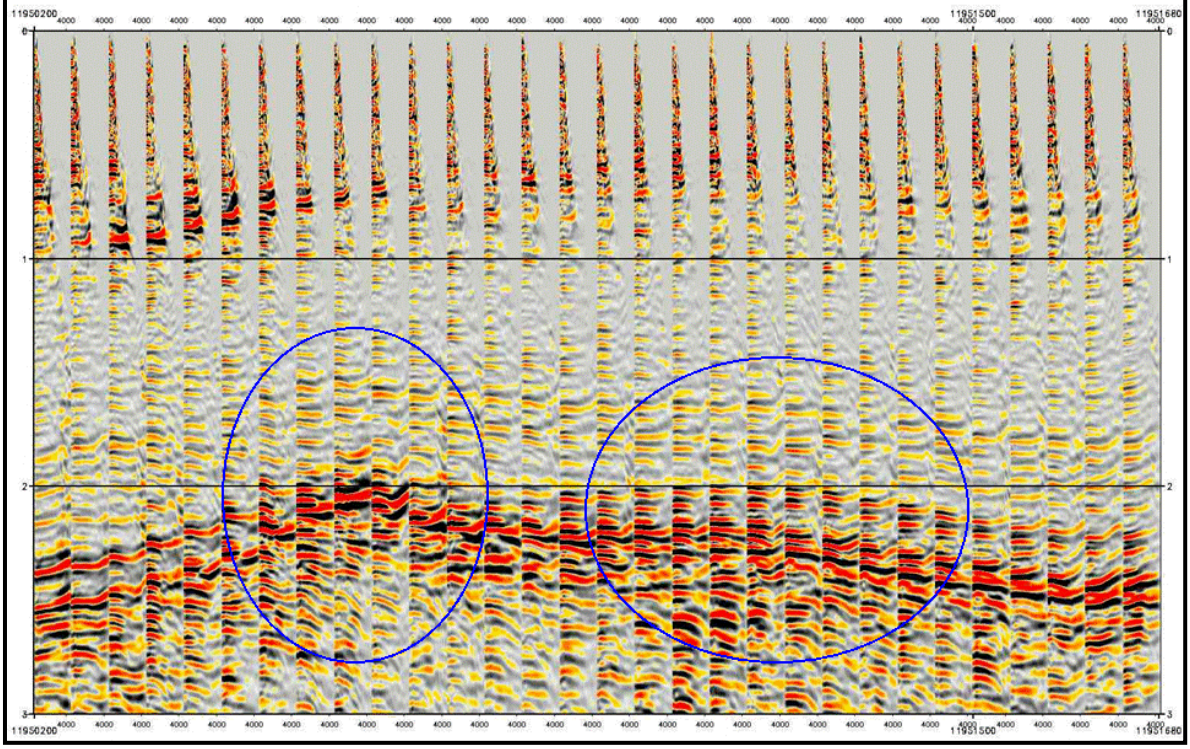
IL 3415: CBM gather with initial model

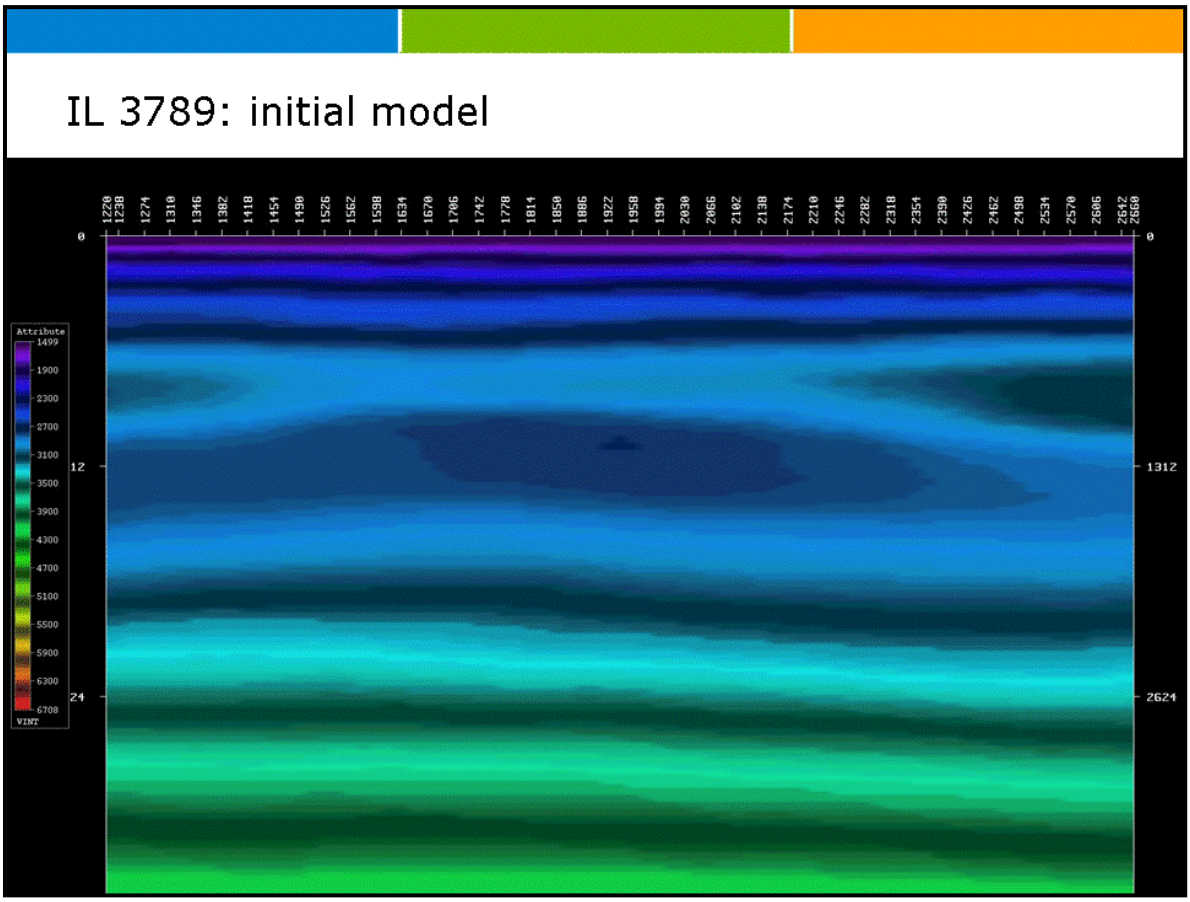


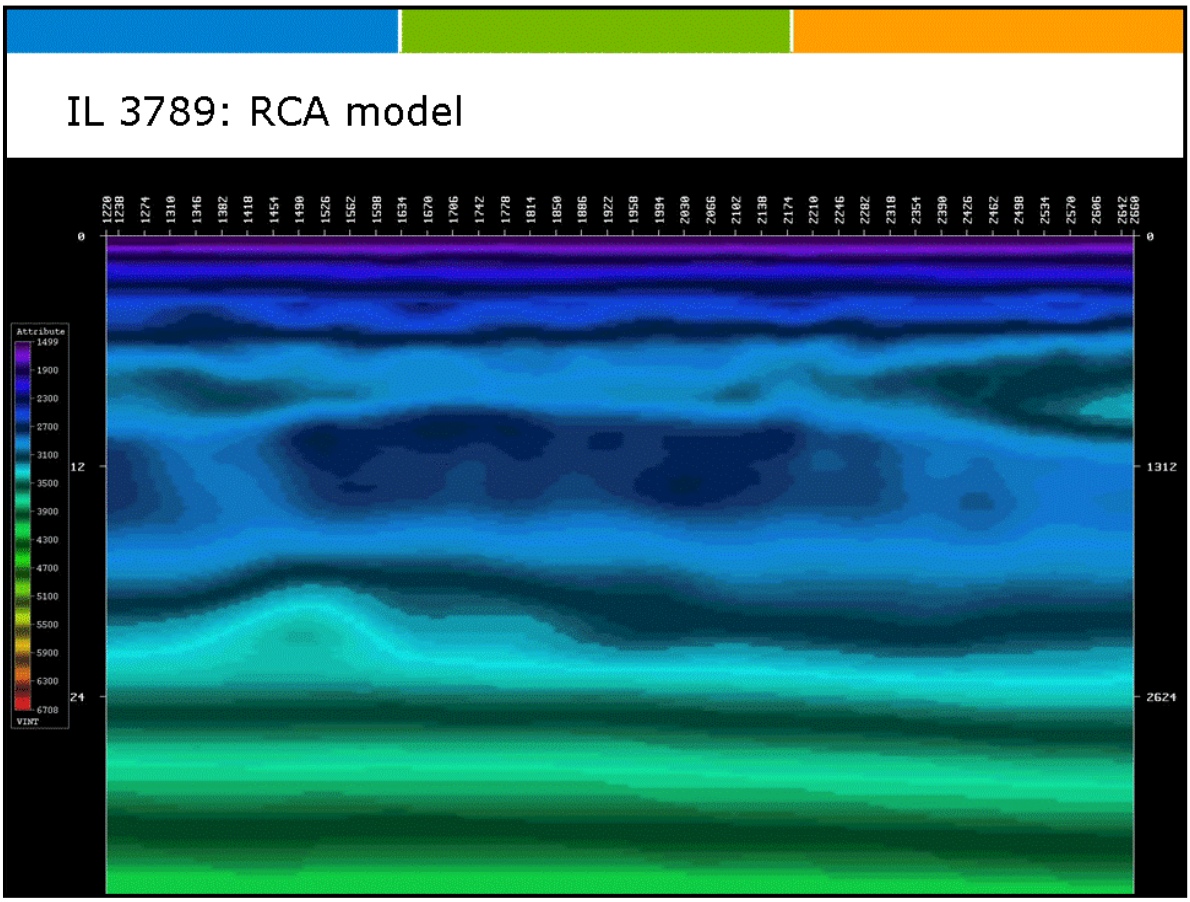
IL 3415: CBM gather with RCA model



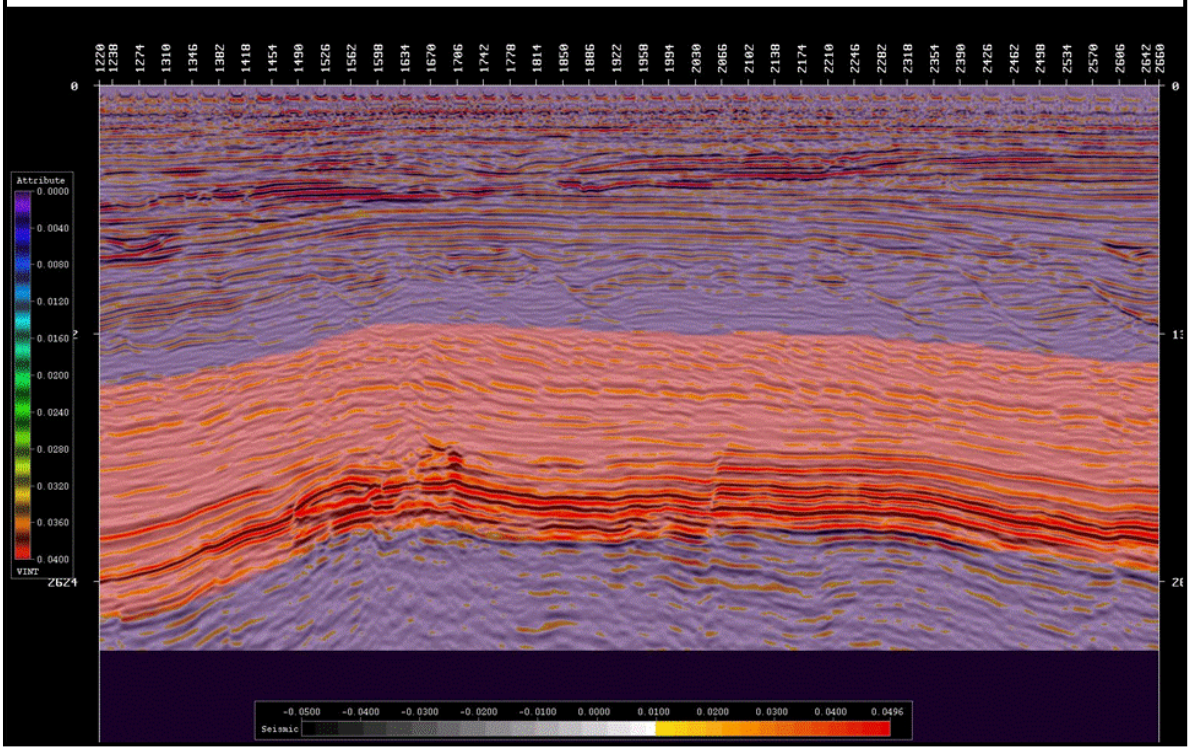
IL 3415: CBM gather with anisotropy model



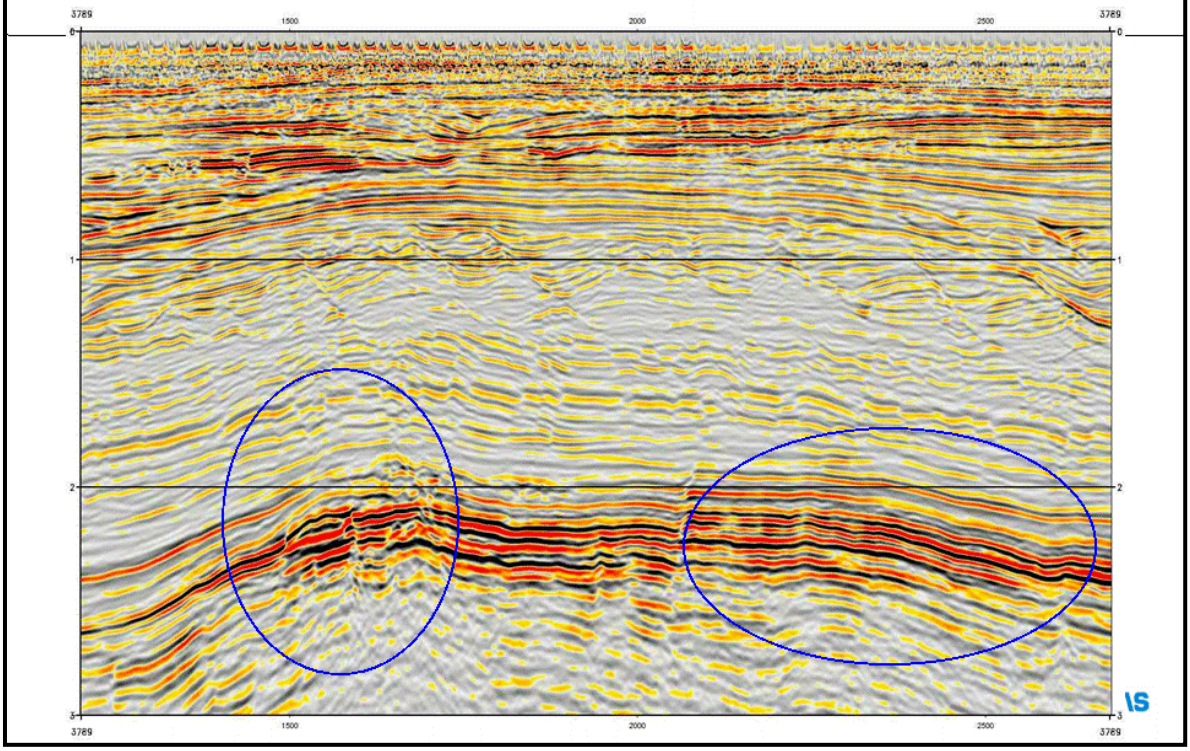

IL 3789: initial model
1220 1238 1274 1310 1346 1382 1418 1454 1490 1526 1562 1598 1634 1670 1706 1742 1778 1814 1850 1886 1922 1958 1994 2030 2066 2102 2138 2174 2210 2246 2282 2318 2354 2390 2426 2462 2498 2534 2570 2606 2642 2660
0
0
Attribute
1499
1900
2300
2700
3100
3500
3900
4300
4700
5100
5500
5900
6300
6708
VINT
12
1312
24
2624


IL 3789: RCA model
1220 1238 1274 1310 1346 1382 1418 1454 1490 1526 1562 1598 1634 1670 1706 1742 1778 1814 1850 1886 1922 1958 1994 2030 2066 2102 2138 2174 2210 2246 2282 2318 2354 2390 2426 2462 2498 2534 2570 2606 2642 2660
0
0
Attribute
1499
1900
2300
2700
3100
3500
3900
4300
4700
5100
5500
5900
6300
6708
VINT
12
1312
24
2624

