OS02 3D SEISMIC SURVEY

VIC/P51 & VIC/P52,

OFFSHORE OTWAY BASIN

AUSTRALIA

SEISMIC DATA PROCESSING REPORT

FOR

SANTOS LIMITED

SUBMITTED BY

VERITAS DGC ASIA PACIFIC LTD.

UNIT 06-01 UNION BUILDING

37 JALAN PEMIMPIN

SINGAPORE 577177

VERITAS
Geophysical Integrity

APRIL 2004

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1. INTRODUCTION

1.1 SURVEY LOCATION

The OS02 3D seismic survey is located in VIC/P51 and VIC/P52, Offshore Otway Basin, Australia.

Geodetic Parameters

The following geodetic parameters were provided by Western Geco together with the navigation data. In the course of using this navigation data during processing, no shifts whatsoever were applied.

Datum : WGS-84

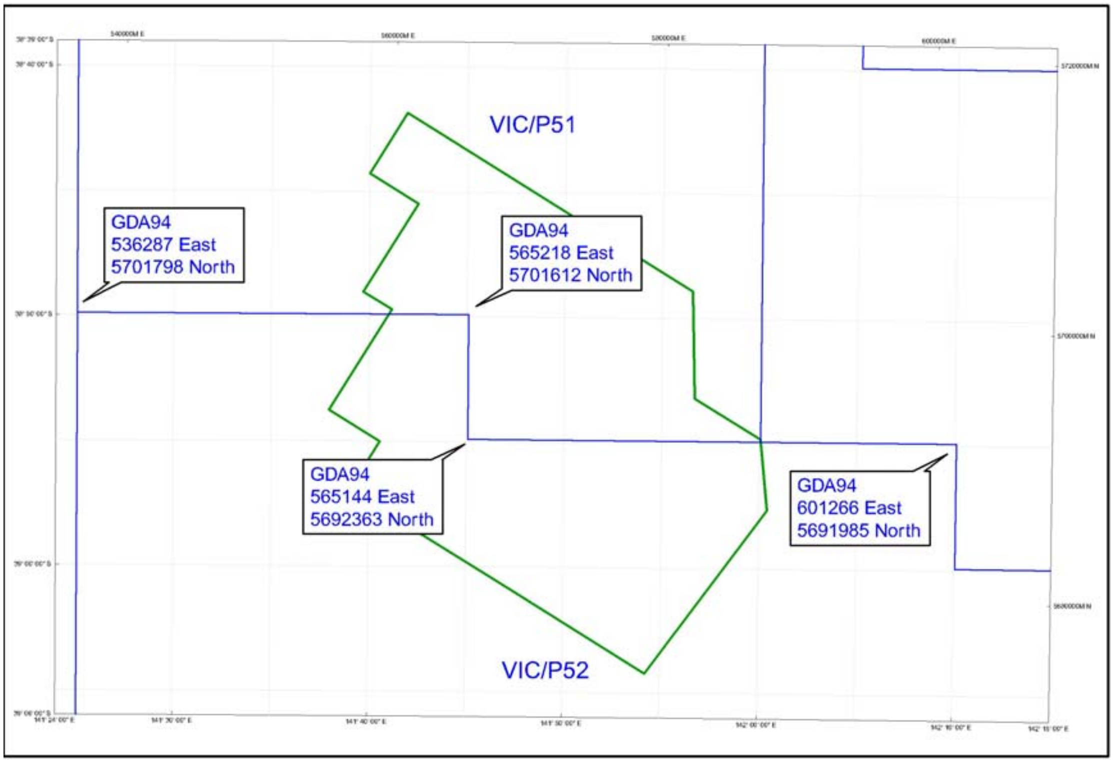
Spheroid : WGS-84

Semi Major Axis	:	6378137.00
Inverse Flat.	:	298.2572236

Projection : 002 U.T.M. Southern Hemisphere

Zone	:	54 S
Central Meridian	:	141.00 E
Scale Factor	:	0.999600
False Easting	:	500000.00 E
False Northing	:	10000000 N
Grid Origin	:	0.00 N 141.00 E

Survey Map



1.2 SURVEY SIZE

The survey consisted of 1040 subsurface lines processed from sail lines 1008 to 2032. A total of 38,065 sail-line CMP kilometres of data (including infill data) were acquired. The total full fold area for the prospect amounted to 773 square kilometres.

Prime and Reshoot Data	33,285.0	CMP kilometres
Infill Data	4,780.1	CMP kilometres
Total	**38,065.1**	**CMP kilometres**

1.3 ACQUISITION

The OS02 3D seismic survey was acquired by Western Geco, using the M/V Western Monarch, between November 2002 and December 2002. It was recorded using dual source array and eight streamers. The subsurface line spacing was 25 metres, the shot spacing 37.5 metres and the group interval was 12.5 metres. There were 368 groups per streamer resulting in nominal CDP bin fold of 61 (12.5 x 25 metre bin size).

1.4 PROCESSING CONTRACTOR/CENTRE, START/FINISH DATES

The data were processed by Veritas DGC Asia Pacific Ltd in their Singapore processing centre using the TANGO software system. The pre-processing started in January 2003 and was completed in March 2003, followed by Fast track DMO/Post stack Migration processing from March to 1st April 2003. This continued with Fast track Hybrid Migration (simple velocity model as well as migration velocity model) and Production Pre-stack Hybrid Migration from April to August 2003. Post stack Processing, optional processing AOK, pore pressure and Scalemult prior to DMO from August to December 2003.

1.5 PROCESSING OBJECTIVES

The processing objective was to make available high quality data that would provide detailed information on the structure, stratigraphic and amplitude attributes of the reservoir and associated strata. The acquisition geometry of a wide multi-streamer with shallow source and receiver depths, and the prevailing weather conditions required that the processing placed particular emphasis on the impact of swell noise and amplitude characteristics of the reservoir interval. There were cable depth changes made throughout the survey to allow for continued shooting in inclement weather – These are dealt in more detail in section 7.1.15.

Stress was placed on focusing the signal in order best image fault and stratigraphic terminations, and to accurately position any amplitude variations that have been caused by hydrocarbons. Complications due to complex water bottom and associated rapid lateral velocity variations meant Pre-Stack "Hybrid" Migration was a cost effective way of implementing Pre-Stack Depth migration routines in this situation. Although the survey was acquired oblique to the sea floor dip, and a wide-tow arrangement was used, no significant striping of the final Pre-Stack Migrated volumes was evident, although up to 8dB of striping was seen on the initial DMO volumes. Striping had been expected at 3-4 dB prior to processing with PSHM.

1.6 PROCESSING LOCATION(S)

All the processing was performed at Veritas DGC Asia Pacific Ltd. Singapore office and QC in Perth.

1.7 KEY PERSONNEL – CONTRACTOR AND SANTOS LIMITED

Veritas DGC Singapore Personnel

Peter Whiting	–	Regional Processing Manager, responsible for all aspects of seismic data processing and overall control of projects.
Dolly Tan	–	Processing Supervisor, responsible for the day-to-day management of processing groups and verification of the data produced.
Peter Lwin	–	Project Leader, responsible for organisation of processing team and co-ordination of tasks
Corinna Yee	–	Senior Geophysicist, responsible for performing processing tasks as directed.
John Tan	–	Senior Geophysicist, responsible for performing processing tasks as directed.
Peter Ho	–	Geophysicist, responsible for performing processing tasks as directed.
Wong Siew Ling	–	Geophysicist, responsible for performing processing tasks as directed.
Loh Fong Cheen	–	Geophysicist, responsible for performing processing tasks as directed.
Dean Miller	–	Programming Manager, provided systems and software support.

Veritas DGC Perth Personnel

Amy Cheang	–	Client Liaison
Heidi Best	–	Geophysicist

Santos Limited Personnel

John Hughes	–	Chief Opts Geophysical
Stuart Brew	–	Senior Staff Geophysicist
John Cant	–	Consultant Processing Geophysicist