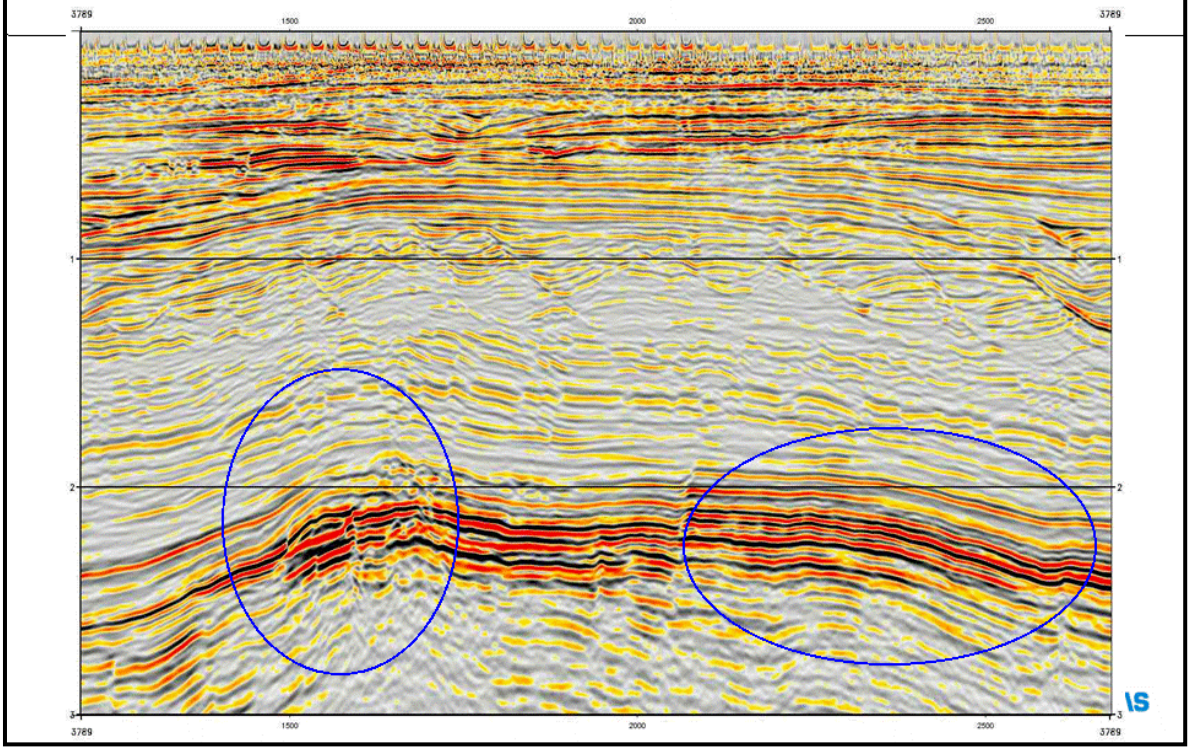
IL 3789: epsilon volume



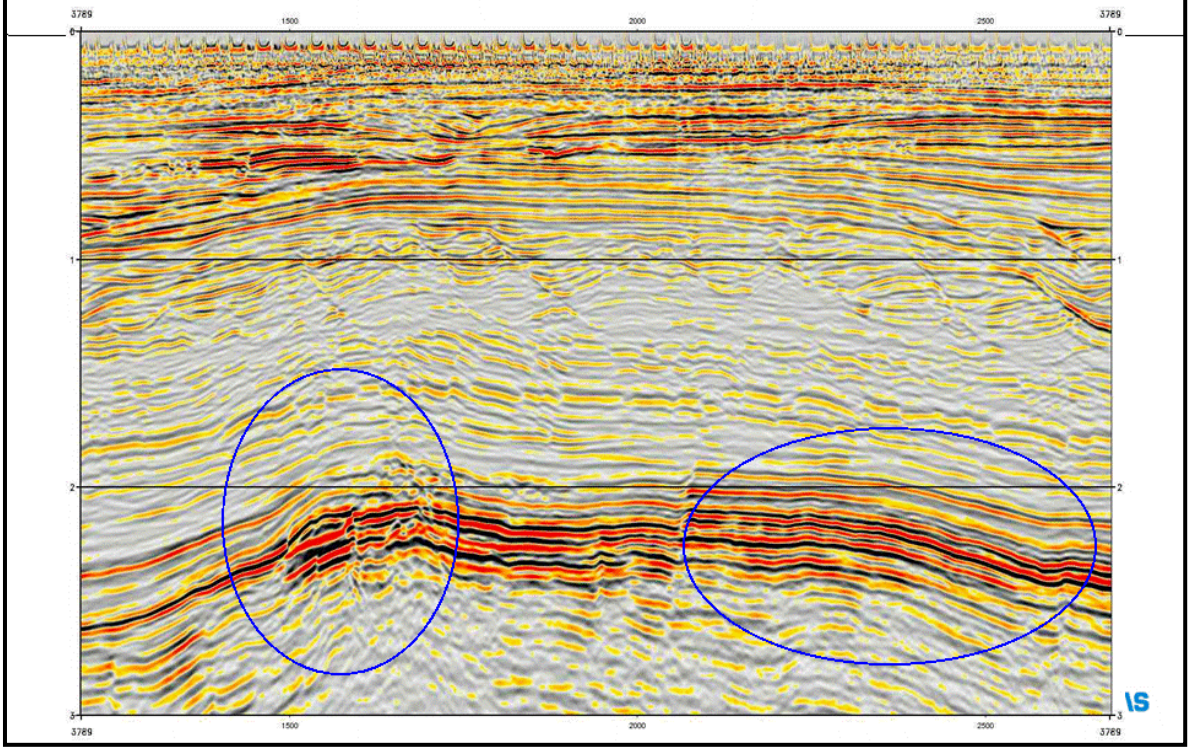
IL 3789: CBM stack with initial model



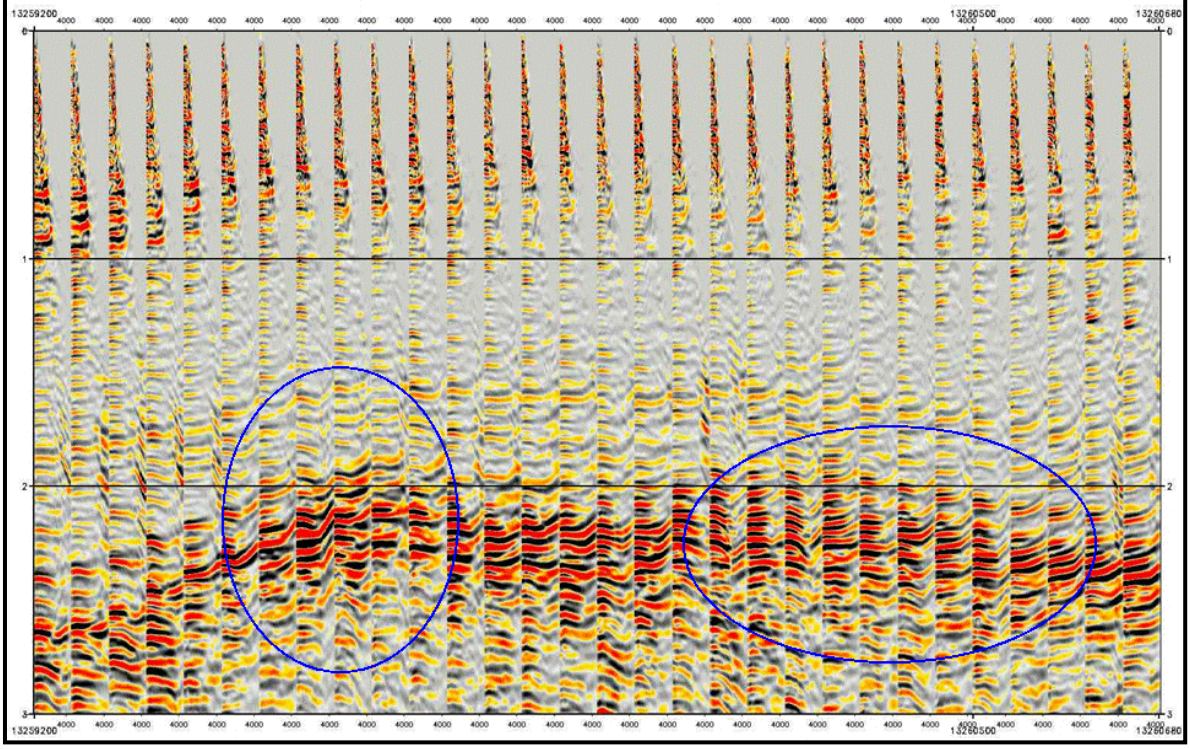
IL 3789: CBM stack with RCA model



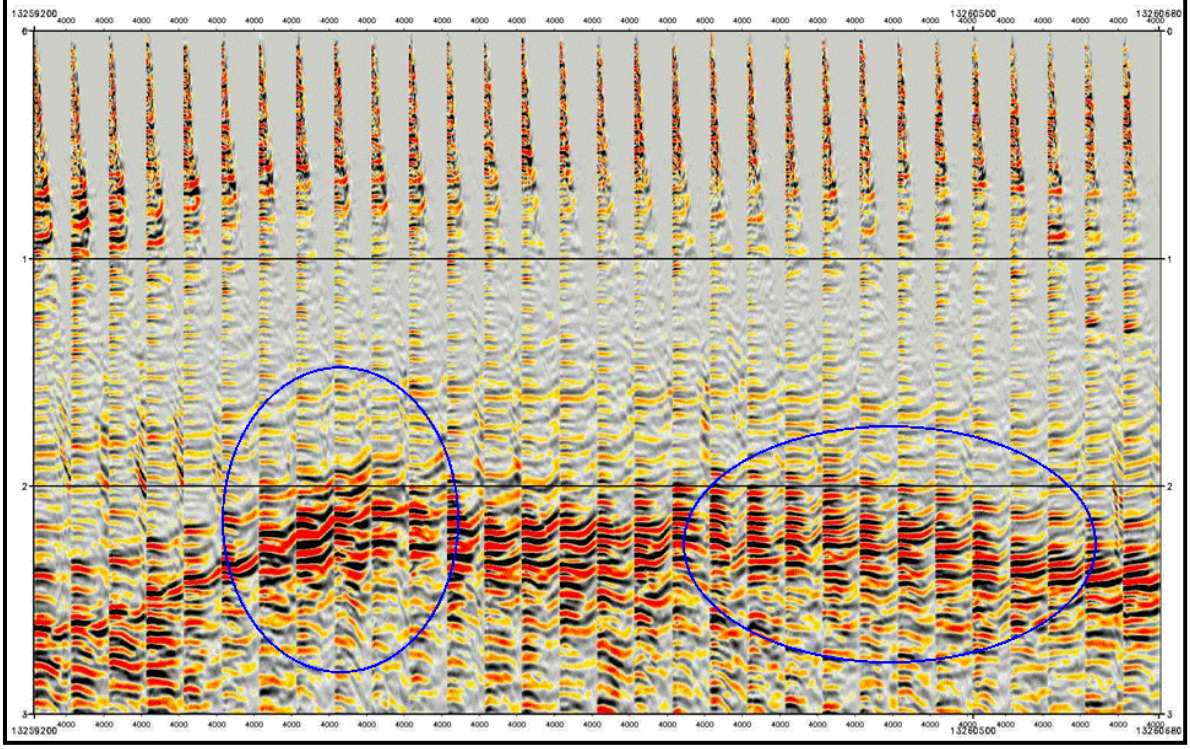
IL 3789: CBM stack with anisotropy model

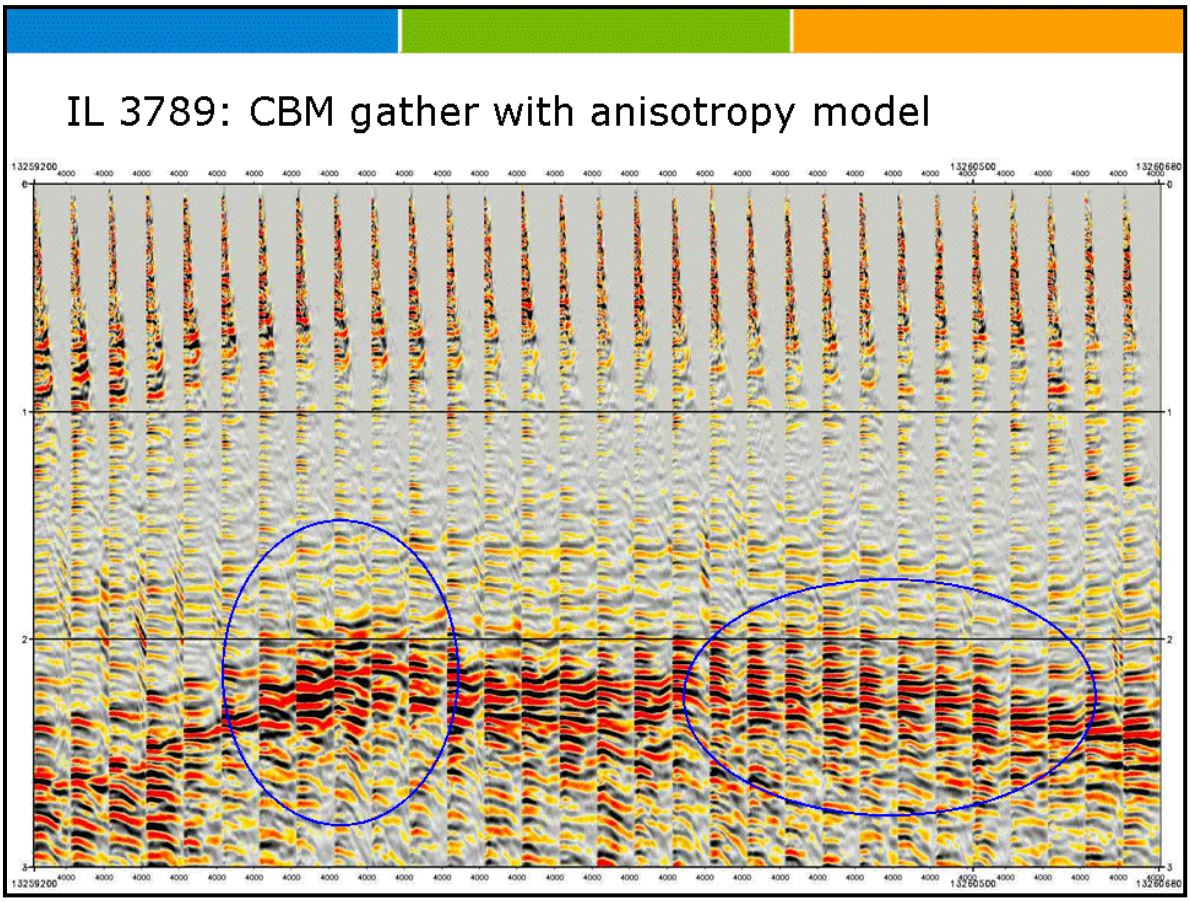


IL 3789: CBM gather with initial model



IL 3789: CBM gather with RCA model




IL 3789: CBM gather with anisotropy model
13259200
13260500
13260680
0
1
2
3

2.7 POST MIGRATION PROCESSING

2.7.1 Amplitude Oriented Kinematics (AOK)

AOK is a method to correct seismic velocities based on attributes derived from AVO analysis. It improves the flatness of pre-stack gathers. A mute was applied to the input data. AOK is run in time domain. The migration gathers were stretched to time domain. The parameters used in the AOK are as follows:

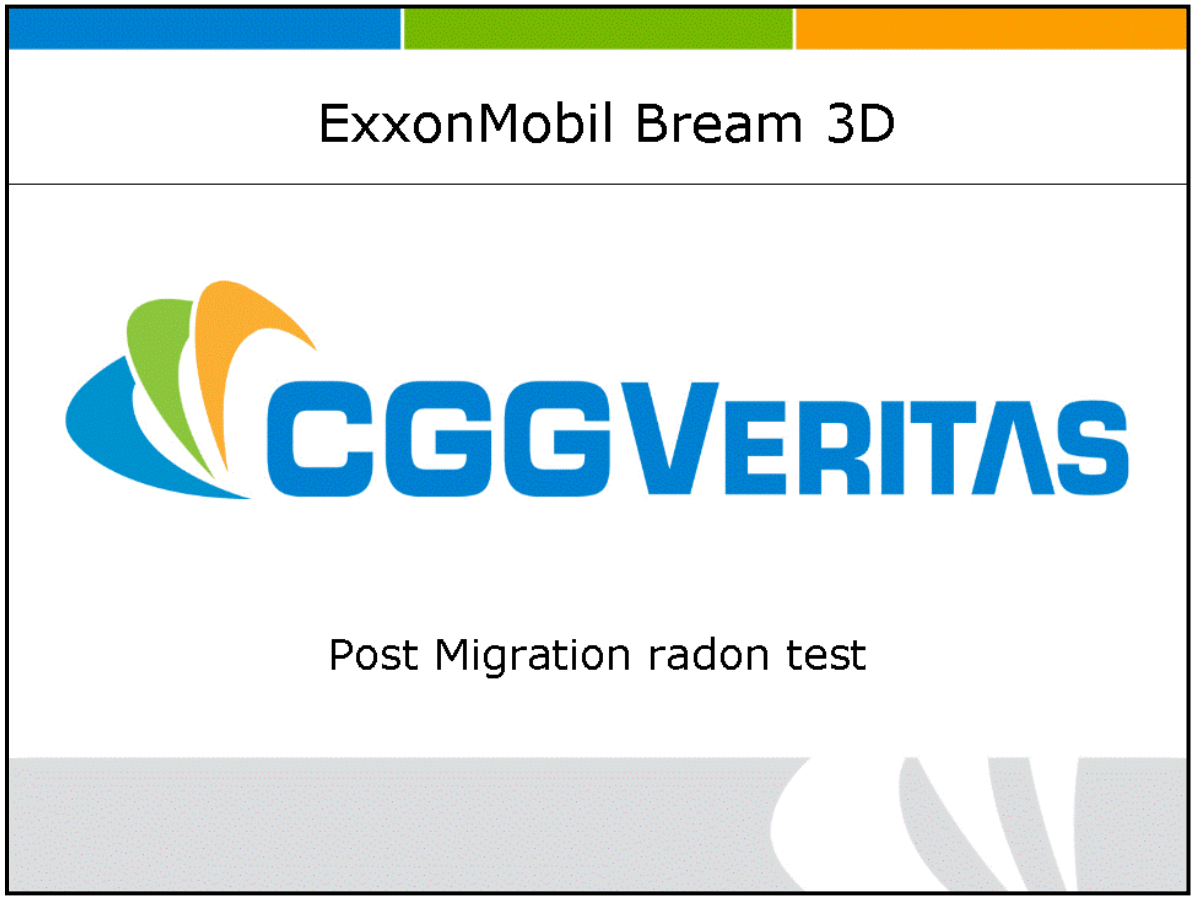
- Input RMS velocity was created by converting the final CBM depth interval velocity to time RMS velocity.
- Window length: 35 traces
- Application start time: 400ms