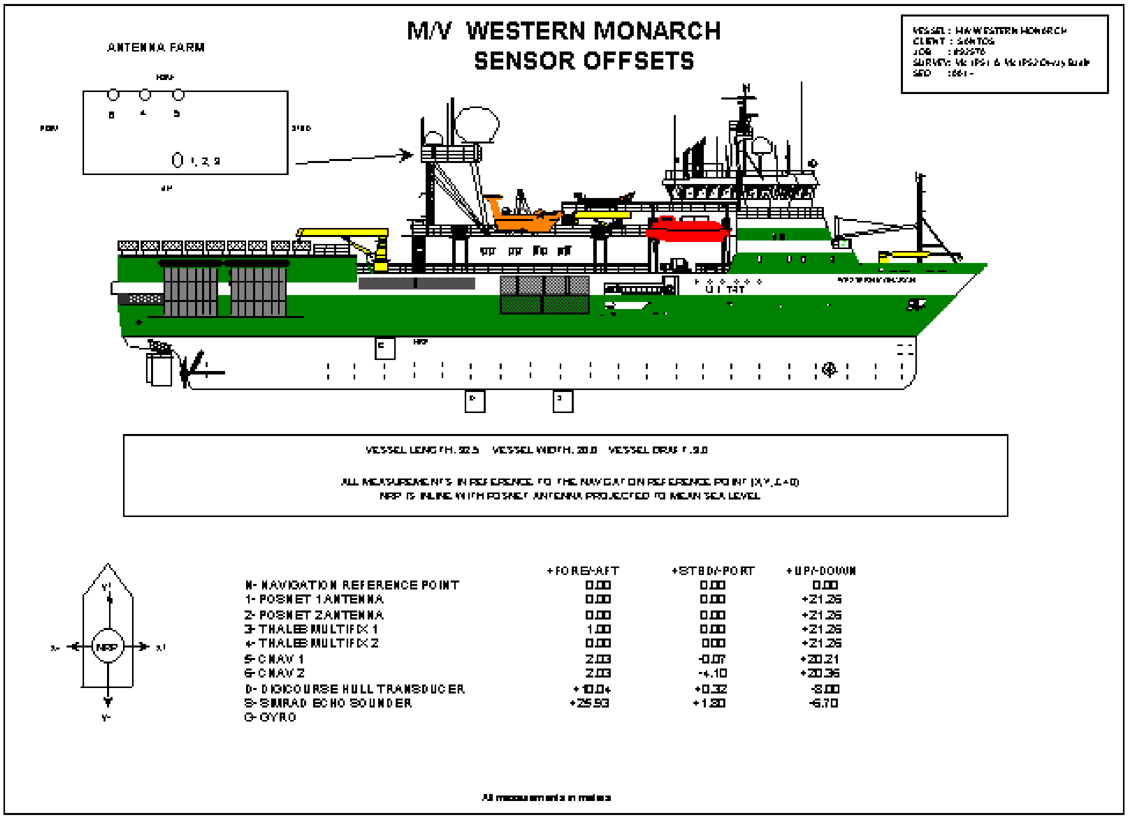
2. ACQUISITION SUMMARY

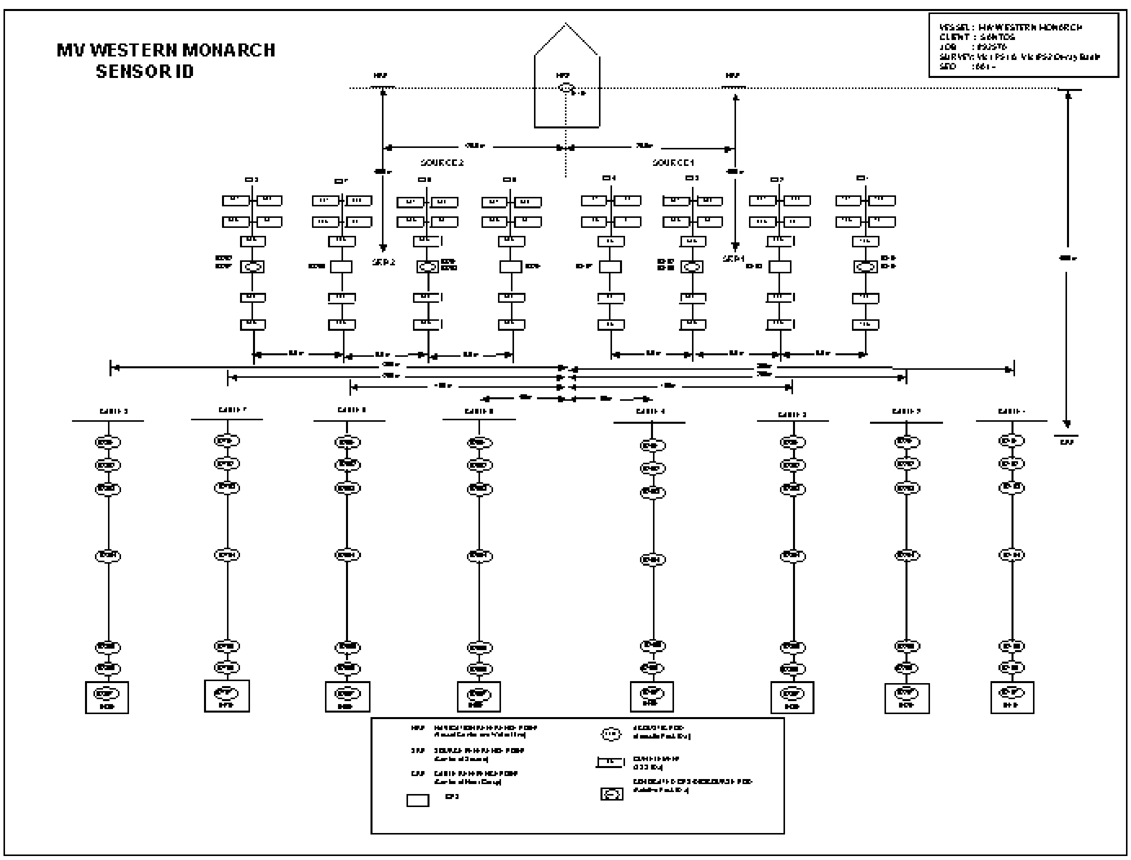
2.1 ACQUISITION PARAMETERS

The OS02 3D seismic survey was acquired with a line orientation of NW-SE (121 – 301 degrees) using dual source / six streamer configuration. The cable separation was 100 metres giving a subsurface CDP line spacing of 25 metres.

The group interval was 12.5 metres and the shot point interval was 37.5 metres. The number of channels per streamer was 320 and that gave a nominal CDP bin fold coverage of 6100% for a bin size of 12.5 x 25 metres.

Acquisition	
Recorded by	Western Geco
Recording vessel	M/V Western Monarch
Date recorded	November 2002
Instrument Configuration	
Recording instrument	TRIACQ vers 1.6c
Recording format	8058 SEG-D
Tape Density	IBM 3590
Record Length	6.5 seconds
Sample Rate	2 msec
Recording Reduction	None
Low Cut Filter / Slope	2 Hz / 12 dB/Oct
High Cut filter / Slope	206 Hz / 264 dB/Oct
Streamer Configuration	
Streamer type	Nessie 4/TRIACQ 2.0
Number of streamers	8
Streamer Length	4600 metres
Streamer separation	100 metres
Groups/Streamer	368
Group Interval	12.50 metres
Record Length	7 seconds
Streamer Depth	± 7.0 metres average
Source	
Instrument	Tuned airgun array
Source array volumes	3147 cu. Inches
Number of sources	2 (each with 3 sub-arrays)
Source separation	50 metres
Source array depth	5 metres
Source operating pressure	2000 psi
Shotpoint Interval	18.75 metres Flip-Flop (37.5 metes for each array)
Nominal offset	175 metres
Navigation Configuration	
Navigation System	DGPS


M/V WESTERN MONARCH
SENSOR OFFSETS
ANTENNA FARM
1, 2, 3
ALL MEASUREMENTS IN REFERENCE TO THE NAVIGATION REFERENCE POINT (X,Y,Z=0)
NRP IS INLINE WITH POSNET ANTENNA PROJECTED TO MEAN SEA LEVEL
NRP
+FORE/-AFT
+STBD/-PORT
+UP/-DOWN
N- NAVIGATION REFERENCE POINT 0.00 0.00 0.00
1- POSNET 1 ANTENNA 0.00 0.00 +21.26
2- POSNET 2 ANTENNA 0.00 0.00 +21.26
3- THALES MULTIFIX 1 1.00 0.00 +21.26
4- THALES MULTIFIX 2 0.00 0.00 +21.26
5- CNAV 1 2.03 -0.07 +20.21
6- CNAV 2 2.03 -4.10 +20.36
D- DIGICOURSE HULL TRANSDUCER +10.04 +0.32 -8.00
S- SIMRAD ECHO SOUNDER +25.93 +1.20 -6.70
G- GYRO
All measurements in metres