Mute applied prior to AOK:

Offset (m)	Time (ms)
400	0
1000	660
4525	1900

2.7.2 High resolution Radon Demultiple (XRMULT)

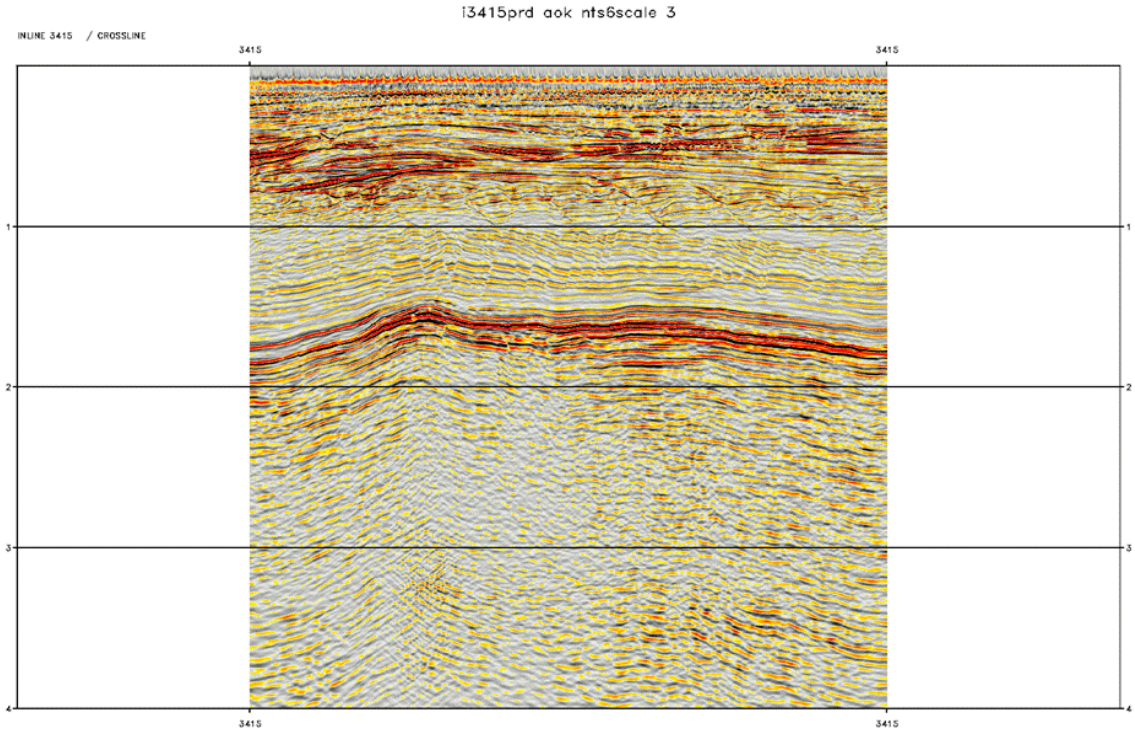
The Radon demultiple test was performed on the pre-stack CBM gathers at inline 3415 and inline 4321 which had been stretched to time domain with the CBM velocity. Transform range was -1500 to 3000ms. Three sets of protection range were tested. Protection range -1500 to 100ms was chosen in production.



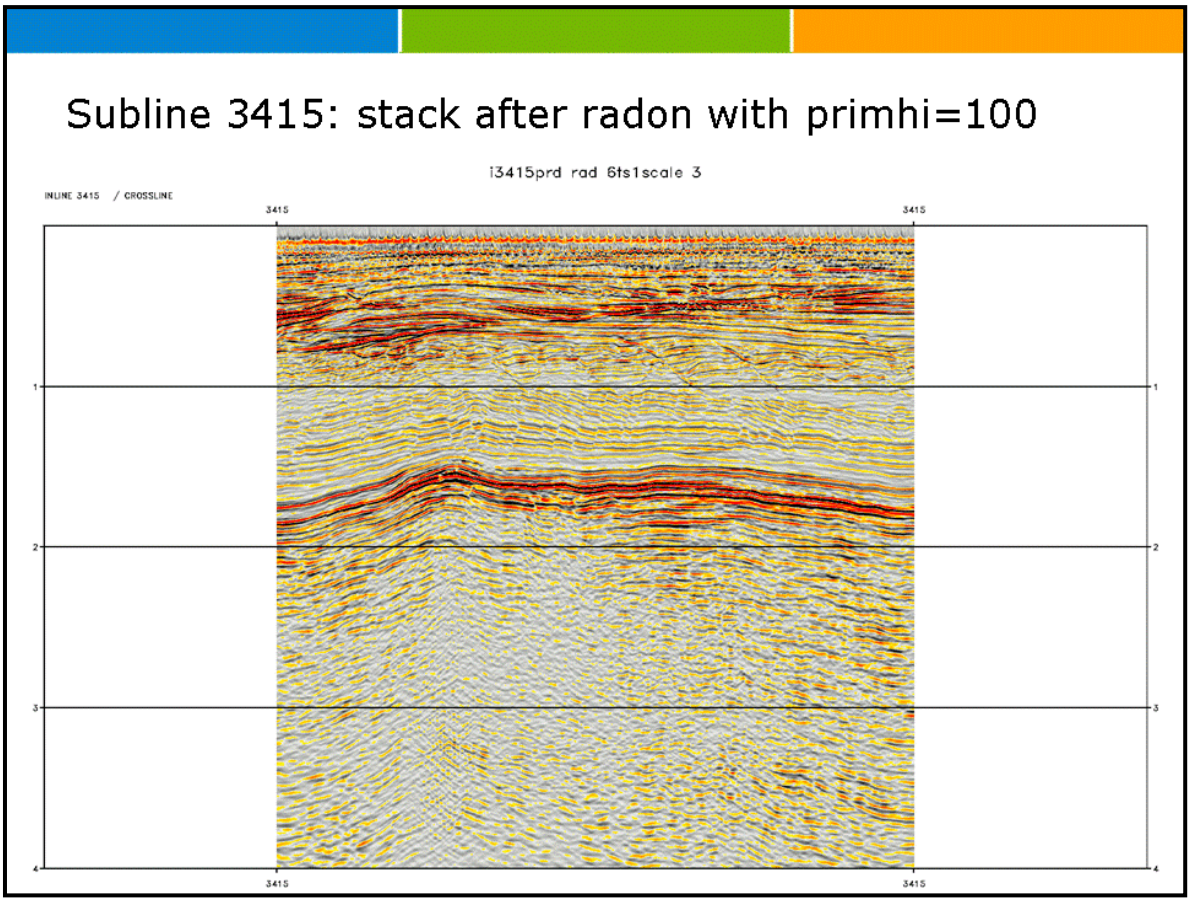
Outline

- Gathers and stacks displayed.
- Two sublines chosen (IL 3415, IL4321).
- Processing sequence
  - CBM
  - Stretch gathers to time domain
  - AOK
  - Radon, movlo=-1500, movhi=3000
    - Primlo=-1500, primhi=100
    - Primlo=-1500, primhi=150
    - Primlo=-1500, primhi=200
- For display purpose, we applied time variant scalar to boost up deep part
  - Time=0, scalar=0dB
  - Time=1900, scalar=0dB
  - Time=3000, scalar=9dB
  - Time=4000, scalar=6dB

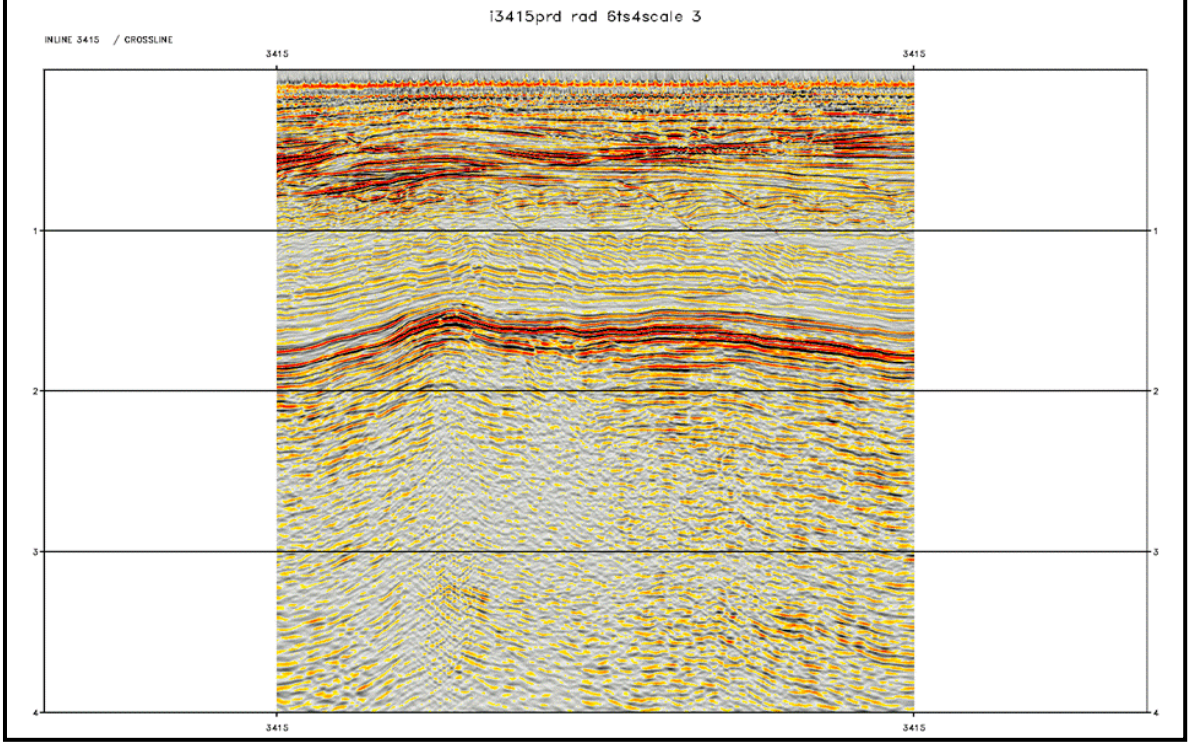
Subline 3415: stack w/o radon



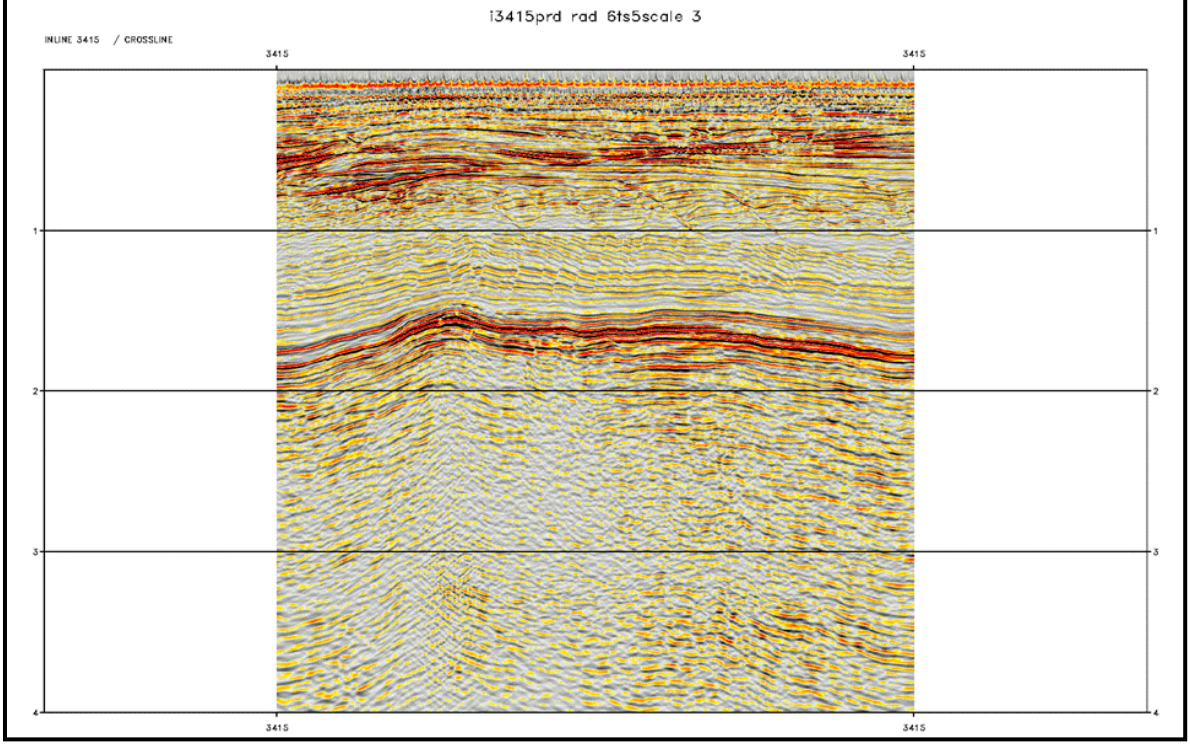
Subline 3415: stack after radon with primhi=100



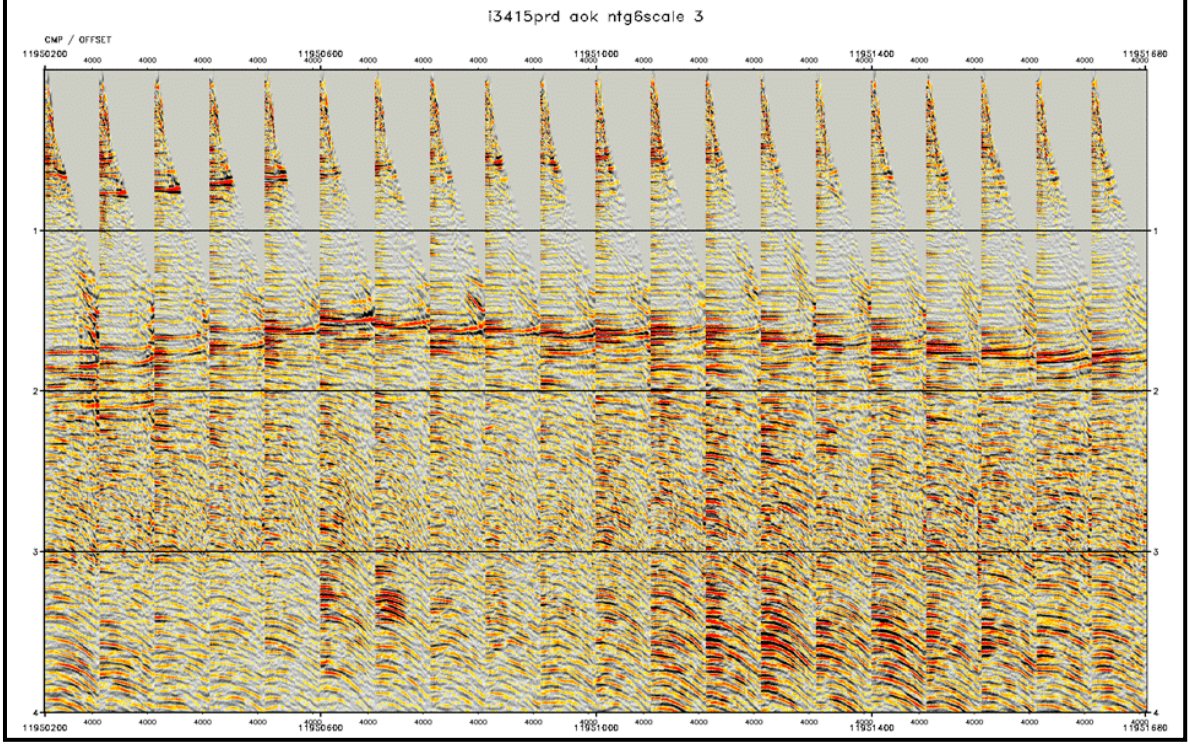
Subline 3415: stack after radon with primhi=150



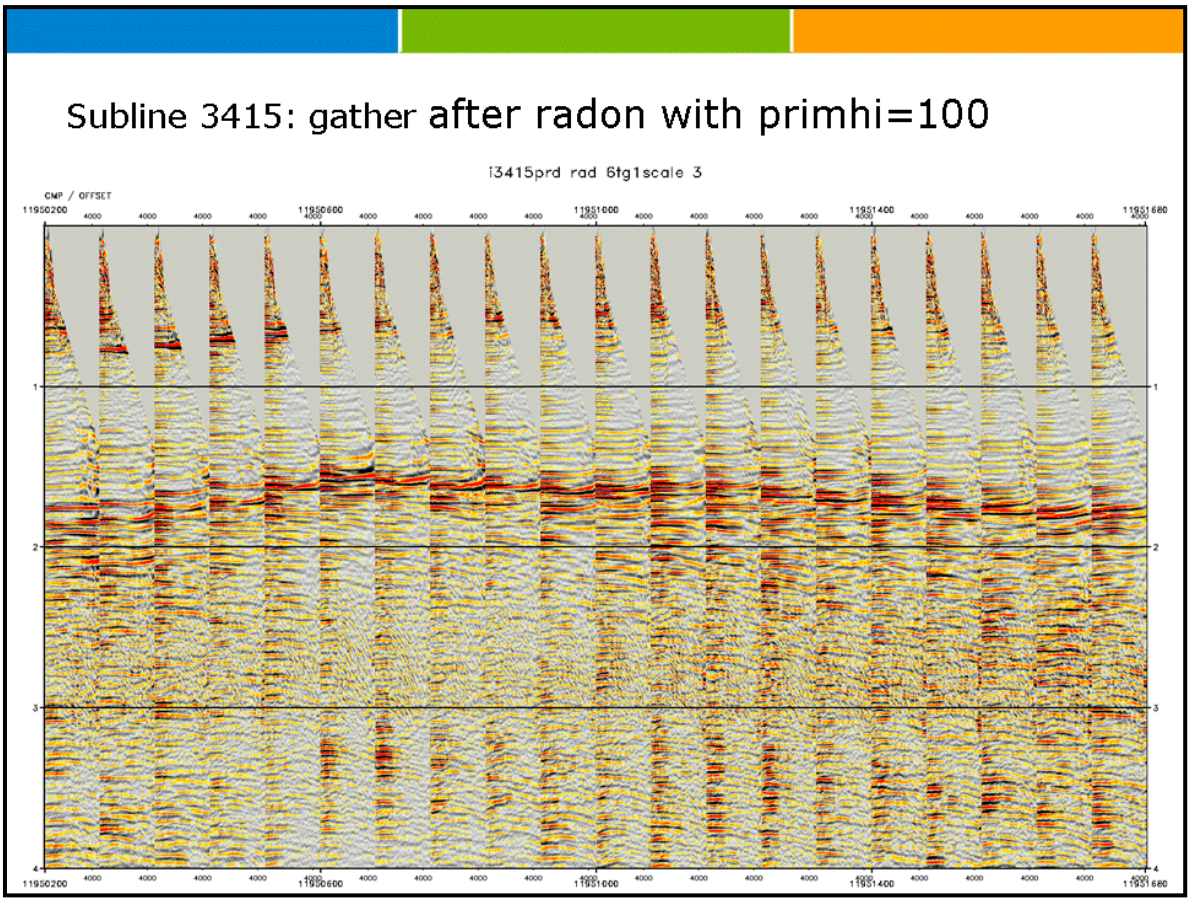
Subline 3415: stack after radon with primhi=200



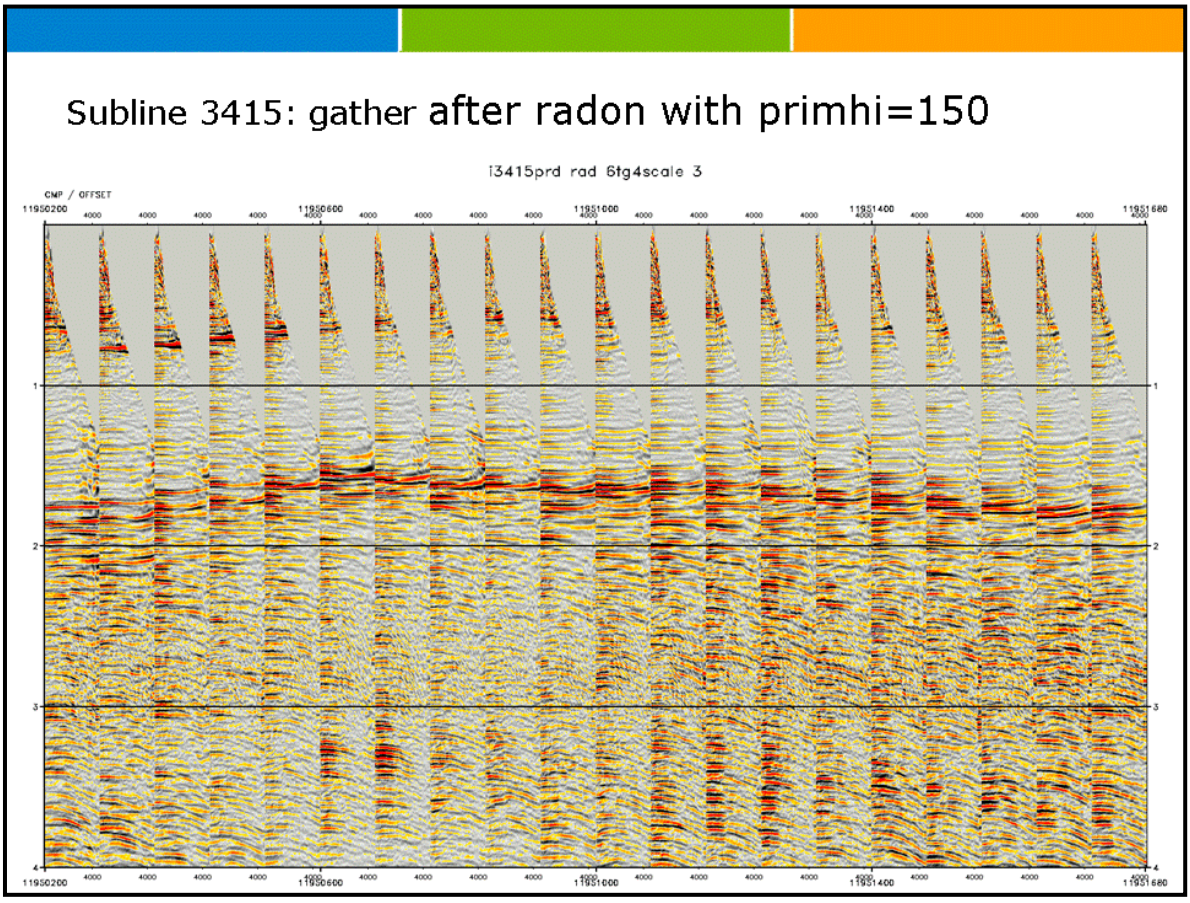
Subline 3415: gather w/o radon



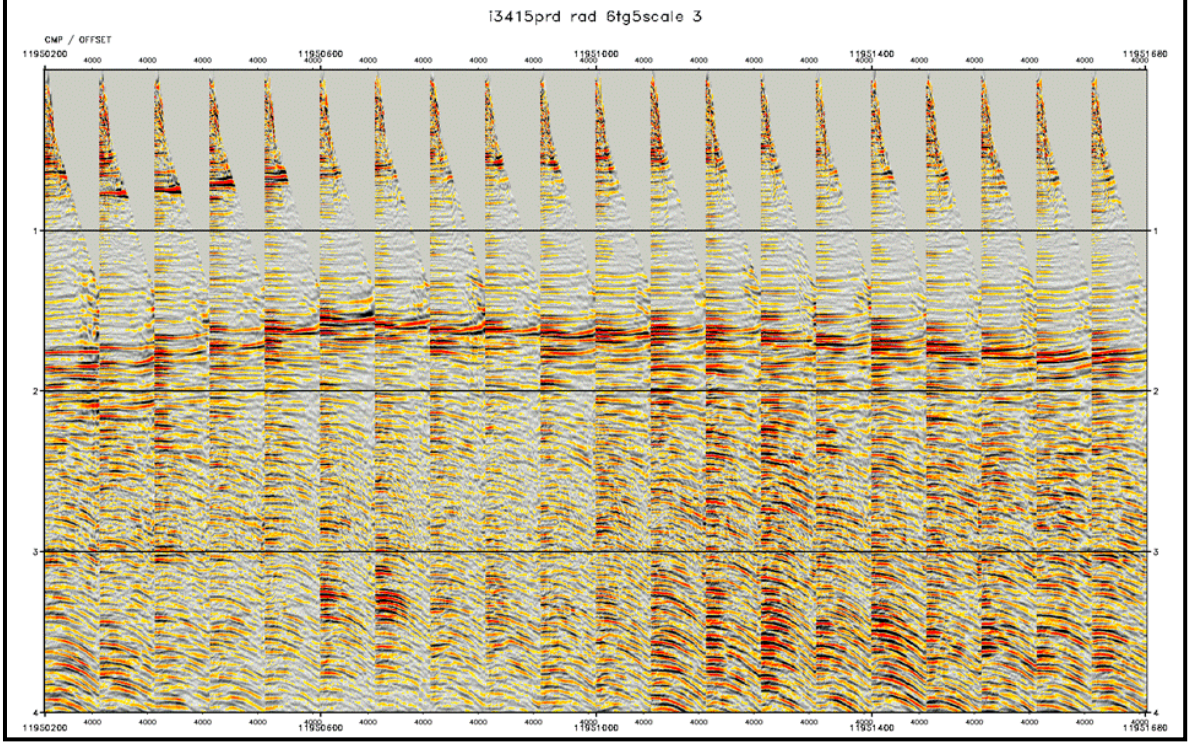
Subline 3415: gather after radon with primhi=100



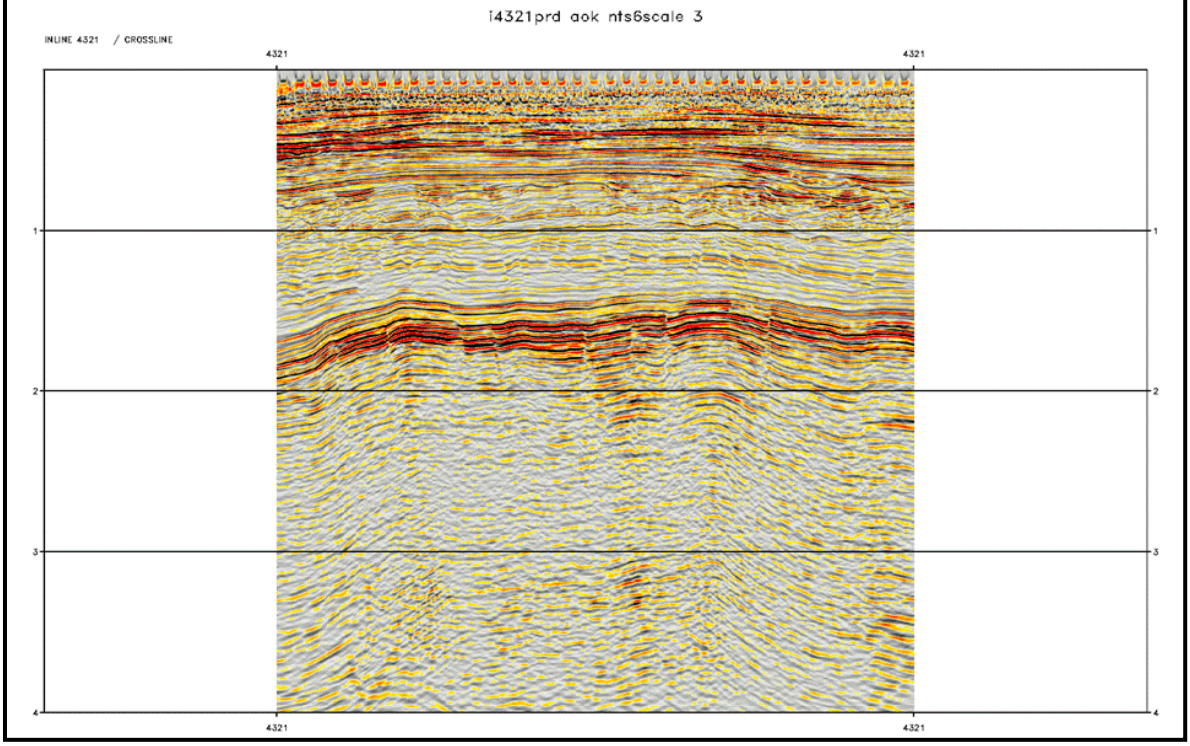
Subline 3415: gather after radon with primhi=150



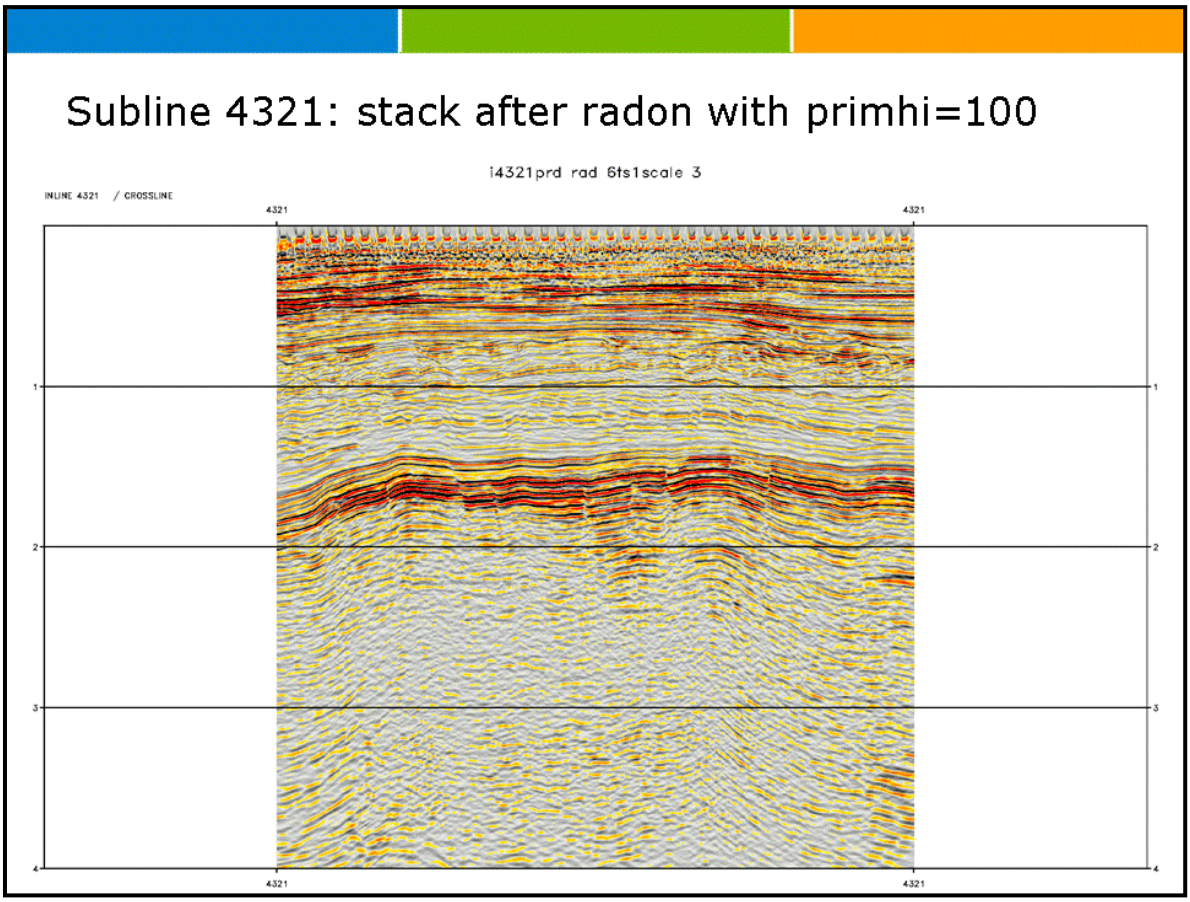
Subline 3415: gather after radon with primhi=200