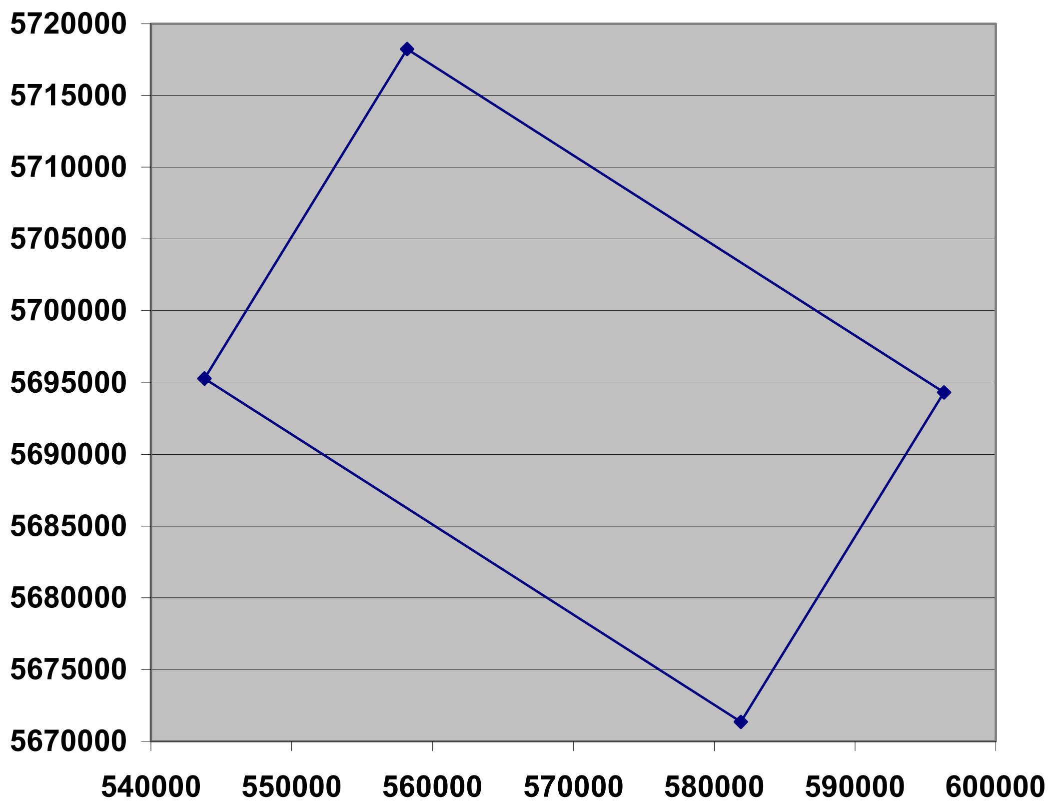

MV WESTERN MONARCH
SENSOR ID
SOURCE 2
SOURCE 1
SRP 2
SRP 1
NRP

3. PROCESSING SUMMARY

3.1 PROCESSING GRID

The processing grid was defined as follows :

NO.	INLINE No.	CROSSLINE NO.	X-COORD	Y-COORD
P1	6902	401	543786.7254	5695267.4940
P2	6902	4001	581903.0377	5671347.9050
P3	9070	4001	596307.9457	5694302.3953
P4	9070	401	558191.6334	5718221.9843
P1	6902	401	543786.7254	5695267.4940



3.2 OS02 3D PROCESSING FLOW - BRIEF SUMMARY

The data supplied to Veritas DGC were in SEG-D format code 8058, 2 msec sample rate, 6.5 second data length on 3590 cartridges. The following is a brief summary of the processing applied to the data.

3.2.1 Production Pre-processing

1. Reformat from SEG-D to Tango internal format (12.5m groups, 37.5m shots flip flop (2 guns 8 cables)
2. Shot and trace edits
3. Instrument Dephase (no gun and no cable ghost, output minimum phase)
4. 3Hz Low cut filter (zero phase)
5. Spherical divergence V**2T using 1 average velocity function
6. Swell Noise Attenuation (FXEDIT) - 2passes
7. Resample to 4ms (100hz zero phase anti-alias filter)
8. Hi-Res Linear Noise Removal (XRLIN) 2100m/s
9. Exponential Gain
10. Velocity Analyses 1 (V1 - 1km grid with mild Radon)
11. Tau-p Deconvolution on data with wbt less than 300ms, ramp to wbt 400ms and no decon for wbt deeper than 400ms, 32ms gap; total operator length = 300ms
12. K-filter and channel decimation
13. 3D seismic and navigation merge
14. Hi-Res Radon demultiple (XRMULT) 300ms cut
15. Cable depth correction
16. Tidal Static correction

    ➔ **Input for section 3.2.2 – Fast Track Processing – DMO/Post Stack Migration**
17. 3D Binning 12.5 by 12.5m grid
18. FLOOD at 12.5 by 12.5m grid

    ➔ **Input for section 3.2.5 – Production Hybrid Migration**

3.2.2 Fast-track Processing - DMO/Post Stack Migration (FOR FULL STACK VOLUME)

CONTINUE FROM SECTION 3.2.1 ITEM 16

1. 2D DMO on velocity lines (item A.16 above) to generate DMO velocities (V2) - pick and QC
2. 3D Binning at 25m X 25m grid
3. FLOOD at 25mX25m grid

   ➔ **Input for section 3.2.3 – Fast Track Processing – Initial PreStack Hybrid Migration**
4. NMO with DMO velocities
5. 3D Kirchhoff DMO (using DECODE)
6. Inner trace and tighter outer stack mute - confirm while QC'ing the DMO vels
7. DMO stack
8. Post stack Kirchhoff migration with maximum dip of 80 degrees
9. Zero phasing - derive from near trace of deep data
10. TVF
11. Exponential gain
12. SSD
    - Full stack raw and filtered volume archives on DLT and DVD respectively.
    - QC'ed velocities - sent digital version to RIC

3.2.3 Fast-track Processing - Initial PreStack Hybrid Migration (FOR FULL AND ANGLE STACK VOLUMES)

CONTINUE FROM SECTION 3.2.2 ITEM 3

1. SCALEMULT (derive and confirm threshold from Radon gathers)
2. Spherical divergence removed

   ➔ Input for section 3.2.4 – Fast Track Processing – 2nd Hybrid Migration
3. Pre-Stack HYBRID migration 3km aperture - simple velocity model built from DMO velocities (V2), spherical divergence calculated in migration
4. Velocity Analyses 3 (pick 1X1km grid – V3) – qc and better interpolated
5. Footprint Removal (also AOK testings)
6. NMO with velocities V3 interpreted from item 4 above
7. Outer and Inner as per section 3.2.2 item 6; Angle mutes - confirm 50-50 split
8. Stack, full, near and far angle stacks
9. Zero phasing
10. TVF
11. Exponential gain
12. SSD

- Filtered full stack archive on DLT (sent on 29 April), angle stack shipped 2nd May
- QC'ed Velocities -Western Geco format - send Ric a digital version
- SEG-Y residual RMS velocity on DVD sent 2nd June and interval velocity velocities on DLT sent to Santos

3.2.4 Fast-track Processing - 2nd Hybrid Migration

CONTINUE FROM SECTION 3.2.3 ITEM 2

1. Pre-stack HYBRID migration 3km aperture with better interpolated velocity model from 1st Hybrid QC'ed vel (V3), mig sphdiv
2. Velocity Analyses 4 – V4 (create 0.5X0.5km grid, pick 1X1km grid) - qc and better interpolated completed on 26 June
3. NMO with velocities V4 interpreted from item 2 above.
4. Outer and Inner (as per section 3.2.2 item 6), Angle mutes - confirm 50-50 split
5. Full, Near and Far Angle stacks
6. Zero phasing
7. TVF
8. Exponential gain
9. SSD