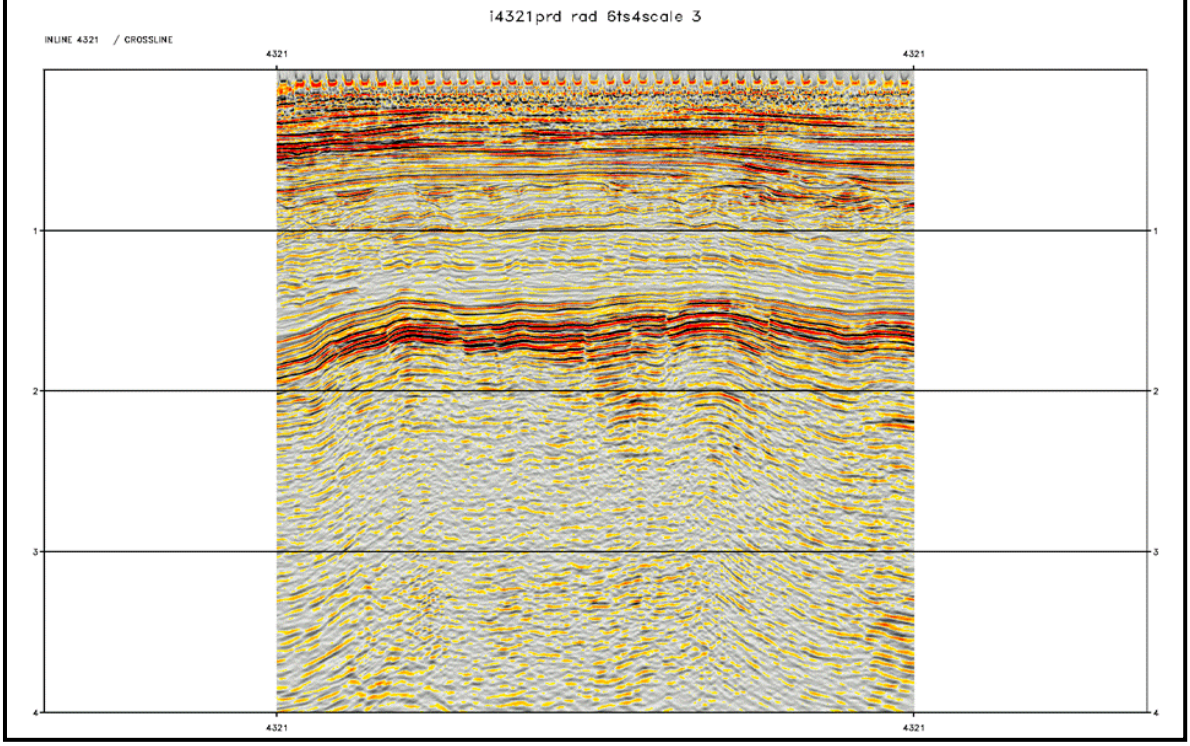
Subline 4321: stack w/o radon



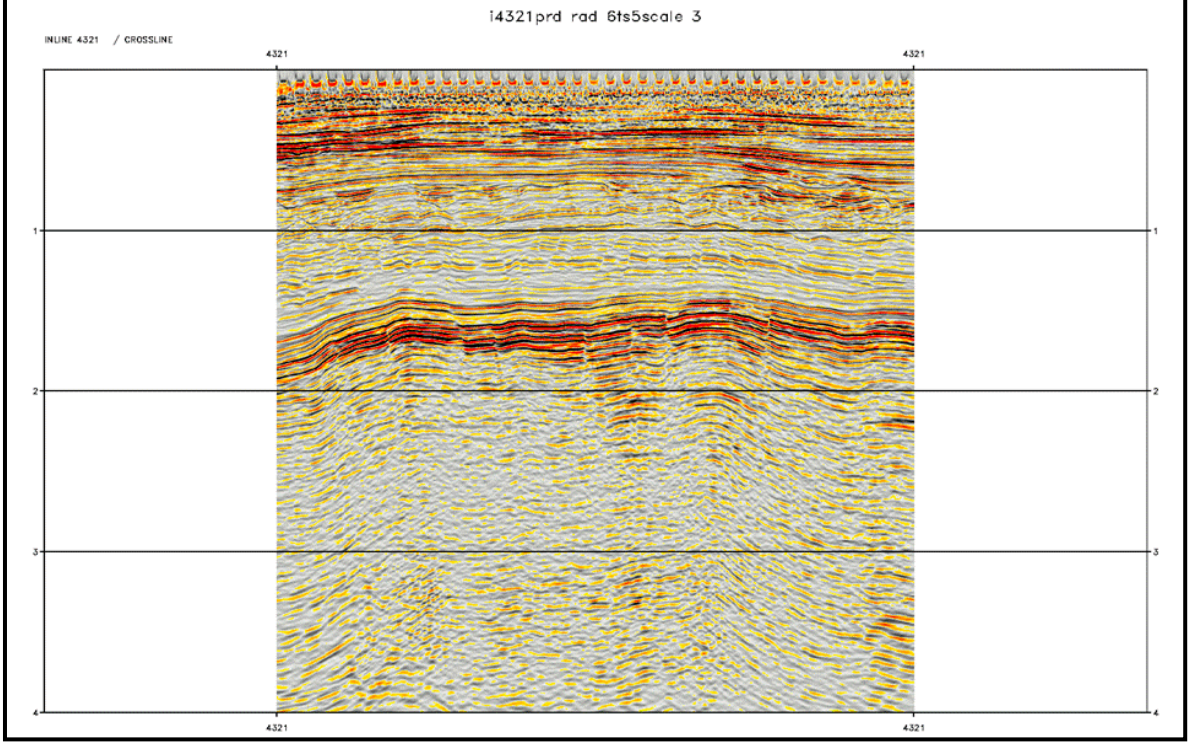
Subline 4321: stack after radon with primhi=100



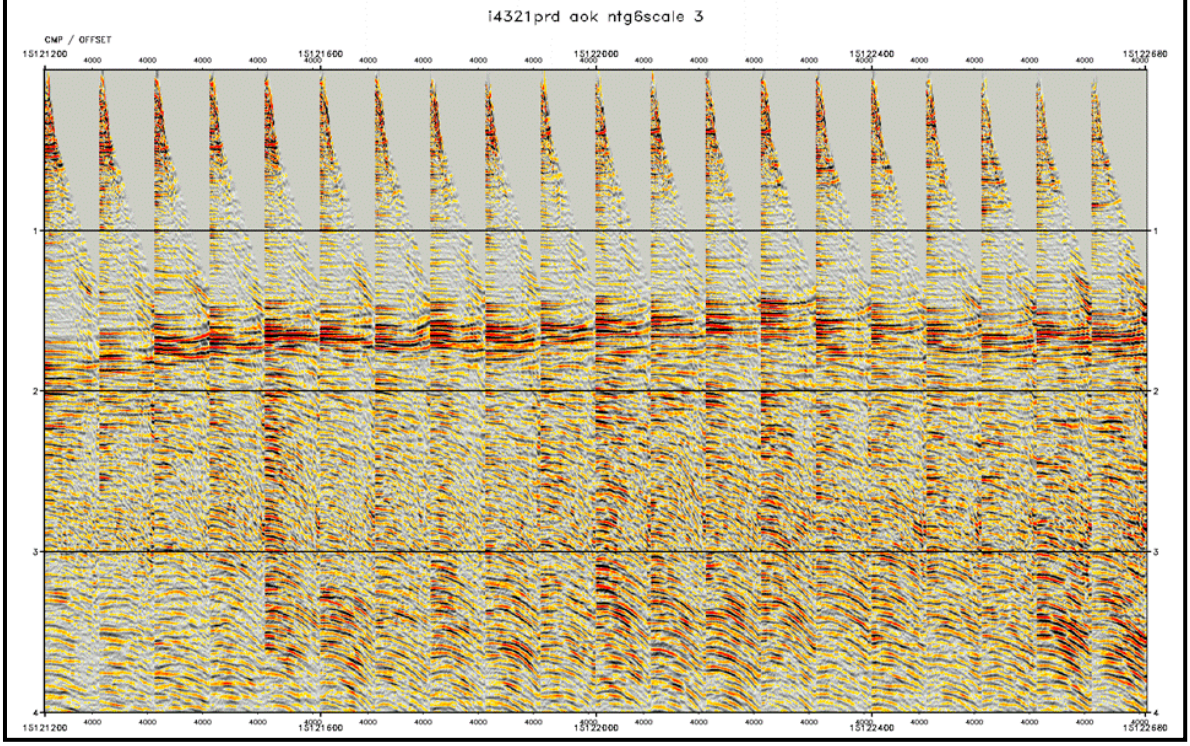
Subline 4321: stack after radon with primhi=150



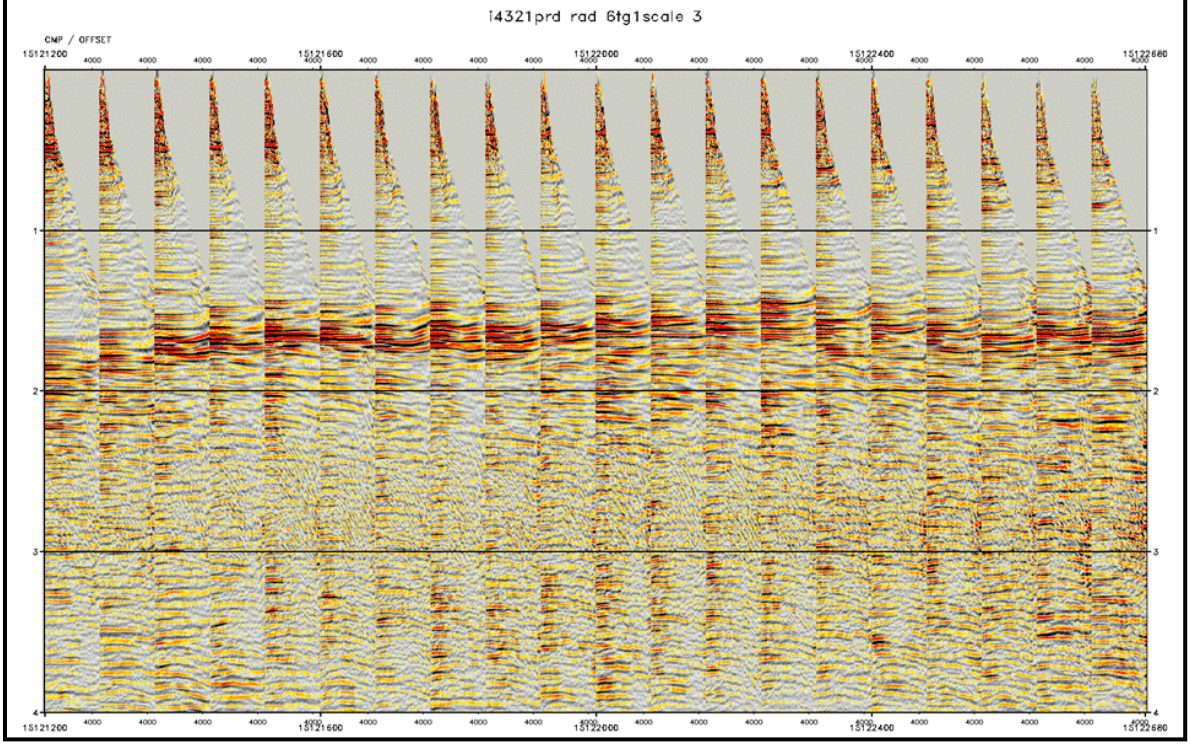
Subline 4321: stack after radon with primhi=200



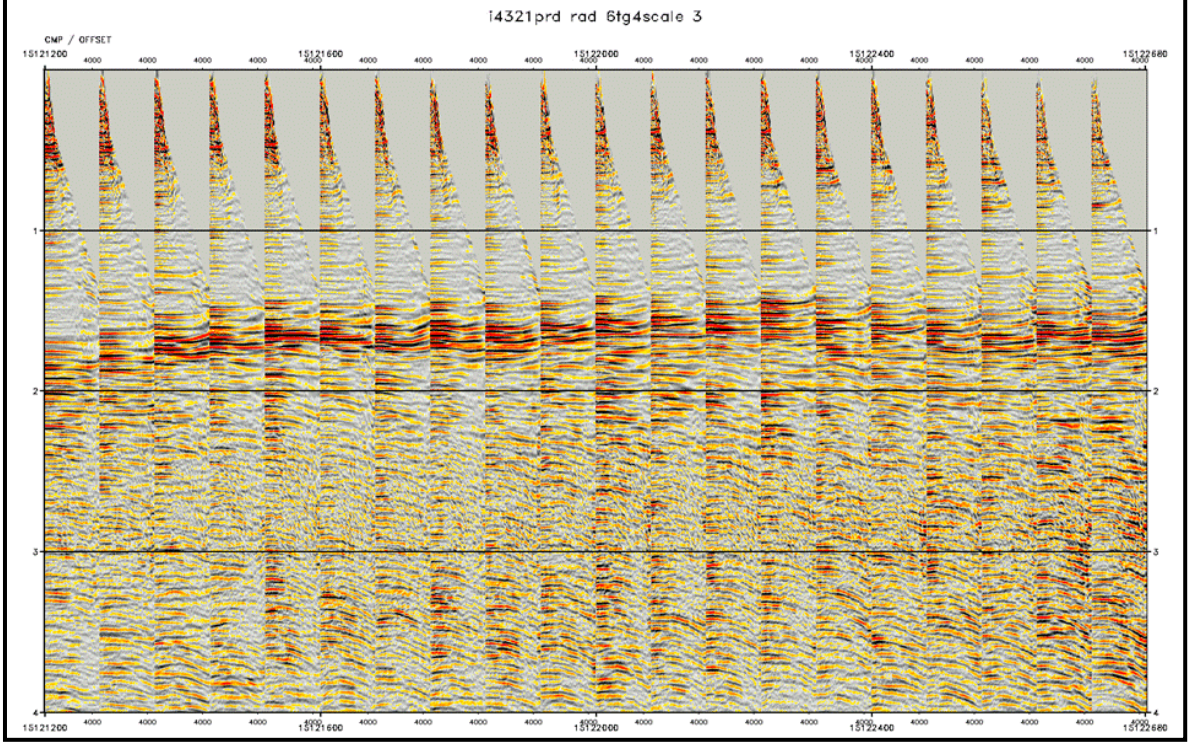
Subline 4321: gather w/o radon



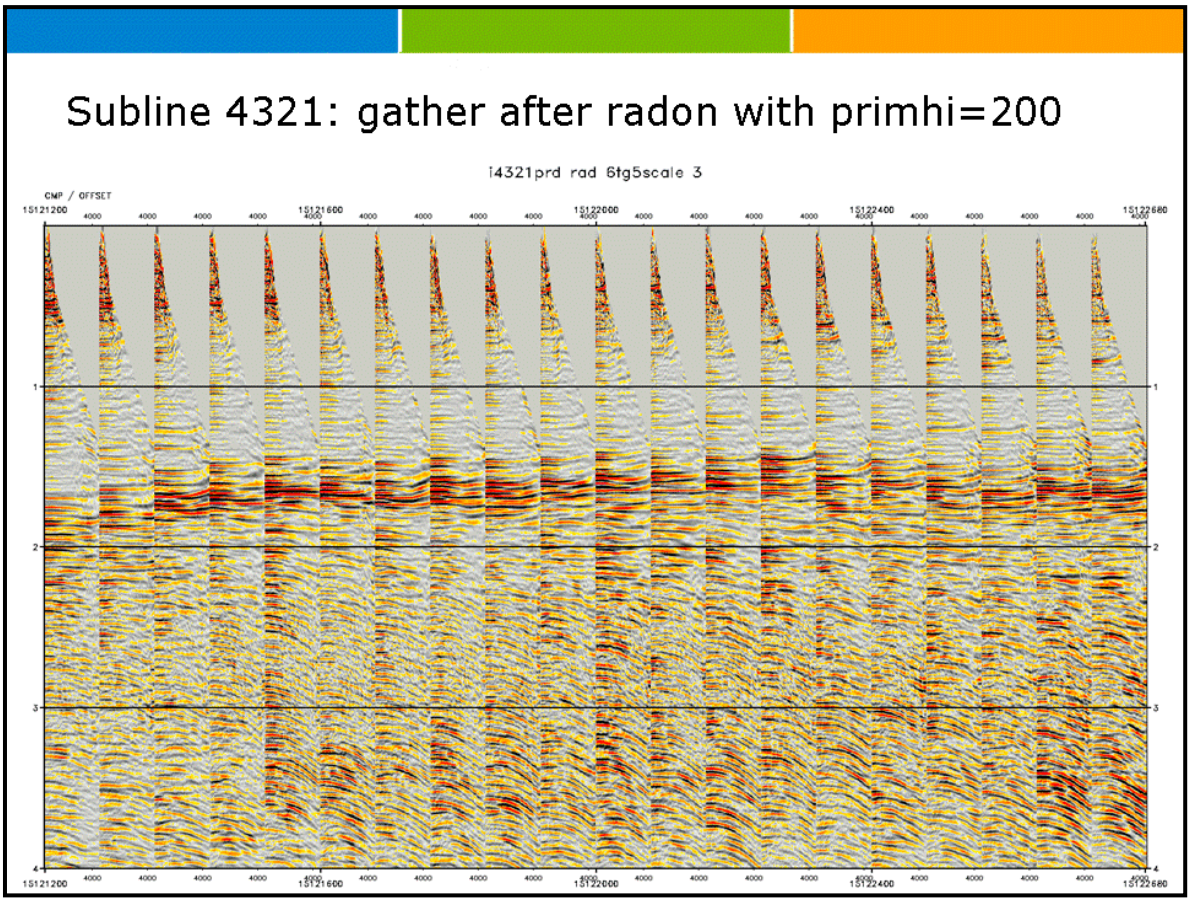
Subline 4321: gather after radon with primhi=100