SEG-Y for 2nd Hybrid Gathers with exponential gain were archived on 3 USB disk caddies

3.2.5 Production Hybrid Migration Processing

CONTINUE FROM SECTION 3.2.1 ITEM 18

19. Edits Bad cables (not in field edit log)
20. Spherical divergence remove and re-apply with V1 velocity
21. Gather Archives on 3590 tapes as per contract
22. SCALEMULT
23. FREESURF - approved 4 June
24. FOOTPRINT REMOVAL
25. Spherical Divergence removed
26. HYBRID migration 2.5km aperture 60deg(decision 2 July)
    I/P 12.5x12.5m o/p 25x25m (using smoothed velocities V4 interpolated from section 3.2.4 item 2.
27. Residual velocity 0.25X0.25 km grid (V5)
28. Pre-stack exponential gain
29. NMO with interpolated residual velocity V5 (125mx125mx20ms) - archive on 3590 and caddies
30. Outer mute and inner, angle mute (extend outer mute to 120%, then split 50-50 with inner mute)
31. Angle Stacks
32. Zero phasing
33. TVF
34. SSD

3.2.6 Optional Processing

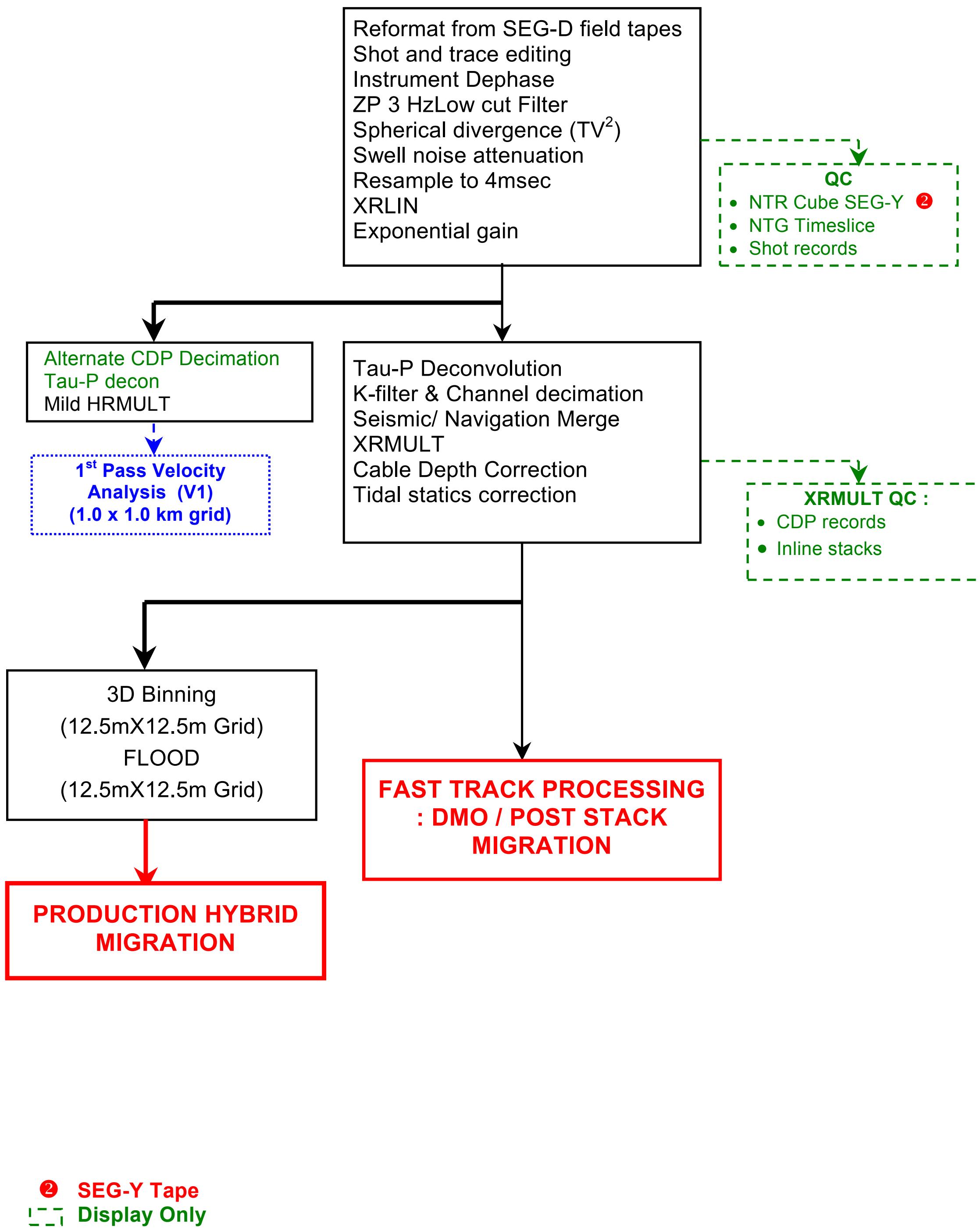
1. AOK - 163sq km
   - Input from section 3.2.5 item 27
   - Archive AOK gathers with exponential gain (jc4) on 3590 tape as well as on caddy AOK final full, optimum, near and far stacks (ZPF/TVF/SSD) were also SEG-Y archive on DLT4
   - AOK RMS vel, interval vel, conditional interval vel – SEG-Y onto DVD

2. Input from section 3.2.5 item 27 Geo Pressure work on inline 7370 and xline 2031

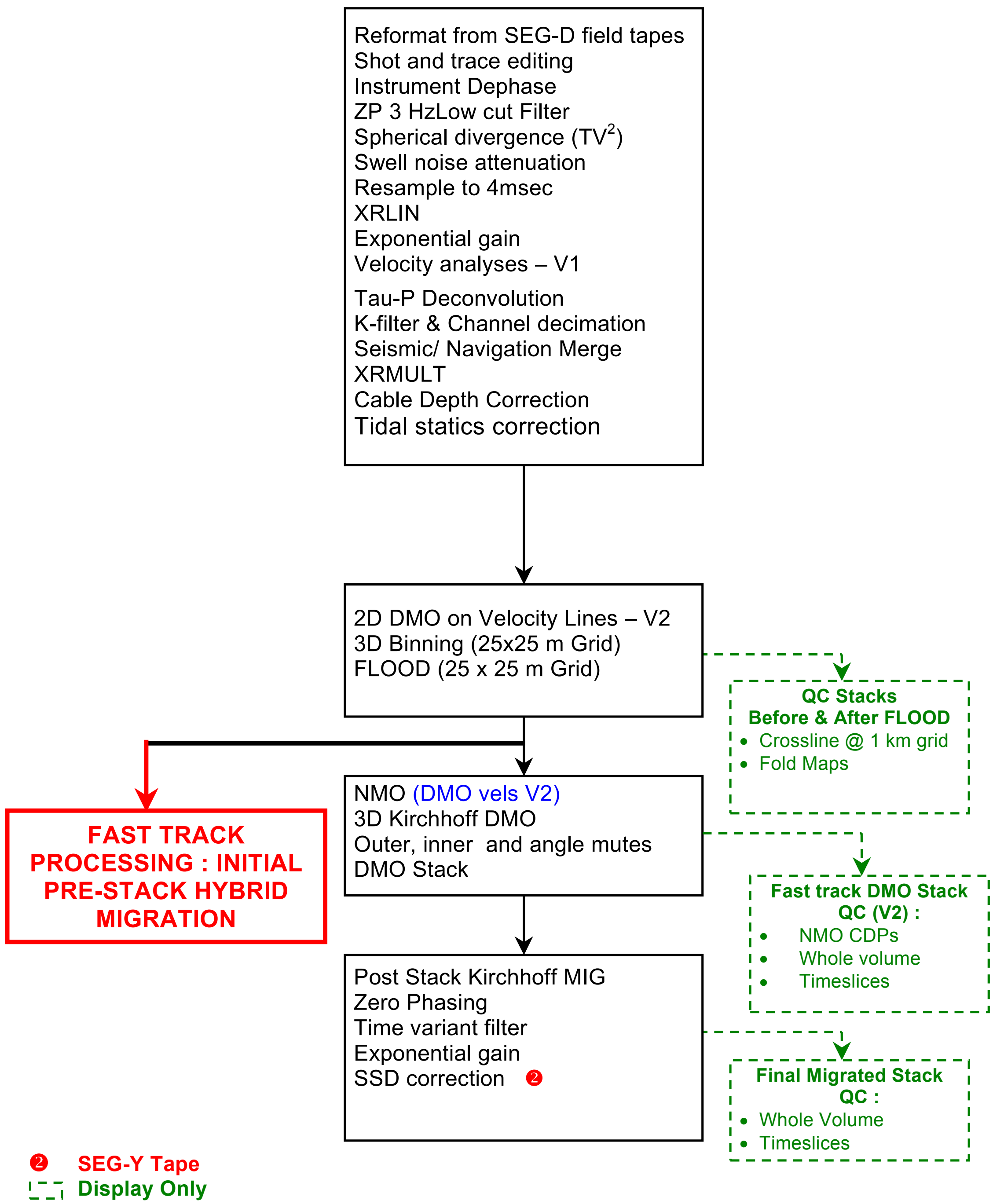
3. Input from section 3.2.2 item 3
   - Scalemult
   - Repeat processing as in section 3.2.2 items 4 to 12 (i.e. DMO stack thru to Post stack Kirchhoff Migration)