Subline 4321: gather after radon with primhi=150



Subline 4321: gather after radon with primhi=200



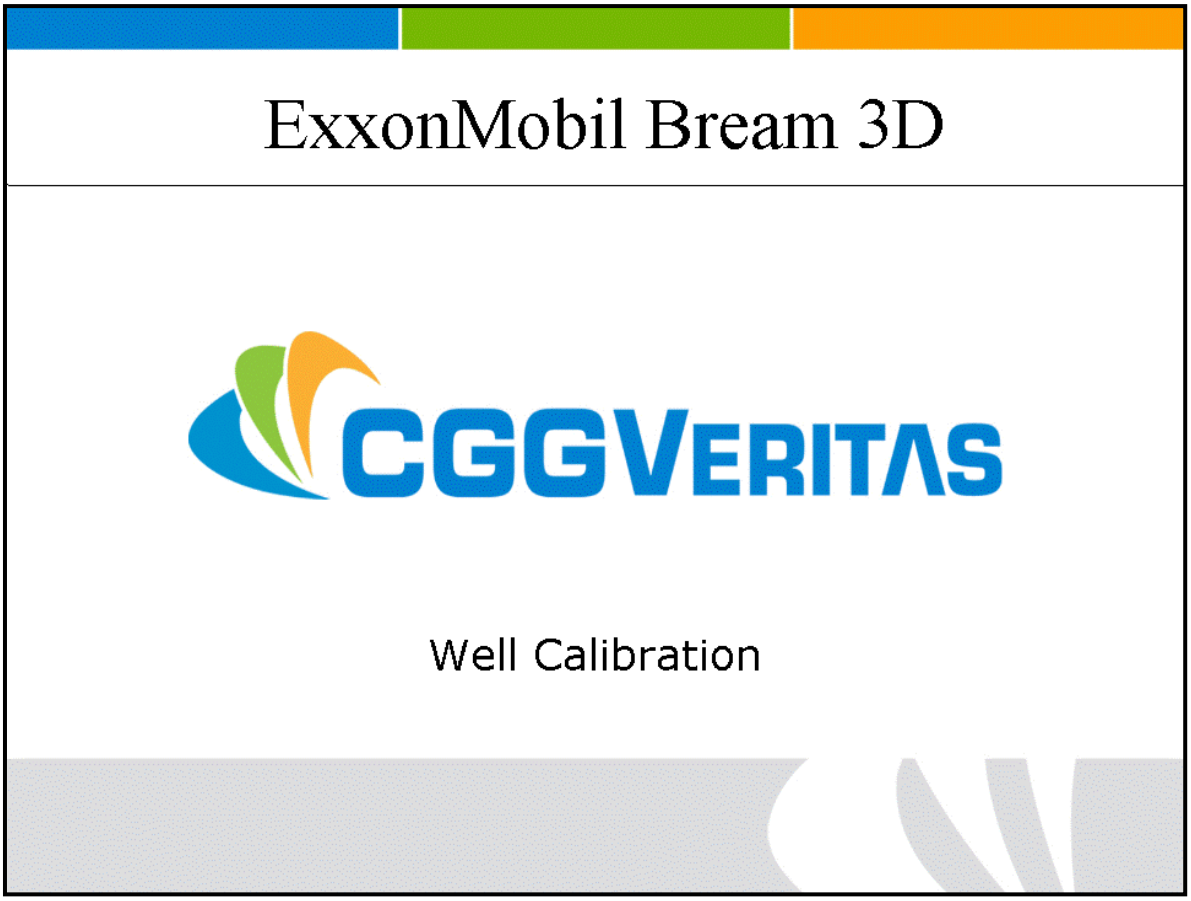
2.7.3 Stacking mute

The stacking mute applied to pre-stack CBM gathers was the same as that applied to the pre-stack PSTM gathers (Please refer to Section 3.2.23 on page 11 of ***BREAM_REPORT***).

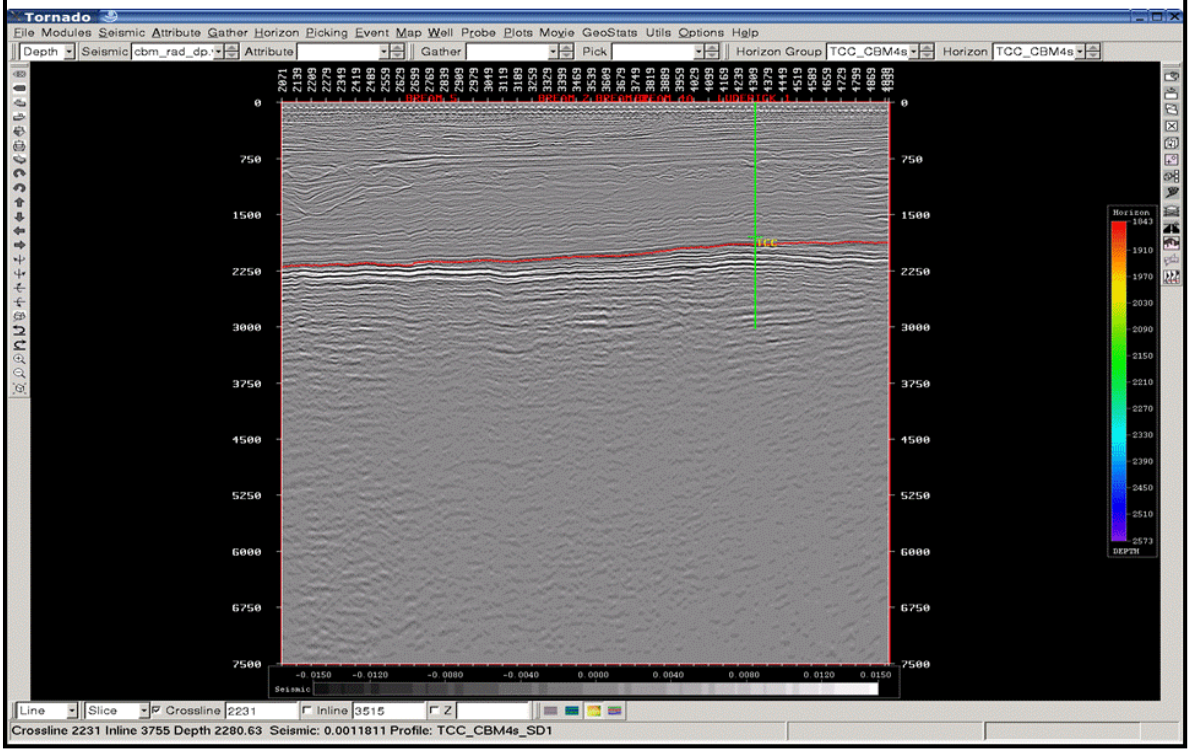
2.7.4 Well calibration

In velocity model building stage, we focused our effort to get best image of structures and hadn't tried to tie with the well markers. After migration and stacking, the stacks need to be calibrated with well markers. It was carried out by perturbing the velocity model below the water bottom to match the coal horizon with five wells. The five wells are luderick1, bream2, bream3, bream4a, bream5.

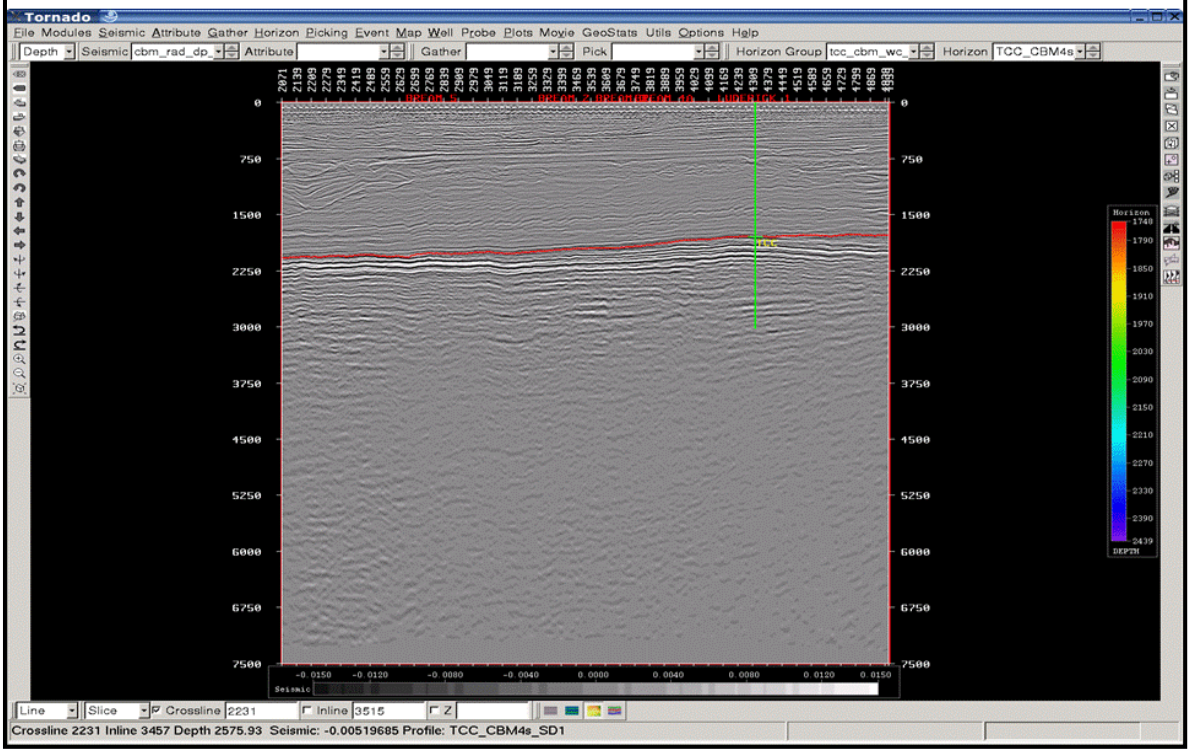
After getting the well-tie velocity, the seismic depth stack is converted to time using migration velocity, and back to depth using the well-tie velocity. The new depth stack should tie with wells.



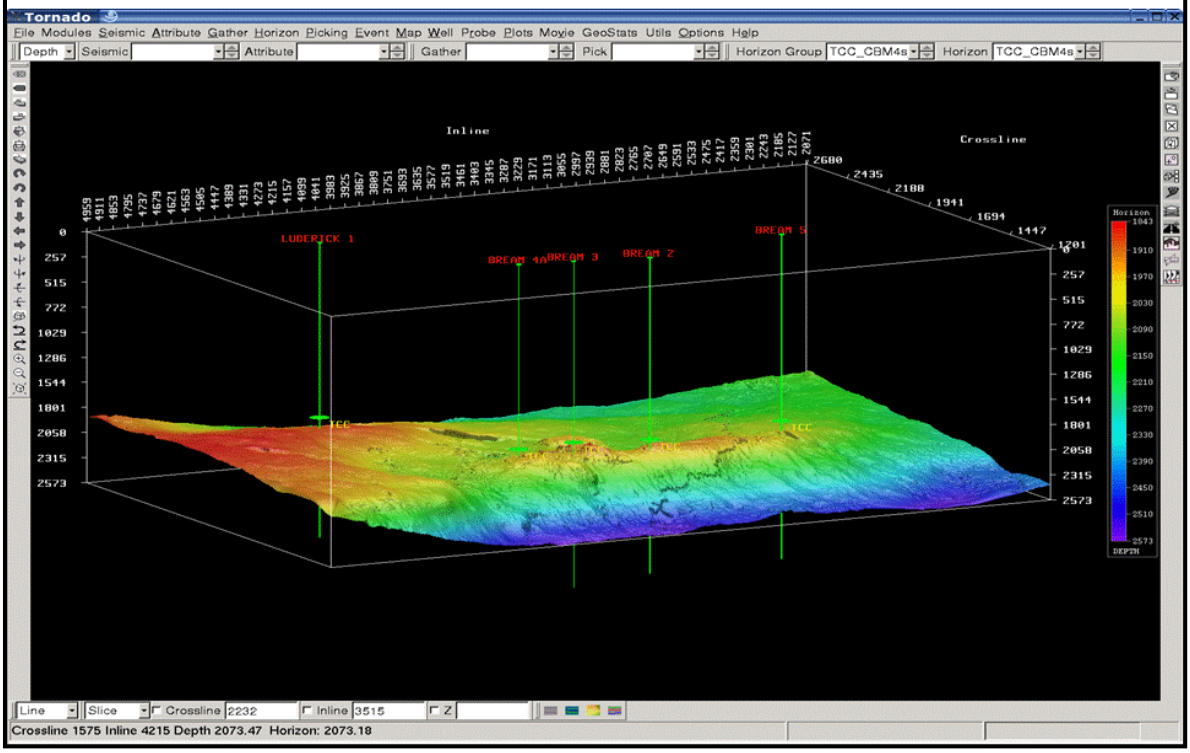
XL 2231 before well calibration (well: Luderick-1)



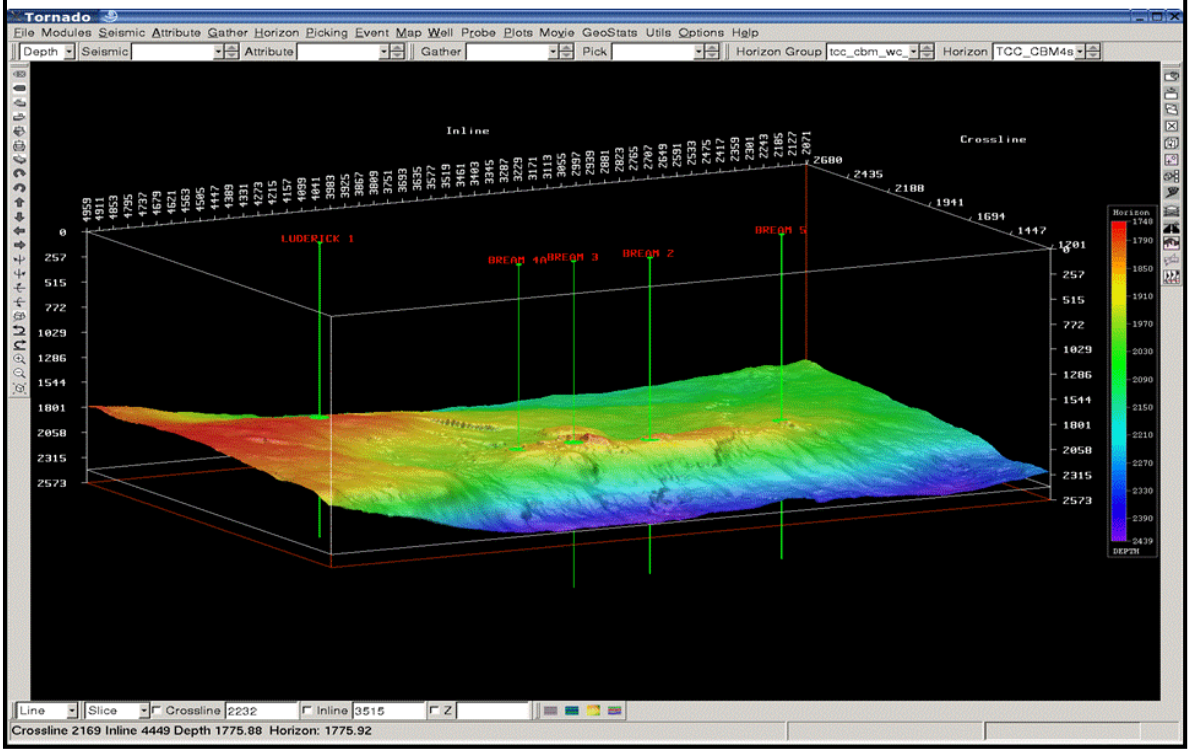
XL 2231 after well calibration (well: Luderick-1)



3D view before well calibration



3D view after well calibration



Well mistie


Tornado
File Modules Seismic Attribute Gather Horizon Picking Event Map Well Probe Plots Movie GeoStats Utils Options Help
Under shooting area
inline
Crossline 2637 Inline 4355 Depth -103.645 Horizon: -103.634

APPENDIX A – DELIVERABLE ITEMS

A0 PROCESSING DELIVERABLE LIST

CBM FINAL CUBE					
NO	**DATA TYPE**	**FORMAT**	**OUTPUT MEDIA**	**TAPE ID.**	**DESTINATION**
1	CBM Full Offset Stack in Time (6s), 12.5x18.75m	SEG-Y	3590	EXX_CBM13KTSTK_1, EXX_CBM13KTSTK_2	Esso Australia Pty Ltd
2	CBM Full Offset Stack in Depth (13km), 12.5x18.75m	SEG-Y	3590	EXX_CBM13KDSTK_1 TO EXX_CBM13KDSTK_4	Esso Australia Pty Ltd
3	CBM Full Offset Stack in Time (4s), 12.5x9.375m	SEG-Y	3590	EXX_CBM7K5TSTK_1, EXX_CBM7K5TSTK_2	Esso Australia Pty Ltd
4	CBM Full Offset Stack in Depth (7.5km), 12.5x9.375m	SEG-Y	3590	EXX_CBM7K5DSTK_1 TO EXX_CBM7K5DSTK_4	Esso Australia Pty Ltd