3.3 OS02 3D PROCESSING FLOW CHART

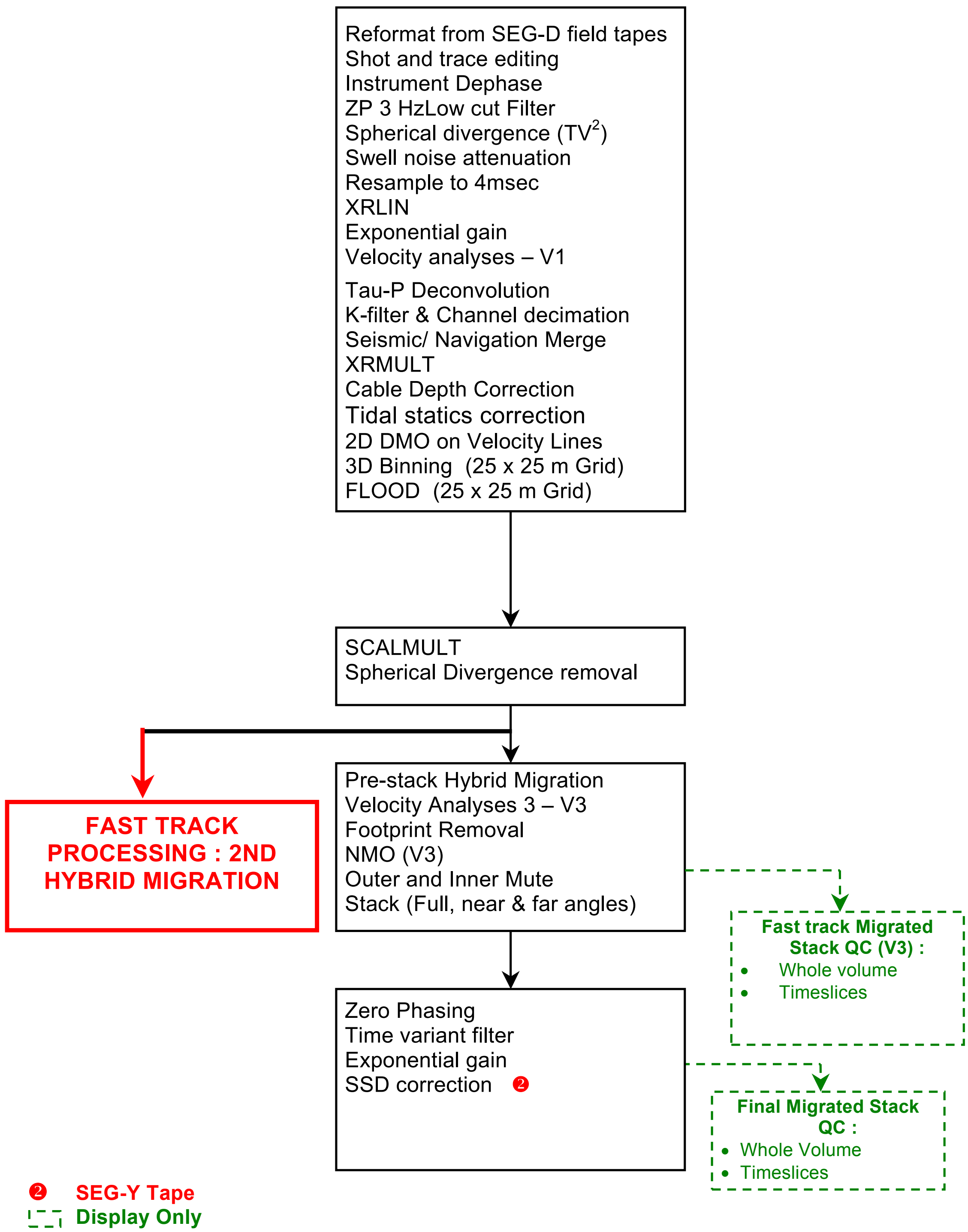
3.3.1 production Pre-Processing



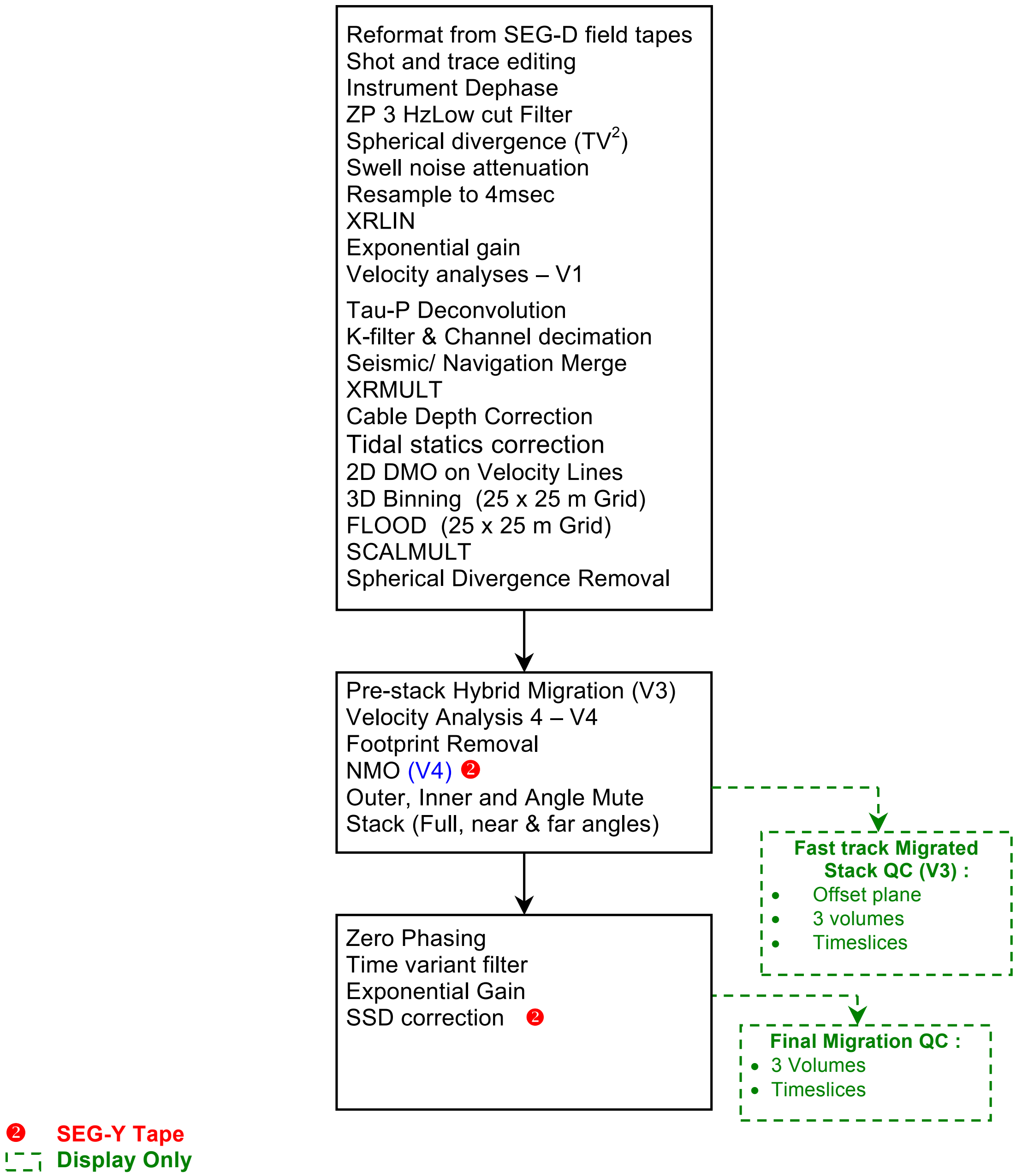
3.3.2 Fast Track Processing – DMO / Post Stack Migration