CBM ANGLE STACKS					
NO	**DATA TYPE**	**FORMAT**	**OUTPUT MEDIA**	**TAPE ID.**	**DESTINATION**
5	CBM Near Angle Stack in Time (4s), 12.5x9.375m	SEG-Y	3590	EXX_CBM7K5NATSTK_1, EXX_CBM7K5NATSTK_2	Esso Australia Pty Ltd
6	CBM Mid Angle Stack in Time (4s), 12.5x9.375m	SEG-Y	3590	EXX_CBM7K5MATSTK_1, EXX_CBM7K5MATSTK_2	Esso Australia Pty Ltd
7	CBM Far Angle Stack in Time (4s), 12.5x9.375m	SEG-Y	3590	EXX_CBM7K5FATSTK_1, EXX_CBM7K5FATSTK_2	Esso Australia Pty Ltd
8	CBM Ultra Far Angle Stack in Time (4s), 12.5x9.375m	SEG-Y	3590	EXX_CBM7K5UATSTK_1, EXX_CBM7K5UATSTK_2	Esso Australia Pty Ltd
CBM FULL OFFSET STACK WELL-CALIBRATED					
NO	**DATA TYPE**	**FORMAT**	**OUTPUT MEDIA**	**TAPE ID.**	**DESTINATION**
9	CBM Full Offset Stack Well-calibrated in Depth (13km), 12.5x18.75m	SEG-Y	3590	EXX_CBM13KWCDSTK_1 TO EXX_CBM13KWCDSTK_4	Esso Australia Pty Ltd
CBM MIGRATION VELOCITY FIELD					
NO	**DATA TYPE**	**FORMAT**	**OUTPUT MEDIA**	**TAPE ID.**	**DESTINATION**
10	CBM Migration Velocity Field (interval in depth)	SEG-Y	3590	EXX_CBMFNLVEL_DL_1	Esso Australia Pty Ltd
11	CBM Migration Velocity Field (interval in time)	SEG-Y	3590	EXX_CBMFNLVEL_TL_1	Esso Australia Pty Ltd

CBM AOK VELOCITY FIELD					
NO	**DATA TYPE**	**FORMAT**	**OUTPUT MEDIA**	**FILE NAME.**	**DESTINATION**
12	CBM AOK Velocity Field (time RMS)	ASCII	CD	cbm_4s_avel_sm.gz	Esso Australia Pty Ltd

CBM GAMMA VOLUME						
NO	**DATA TYPE**	**FORMAT**	**OUTPUT MEDIA**	**CD ID.**	**FILE NAME**	**DESTINATION**
13	CBM Gamma Volume	SEG-Y	CD	CBM_FNL_GAM	cbm_fnl_gam.sgy	Esso Australia Pty Ltd

CBM WELL-TIE INTERVAL VELOCITY FIELD					
NO	**DATA TYPE**	**FORMAT**	**OUTPUT MEDIA**	**TAPE ID.**	**DESTINATION**
14	CBM Well-tie Interval Velocity Field in Depth	SEG-Y	3590	EXX_CBMWCVEL_DL_1	Esso Australia Pty Ltd
15	CBM Well-tie Interval Velocity Field in Time	SEG-Y	3590	EXX_CBMWCVEL_TL_1	Esso Australia Pty Ltd

CBM WELL-TIE INTERVAL VELOCITY FIELD						
NO	**DATA TYPE**	**FORMAT**	**OUTPUT MEDIA**	**DVD ID.**	**FILE NAME**	**DESTINATION**
16	CBM Well-tie Interval Velocity Field in Depth	SEG-Y	DVD	CBM_welltie_vel	cbm_wc_vel_dl.sgy	Esso Australia Pty Ltd
17	CBM Well-tie Interval Velocity Field in Time	SEG-Y	DVD	CBM_welltie_vel	cbm_wc_vel_tl.sgy	Esso Australia Pty Ltd

CBM FINAL PROCESSING REPORT						
NO	**DATA TYPE**	**FORMAT**	**OUTPUT MEDIA**	**CD ID.**	**FILE NAME**	**DESTINATION**
18	CBM Final Processing Report	PDF	CD	BREAM_CBM_REPORT	bream_cbm_report.pdf	Esso Australia Pty Ltd

CBM FINAL CUBE					
NO	**DATA TYPE**	**FORMAT**	**OUTPUT MEDIA**	**TAPE ID.**	**DESTINATION**
19	CBM Full Offset Stack in Time (6s), 12.5x18.75m	SEG-Y	3590	EXX_CBM13KTSTK_1, EXX_CBM13KTSTK_2	BHPBilliton Petroleum Limited Pty Ltd
20	CBM Full Offset Stack in Depth (13km), 12.5x18.75m	SEG-Y	3590	EXX_CBM13KDSTK_1 TO EXX_CBM13KDSTK_4	BHPBilliton Petroleum Limited Pty Ltd
CBM MIGRATION VELOCITY FIELD					
NO	**DATA TYPE**	**FORMAT**	**OUTPUT MEDIA**	**TAPE ID.**	**DESTINATION**
21	CBM Migration Velocity Field (interval in depth)	SEG-Y	3590	EXX_CBMFNLVEL_DL_1	BHPBilliton Petroleum Limited Pty Ltd
22	CBM Migration Velocity Field (interval in time)	SEG-Y	3590	EXX_CBMFNLVEL_TL_1	BHPBilliton Petroleum Limited Pty Ltd

CBM AOK VELOCITY FIELD						
NO	**DATA TYPE**	**FORMAT**	**OUTPUT MEDIA**	**DVD ID.**	**FILE NAME.**	**DESTINATION**
23	CBM AOK Velocity Field (time RMS)	ASCII	DVD	CBM_misc_CGGV	cbm_4s_avel_sm.gz	BHPBilliton Petroleum Limited Pty Ltd

CBM GAMMA VOLUME						
NO	**DATA TYPE**	**FORMAT**	**OUTPUT MEDIA**	**DVD ID.**	**FILE NAME**	**DESTINATION**
24	CBM Gamma Volume	SEG-Y	DVD	CBM_misc_CGGV	cbm_fnl_gam.sgy	BHPBilliton Petroleum Limited Pty Ltd

CBM WELL-TIE INTERVAL VELOCITY FIELD						
NO	**DATA TYPE**	**FORMAT**	**OUTPUT MEDIA**	**DVD ID.**	**FILE NAME**	**DESTINATION**
25	CBM Well-tie Interval Velocity Field in Depth	SEG-Y	DVD	CBM_misc_CGGV	cbm_wc_vel_dl.sgy	BHPBilliton Petroleum Limited Pty Ltd
26	CBM Well-tie Interval Velocity Field in Time	SEG-Y	DVD	CBM_misc_CGGV	cbm_wc_vel_tl.sgy	BHPBilliton Petroleum Limited Pty Ltd
CBM FINAL PROCESSING REPORT						
NO	**DATA TYPE**	**FORMAT**	**OUTPUT MEDIA**	**CD ID.**	**FILE NAME**	**DESTINATION**
27	CBM Final Processing Report	PDF	CD	BREAM_CBM_REPORT	bream_cbm_report.pdf	BHPBilliton Petroleum Limited Pty Ltd
			PAPER			

CBM FINAL CUBE					
NO	**DATA TYPE**	**FORMAT**	**OUTPUT MEDIA**	**TAPE ID.**	**DESTINATION**
28	CBM Full Offset Stack in Depth (13km), 12.5x18.75m	SEG-Y	3590	EXX_CBM13KDSTK_1 TO EXX_CBM13KDSTK_4	Esso Australia Pty Ltd For Government

CBM MIGRATION VELOCITY FIELD						
NO	**DATA TYPE**	**FORMAT**	**OUTPUT MEDIA**	**DVD ID**	**FILE NAME**	**DESTINATION**
29	CBM Migration Velocity Field (interval in depth)	SEG-Y	DVD	EXX_CBM_VEL	cbm_fnl_vel_dl.sgy	Esso Australia Pty Ltd For Government
30	CBM Migration Velocity Field (interval in time)	SEG-Y	DVD	EXX_CBM_VEL	cbm_fnl_vel_tl.sgy	Esso Australia Pty Ltd For Government

CBM FINAL PROCESSING REPORT						
NO	**DATA TYPE**	**FORMAT**	**OUTPUT MEDIA**	**CD ID.**	**FILE NAME**	**DESTINATION**
31	CBM Final Processing Report	PDF	CD	BREAM_CBM_REPORT	bream_cbm_report.pdf	Esso Australia Pty Ltd For Government

A1 SEG-Y ARCHIVE OF STACK

A1.1 CBM Full Offset Stack In Time Domain (6S)

CLIENT	:	ESSO AUSTRALIA PTY.LTD
AREA	:	BREAM 3D
PROCESS	:	FINAL CONTROLLED BEAM PSDM STACK (TIME DOMAIN, 6S)
SAMPLE RATE	:	4 MSEC
RECORD LENGTH	:	6000 MSEC
FORMAT	:	SEG-Y
DESTINATION	:	ESSO AUSTRALIA PTY.LTD, AUSTRALIA

TAPE NUMBER	TAPE TYPE	PROCESSING INLINE	CROSSLINE
EXX_CBM13KTSTK_1	3590	2071 – 3569	1200 – 2680
EXX_CBM13KTSTK_2	3590	3571 – 4959	1200 – 2680

BYTE NUMBERS	DESCRIPTION
001 – 004	TRACE SEQUENCE NUMBER
005 – 008	TRACE SEQUENCE NUMBER WITHIN REEL
021 – 024	CDP ENSEMBLE NUMBER
025 – 028	TRACE NUMBER
031 – 032	FOLD
103 – 104	TOTAL STATIC
115 – 116	NUMBER OF SAMPLES
117 – 118	SAMPLE RATE
181 – 184	PROCESSING INLINE NUMBER
185 – 188	ACQUISITION CROSSLINE NUMBER
189 – 192	ACQUISITION INLINE NUMBER
197 – 200 (IBM REAL)	CDP-X (CMP) CO-ORDINATE
201 – 204 (IBM REAL)	CDP-Y (CMP) CO-ORDINATE
205 – 208	CDP-X (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)
209 – 212	CDP-Y (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)

A1.2 CBM Full Offset Stack In Depth Domain (13KM)

CLIENT	:	ESSO AUSTRALIA PTY.LTD
AREA	:	BREAM 3D
PROCESS	:	FINAL CONTROLLED BEAM PSDM STACK (DEPTH DOMAIN 13KM)
SAMPLE RATE	:	4 M
RECORD LENGTH	:	13000 M
FORMAT	:	SEG-Y
DESTINATION	:	ESSO AUSTRALIA PTY.LTD, AUSTRALIA

TAPE NUMBER	TAPE TYPE	PROCESSING INLINE	CROSSLINE
EXX_CBM13KDSTK_1	3590	2071 – 2819	1200 – 2680
EXX_CBM13KDSTK_2	3590	2821 – 3569	1200 – 2680
EXX_CBM13KDSTK_3	3590	3571 – 4319	1200 – 2680
EXX_CBM13KDSTK_4	3590	4321 – 4959	1200 – 2680

BYTE NUMBERS	DESCRIPTION
001 – 004	TRACE SEQUENCE NUMBER
005 – 008	TRACE SEQUENCE NUMBER WITHIN REEL
021 – 024	CDP ENSEMBLE NUMBER
025 – 028	TRACE NUMBER
031 – 032	FOLD
103 – 104	TOTAL STATIC
115 – 116	NUMBER OF SAMPLES
117 – 118	SAMPLE RATE
181 – 184	PROCESSING INLINE NUMBER
185 – 188	ACQUISITION CROSSLINE NUMBER
189 – 192	ACQUISITION INLINE NUMBER
197 – 200 (IBM REAL)	CDP-X (CMP) CO-ORDINATE
201 – 204 (IBM REAL)	CDP-Y (CMP) CO-ORDINATE
205 – 208	CDP-X (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)
209 – 212	CDP-Y (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)

A1.3 CBM Full Offset Stack In Time Domain (4S)

CLIENT	:	ESSO AUSTRALIA PTY.LTD
AREA	:	BREAM 3D
PROCESS	:	FINAL CONTROLLED BEAM PSDM STACK (TIME DOMAIN, 4S)
SAMPLE RATE	:	4 MSEC
RECORD LENGTH	:	4000 MSEC
FORMAT	:	SEG-Y
DESTINATION	:	ESSO AUSTRALIA PTY.LTD, AUSTRALIA

TAPE NUMBER	TAPE TYPE	PROCESSING INLINE	CROSSLINE
EXX_CBM7K5TSTK_1	3590	2070 – 3569	1200 – 2680
EXX_CBM7K5TSTK_2	3590	3570 – 4960	1200 – 2680

BYTE NUMBERS	DESCRIPTION
001 – 004	TRACE SEQUENCE NUMBER
005 – 008	TRACE SEQUENCE NUMBER WITHIN REEL
021 – 024	CDP ENSEMBLE NUMBER
025 – 028	TRACE NUMBER
031 – 032	FOLD
103 – 104	TOTAL STATIC
115 – 116	NUMBER OF SAMPLES
117 – 118	SAMPLE RATE
181 – 184	PROCESSING INLINE NUMBER
185 – 188	ACQUISITION CROSSLINE NUMBER
189 – 192	ACQUISITION INLINE NUMBER
197 – 200 (IBM REAL)	CDP-X (CMP) CO-ORDINATE
201 – 204 (IBM REAL)	CDP-Y (CMP) CO-ORDINATE
205 – 208	CDP-X (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)
209 – 212	CDP-Y (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)

A1.4 CBM Full Offset Stack In Depth Domain (7.5KM)

CLIENT	:	ESSO AUSTRALIA PTY.LTD
AREA	:	BREAM 3D
PROCESS	:	FINAL CONTROLLED BEAM PSDM STACK (DEPTH DOMAIN 7.5KM)
SAMPLE RATE	:	4 M
RECORD LENGTH	:	7500 M
FORMAT	:	SEG-Y
DESTINATION	:	ESSO AUSTRALIA PTY.LTD, AUSTRALIA

TAPE NUMBER	TAPE TYPE	PROCESSING INLINE	CROSSLINE
EXX_CBM13KDSTK_1	3590	2070 – 2819	1200 – 2680
EXX_CBM13KDSTK_2	3590	2820 – 3569	1200 – 2680
EXX_CBM13KDSTK_3	3590	3570 – 4319	1200 – 2680
EXX_CBM13KDSTK_4	3590	4320 – 4960	1200 – 2680

BYTE NUMBERS	DESCRIPTION
001 – 004	TRACE SEQUENCE NUMBER
005 – 008	TRACE SEQUENCE NUMBER WITHIN REEL
021 – 024	CDP ENSEMBLE NUMBER
025 – 028	TRACE NUMBER
031 – 032	FOLD
103 – 104	TOTAL STATIC
115 – 116	NUMBER OF SAMPLES
117 – 118	SAMPLE RATE
181 – 184	PROCESSING INLINE NUMBER
185 – 188	ACQUISITION CROSSLINE NUMBER
189 – 192	ACQUISITION INLINE NUMBER
197 – 200 (IBM REAL)	CDP-X (CMP) CO-ORDINATE
201 – 204 (IBM REAL)	CDP-Y (CMP) CO-ORDINATE
205 – 208	CDP-X (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)
209 – 212	CDP-Y (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)

A1.5 CBM Near Angle Stack In Time Domain (4S)

CLIENT : ESSO AUSTRALIA PTY.LTD
AREA : BREAM 3D
PROCESS : FINAL CONTROLLED BEAM PSDM NEAR ANGLE STACK (TIME DOMAIN 4S)
SAMPLE RATE : 4 MSEC
RECORD LENGTH : 4000 MSEC
FORMAT : SEG-Y
DESTINATION : ESSO AUSTRALIA PTY.LTD, AUSTRALIA

TAPE NUMBER	TAPE TYPE	PROCESSING INLINE	CROSSLINE
EXX_CBM7K5NATSTK_1	3590	2070 – 3569	1200 – 2680
EXX_CBM7K5NATSTK_2	3590	3570 – 4960	1200 – 2680

BYTE NUMBERS	DESCRIPTION
001 – 004	TRACE SEQUENCE NUMBER
005 – 008	TRACE SEQUENCE NUMBER WITHIN REEL
021 – 024	CDP ENSEMBLE NUMBER
025 – 028	TRACE NUMBER
031 – 032	FOLD
103 – 104	TOTAL STATIC
115 – 116	NUMBER OF SAMPLES
117 – 118	SAMPLE RATE
181 – 184	PROCESSING INLINE NUMBER
185 – 188	ACQUISITION CROSSLINE NUMBER
189 – 192	ACQUISITION INLINE NUMBER
197 – 200 (IBM REAL)	CDP-X (CMP) CO-ORDINATE
201 – 204 (IBM REAL)	CDP-Y (CMP) CO-ORDINATE
205 – 208	CDP-X (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)
209 – 212	CDP-Y (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)

A1.6 CBM Mid Angle Stack In Time Domain (4S)

CLIENT	:	ESSO AUSTRALIA PTY.LTD
AREA	:	BREAM 3D
PROCESS	:	FINAL CONTROLLED BEAM PSDM MID ANGLE STACK (TIME DOMAIN 4S)
SAMPLE RATE	:	4 MSEC
RECORD LENGTH	:	4000 MSEC
FORMAT	:	SEG-Y
DESTINATION	:	ESSO AUSTRALIA PTY.LTD, AUSTRALIA

TAPE NUMBER	TAPE TYPE	PROCESSING INLINE	CROSSLINE
EXX_CBM7K5MATSTK_1	3590	2070 – 3569	1200 – 2680
EXX_CBM7K5MATSTK_2	3590	3570 – 4960	1200 – 2680

BYTE NUMBERS	DESCRIPTION
001 – 004	TRACE SEQUENCE NUMBER
005 – 008	TRACE SEQUENCE NUMBER WITHIN REEL
021 – 024	CDP ENSEMBLE NUMBER
025 – 028	TRACE NUMBER
031 – 032	FOLD
103 – 104	TOTAL STATIC
115 – 116	NUMBER OF SAMPLES
117 – 118	SAMPLE RATE
181 – 184	PROCESSING INLINE NUMBER
185 – 188	ACQUISITION CROSSLINE NUMBER
189 – 192	ACQUISITION INLINE NUMBER
197 – 200 (IBM REAL)	CDP-X (CMP) CO-ORDINATE
201 – 204 (IBM REAL)	CDP-Y (CMP) CO-ORDINATE
205 – 208	CDP-X (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)
209 – 212	CDP-Y (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)

A1.7 CBM Far Angle Stack In Time Domain (4S)

CLIENT : ESSO AUSTRALIA PTY.LTD
AREA : BREAM 3D
PROCESS : FINAL CONTROLLED BEAM PSDM FAR ANGLE STACK (TIME DOMAIN 4S)
SAMPLE RATE : 4 MSEC
RECORD LENGTH : 4000 MSEC
FORMAT : SEG-Y
DESTINATION : ESSO AUSTRALIA PTY.LTD, AUSTRALIA

TAPE NUMBER	TAPE TYPE	PROCESSING INLINE	CROSSLINE
EXX_CBM7K5FATSTK_1	3590	2070 – 3569	1200 – 2680
EXX_CBM7K5FATSTK_2	3590	3570 – 4960	1200 – 2680

BYTE NUMBERS	DESCRIPTION
001 – 004	TRACE SEQUENCE NUMBER
005 – 008	TRACE SEQUENCE NUMBER WITHIN REEL
021 – 024	CDP ENSEMBLE NUMBER
025 – 028	TRACE NUMBER
031 – 032	FOLD
103 – 104	TOTAL STATIC
115 – 116	NUMBER OF SAMPLES
117 – 118	SAMPLE RATE
181 – 184	PROCESSING INLINE NUMBER
185 – 188	ACQUISITION CROSSLINE NUMBER
189 – 192	ACQUISITION INLINE NUMBER
197 – 200 (IBM REAL)	CDP-X (CMP) CO-ORDINATE
201 – 204 (IBM REAL)	CDP-Y (CMP) CO-ORDINATE
205 – 208	CDP-X (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)
209 – 212	CDP-Y (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)

A1.8 CBM Ultra Far Angle Stack In Time Domain (4S)

CLIENT	:	ESSO AUSTRALIA PTY.LTD
AREA	:	BREAM 3D
PROCESS	:	FINAL CONTROLLED BEAM PSDM ULTRA FAR ANGLE STACK (TIME DOMAIN 4S)
SAMPLE RATE	:	4 MSEC
RECORD LENGTH	:	4000 MSEC
FORMAT	:	SEG-Y
DESTINATION	:	ESSO AUSTRALIA PTY.LTD, AUSTRALIA

TAPE NUMBER	TAPE TYPE	PROCESSING INLINE	CROSSLINE
EXX_CBM7K5UATSTK_1	3590	2070 – 3569	1200 – 2680
EXX_CBM7K5UATSTK_2	3590	3570 – 4960	1200 – 2680

BYTE NUMBERS	DESCRIPTION
001 – 004	TRACE SEQUENCE NUMBER
005 – 008	TRACE SEQUENCE NUMBER WITHIN REEL
021 – 024	CDP ENSEMBLE NUMBER
025 – 028	TRACE NUMBER
031 – 032	FOLD
103 – 104	TOTAL STATIC
115 – 116	NUMBER OF SAMPLES
117 – 118	SAMPLE RATE
181 – 184	PROCESSING INLINE NUMBER
185 – 188	ACQUISITION CROSSLINE NUMBER
189 – 192	ACQUISITION INLINE NUMBER
197 – 200 (IBM REAL)	CDP-X (CMP) CO-ORDINATE
201 – 204 (IBM REAL)	CDP-Y (CMP) CO-ORDINATE
205 – 208	CDP-X (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)
209 – 212	CDP-Y (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)

A1.9 CBM Full Offset Stack Well-Calibrated In Depth Domain (13KM)

CLIENT	:	ESSO AUSTRALIA PTY.LTD
AREA	:	BREAM 3D
PROCESS	:	CBM FULL OFFSET STACK WELL-CALIBRATED (DEPTH DOMAIN 13KM)
SAMPLE RATE	:	4 M
RECORD LENGTH	:	13000 M
FORMAT	:	SEG-Y
DESTINATION	:	ESSO AUSTRALIA PTY.LTD, AUSTRALIA

TAPE NUMBER	TAPE TYPE	PROCESSING INLINE	CROSSLINE
EXX_CBM13KWCDSTK_1	3590	2071 – 2819	1200 – 2680
EXX_CBM13KWCDSTK_2	3590	2821 – 3569	1200 – 2680
EXX_CBM13KWCDSTK_3	3590	3571 – 4319	1200 – 2680
EXX_CBM13KWCDSTK_4	3590	4321 – 4959	1200 – 2680

BYTE NUMBERS	DESCRIPTION
001 – 004	TRACE SEQUENCE NUMBER
005 – 008	TRACE SEQUENCE NUMBER WITHIN REEL
021 – 024	CDP ENSEMBLE NUMBER
025 – 028	TRACE NUMBER
031 – 032	FOLD
103 – 104	TOTAL STATIC
115 – 116	NUMBER OF SAMPLES
117 – 118	SAMPLE RATE
181 – 184	PROCESSING INLINE NUMBER
185 – 188	ACQUISITION CROSSLINE NUMBER
189 – 192	ACQUISITION INLINE NUMBER
197 – 200 (IBM REAL)	CDP-X (CMP) CO-ORDINATE
201 – 204 (IBM REAL)	CDP-Y (CMP) CO-ORDINATE
205 – 208	CDP-X (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)
209 – 212	CDP-Y (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)

A1.10 CBM Migration Velocity Field (Interval In Depth)

CLIENT	:	ESSO AUSTRALIA PTY.LTD
AREA	:	BREAM 3D
PROCESS	:	CBM MIGRATION VELOCITY FIELD (INTERVAL IN DEPTH)
SAMPLE RATE	:	20 M
RECORD LENGTH	:	13120 M
FORMAT	:	SEG-Y
DESTINATION	:	ESSO AUSTRALIA PTY.LTD, AUSTRALIA

TAPE NUMBER	TAPE TYPE	PROCESSING INLINE	CROSSLINE
EXX_CBMFNLVEL_DL_1	3590	2071 – 4959	1200 – 2680

BYTE NUMBERS	DESCRIPTION
001 – 004	TRACE SEQUENCE NUMBER
005 – 008	TRACE SEQUENCE NUMBER WITHIN REEL
021 – 024	CDP ENSEMBLE NUMBER
025 – 028	TRACE NUMBER
031 – 032	FOLD
103 – 104	TOTAL STATIC
115 – 116	NUMBER OF SAMPLES
117 – 118	SAMPLE RATE
181 – 184	PROCESSING INLINE NUMBER
185 – 188	ACQUISITION CROSSLINE NUMBER
189 – 192	ACQUISITION INLINE NUMBER
197 – 200 (IBM REAL)	CDP-X (CMP) CO-ORDINATE
201 – 204 (IBM REAL)	CDP-Y (CMP) CO-ORDINATE
205 – 208	CDP-X (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)
209 – 212	CDP-Y (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)

A1.11 CBM Migration Velocity Field (Interval In Time)

CLIENT	:	ESSO AUSTRALIA PTY.LTD
AREA	:	BREAM 3D
PROCESS	:	CBM MIGRATION VELOCITY FIELD (INTERVAL IN TIME)
SAMPLE RATE	:	10 MSEC
RECORD LENGTH	:	6000 MSEC
FORMAT	:	SEG-Y
DESTINATION	:	ESSO AUSTRALIA PTY.LTD, AUSTRALIA

TAPE NUMBER	TAPE TYPE	PROCESSING INLINE	CROSSLINE
EXX_CBMFNLVEL_TL_1	3590	2071 – 4959	1200 – 2680

BYTE NUMBERS	DESCRIPTION
001 – 004	TRACE SEQUENCE NUMBER
005 – 008	TRACE SEQUENCE NUMBER WITHIN REEL
021 – 024	CDP ENSEMBLE NUMBER
025 – 028	TRACE NUMBER
031 – 032	FOLD
103 – 104	TOTAL STATIC
115 – 116	NUMBER OF SAMPLES
117 – 118	SAMPLE RATE
181 – 184	PROCESSING INLINE NUMBER
185 – 188	ACQUISITION CROSSLINE NUMBER
189 – 192	ACQUISITION INLINE NUMBER
197 – 200 (IBM REAL)	CDP-X (CMP) CO-ORDINATE
201 – 204 (IBM REAL)	CDP-Y (CMP) CO-ORDINATE
205 – 208	CDP-X (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)
209 – 212	CDP-Y (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)

A1.12 CBM AOK Velocity Field (Time RMS)

CLIENT	:	ESSO AUSTRALIA PTY.LTD
AREA	:	BREAM 3D
PROCESS	:	CBM AOK VELOCITY FIELD (INTERVAL IN TIME)
SAMPLE RATE	:	20 MSEC
RECORD LENGTH	:	4500 MSEC
FORMAT	:	ASCII
DESTINATION	:	ESSO AUSTRALIA PTY.LTD, AUSTRALIA

FILE NAME	PROCESSING INLINE	CROSSLINE
cbm_4s_avel_sm.gz	2070 – 4959	1200 – 2680

A1.13 CBM Gamma Volume

CLIENT : ESSO AUSTRALIA PTY.LTD
AREA : BREAM 3D
PROCESS : CBM GAMMA VOLUME
SAMPLE RATE : 20 M
RECORD LENGTH : 5000 M
FORMAT : SEG-Y
DESTINATION : ESSO AUSTRALIA PTY.LTD, AUSTRALIA

FILE NAME	MEDIA	PROCESSING INLINE	CROSSLINE
cbm_fnl_gam.sgy	CD	2071 – 4951	1205 – 2669

BYTE NUMBERS	DESCRIPTION
001 – 004	TRACE SEQUENCE NUMBER
005 – 008	TRACE SEQUENCE NUMBER WITHIN REEL
021 – 024	CDP ENSEMBLE NUMBER
025 – 028	TRACE NUMBER
031 – 032	FOLD
103 – 104	TOTAL STATIC
115 – 116	NUMBER OF SAMPLES
117 – 118	SAMPLE RATE
181 – 184	PROCESSING INLINE NUMBER
185 – 188	ACQUISITION CROSSLINE NUMBER
189 – 192	ACQUISITION INLINE NUMBER
197 – 200 (IBM REAL)	CDP-X (CMP) CO-ORDINATE
201 – 204 (IBM REAL)	CDP-Y (CMP) CO-ORDINATE
205 – 208	CDP-X (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)
209 – 212	CDP-Y (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)

A1.14 CBM Well-Tie Interval Velocity Field (Interval In Depth)

CLIENT	:	ESSO AUSTRALIA PTY.LTD
AREA	:	BREAM 3D
PROCESS	:	CBM WELL-TIE INTERVAL VELOCITY FIELD (INTERVAL IN DEPTH)
SAMPLE RATE	:	20 M
RECORD LENGTH	:	13120 M
FORMAT	:	SEG-Y
DESTINATION	:	ESSO AUSTRALIA PTY.LTD, AUSTRALIA

FILE NAME	MEDIA	PROCESSING INLINE	CROSSLINE
cbm_wc_vel_dl.sgy	DVD	2071 – 4959	1200 – 2680

BYTE NUMBERS	DESCRIPTION
001 – 004	TRACE SEQUENCE NUMBER
005 – 008	TRACE SEQUENCE NUMBER WITHIN REEL
021 – 024	CDP ENSEMBLE NUMBER
025 – 028	TRACE NUMBER
031 – 032	FOLD
103 – 104	TOTAL STATIC
115 – 116	NUMBER OF SAMPLES
117 – 118	SAMPLE RATE
181 – 184	PROCESSING INLINE NUMBER
185 – 188	ACQUISITION CROSSLINE NUMBER
189 – 192	ACQUISITION INLINE NUMBER
197 – 200 (IBM REAL)	CDP-X (CMP) CO-ORDINATE
201 – 204 (IBM REAL)	CDP-Y (CMP) CO-ORDINATE
205 – 208	CDP-X (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)
209 – 212	CDP-Y (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)

A1.15 CBM Well-Tie Interval Velocity Field (Interval In Time)

CLIENT	:	ESSO AUSTRALIA PTY.LTD
AREA	:	BREAM 3D
PROCESS	:	CBM WELL-TIE INTERVAL VELOCITY FIELD (INTERVAL IN TIME)
SAMPLE RATE	:	10 MSEC
RECORD LENGTH	:	6000 MSEC
FORMAT	:	SEG-Y
DESTINATION	:	ESSO AUSTRALIA PTY.LTD, AUSTRALIA

FILE NAME	MEDIA	PROCESSING INLINE	CROSSLINE
cbm_wc_vel_tl.sgy	DVD	2071 – 4959	1200 – 2680

BYTE NUMBERS	DESCRIPTION
001 – 004	TRACE SEQUENCE NUMBER
005 – 008	TRACE SEQUENCE NUMBER WITHIN REEL
021 – 024	CDP ENSEMBLE NUMBER
025 – 028	TRACE NUMBER
031 – 032	FOLD
103 – 104	TOTAL STATIC
115 – 116	NUMBER OF SAMPLES
117 – 118	SAMPLE RATE
181 – 184	PROCESSING INLINE NUMBER
185 – 188	ACQUISITION CROSSLINE NUMBER
189 – 192	ACQUISITION INLINE NUMBER
197 – 200 (IBM REAL)	CDP-X (CMP) CO-ORDINATE
201 – 204 (IBM REAL)	CDP-Y (CMP) CO-ORDINATE
205 – 208	CDP-X (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)
209 – 212	CDP-Y (CMP) CO-ORDINATE (VALUES STORED WAS MULTIPLED BY 100)

APPENDIX B – TECHNOLOGY DESCRIPTIONS

CONTROLLED BEAM DEPTH MIGRATION (CBM)

CBM is an, accurate, and efficient depth migration method. It retains the steep dip and anisotropic imaging capability of Kirchhoff and has the multi-arrival imaging capability of wavefield extrapolation methods. It retains the flexibility of Kirchhoff migration, and is optimised to produce high signal-to-noise, artifact free images of complex structures.

RCA TOMOGRAPHY – VIA RESIDUAL CURVATURE ANALYSIS

RCA3D is a global tomographic inversion method that updates a gridded velocity model. No horizons are needed. Residual depth errors are picked automatically as a function of offset on depth migrated image gathers; the associated dip of the reflector is also picked. Accounting for offset and reflector dip, each pick is emulated by ray-tracing through the gridded velocity model. The gridded velocity model is then updated to minimize the residual depth error of all picks simultaneously. The updated velocity model can be used for another depth migration to further refine the velocity model. Parts of the initial model may be 'frozen' in the sense that the tomography is not allowed to change the velocities within that area.

Typical QC products for RCA tomography include;

- Selected inline or crossline stacks before and after tomography. Either on a regular grid or at specified locations.
- CRP gathers on a regular grid (usually matching the travel-time grid used in the tomography) before and after tomography.
- Travel-time picks overlaid on CRP gathers.
- The velocity model before and after tomography.
- The tomographic velocity perturbation model.
- Gamma cubes before and after tomography. Gamma is an estimate of the residual moveout still present in CRP gathers after PSDM. It is computed from travel-time information picked from depth migrated CRP gathers. Gamma values are output as a 3D cube on the same grid as the velocity and perturbation model. This makes it easy to scan through an entire 3D cube within a very short period of time and identify potential problem areas. It is also possible to overlay the gamma cube on seismic stacks or toggle it with the velocity model, perturbation model or gamma cubes of previous tomographic iterations. It is a very powerful QC tool and the one that most easily identifies any potential data problems.

XRMULT – High(er) Resolution Radon Multiple Attenuation

XRMULT uses a constrained least squares version of the parabolic transform. The representation of the data in the Radon domain is better focussed than with the conventional Radon transform. It focuses energy along both the p and time axes.
It is designed to overcome some of the limitations of the conventional transform. It is able to preserve primary amplitudes better as a function of offset whilst simultaneously giving a more complete multiple attenuation. It also is somewhat resistant to spatial aliasing and can therefore reduce the need for trace interpolation before the transform. The parameterisation and method of use are similar to that of the conventional Radon transform.

N.M.O CORRECTION

The NMO is performed assuming that the energy travels in a straight ray path and utilizes the following equation:

Conventional NMO : $T_x^2 = T_0^2 + x^2/v^2$
4th Order NMO $T_x^2 = T_0^2 + x^2/v^2 + Cx^4$

where:
T_x = *Total recorded travel time in seconds*
x = *Offset*
T_0 = *Time of reflector at zero offset in seconds*
V = *RMS velocity*
C = *usually a very small negative number*

Velocity-time knee points are honoured on adjacent control points prior to interpolation of the temporal velocity field. The space variant velocity function is then derived by linear interpolation between control points.