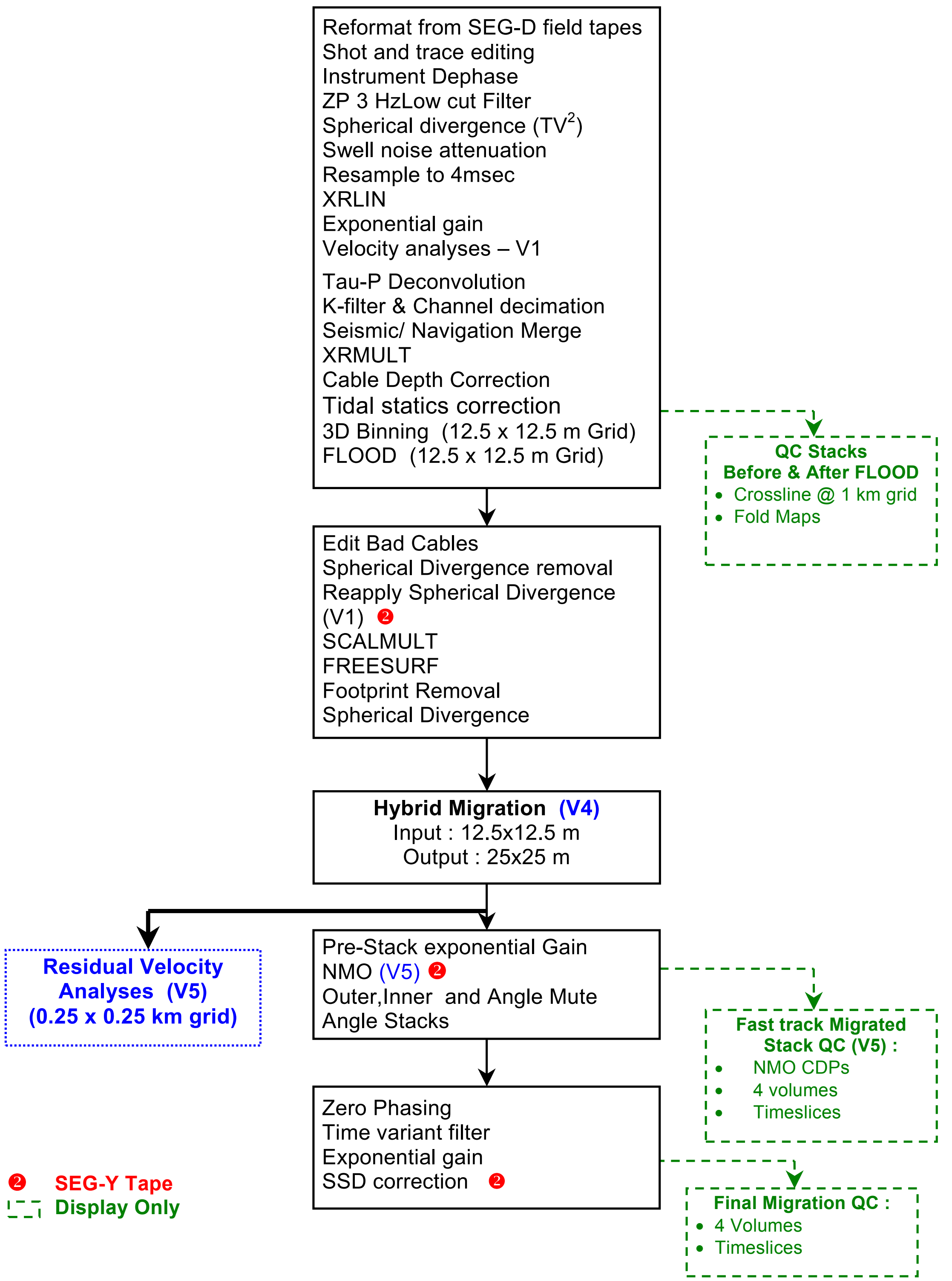
3.3.3 Fast Track Processing – Initial Pre-Stack Hybrid Migration



3.3.4 Fast Track Processing – 2nd Hybrid Migration



3.3.5 Production Hybrid Migration

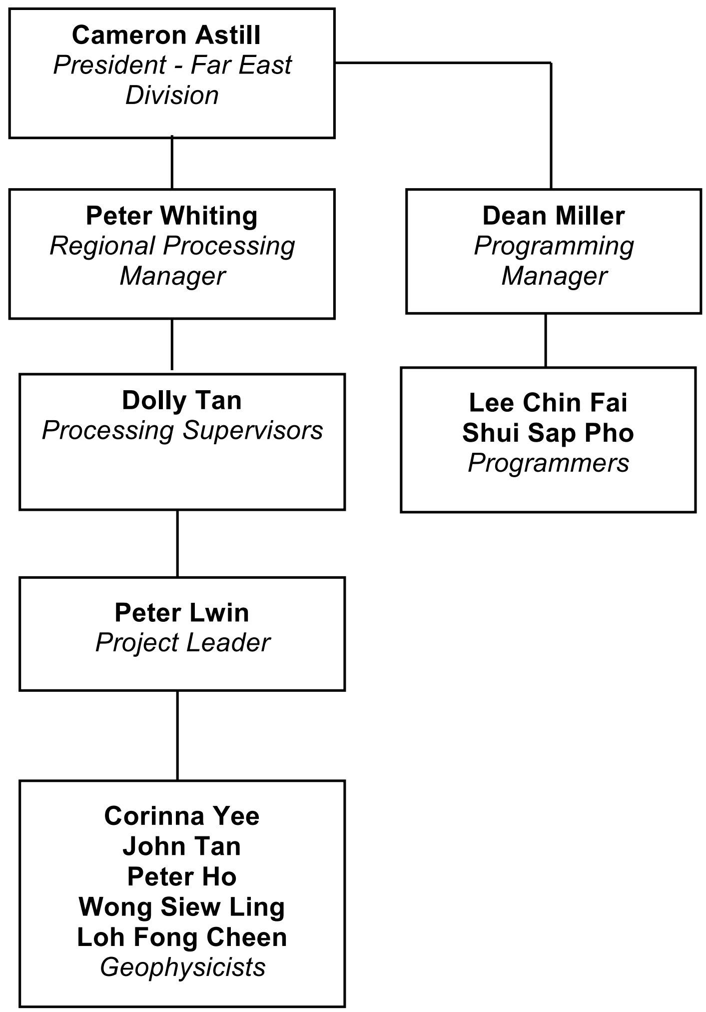


4. PERSONNEL AND EQUIPMENT

4.1 GEOPHYSICAL STAFFING AND ORGANISATION

Peter Whiting was the overall project manager for this project. Dolly Tan was the project supervisor, responsible for project management and processing schedule and control of the accuracy and progress of the project throughout its duration. Peter Lwin led the production processing team.

Singapore Centre



4.2 COMPUTER HARDWARE DESCRIPTION

This survey was processed in Veritas DGC's Singapore processing centre. Listed below is the hardware inventory of the Singapore processing centre.

SINGAPORE BEOWULF CLUSTER SYSTEM

PROCESSORS	1732 Nodes, 1.2 – 2.0 GHz CPUs with 24 Dual CPU Master Servers
REAL MEMORY	2090 Gigabytes
DISKS	160 Terabytes total storage
NETWORK	Hi-Speed Gigabit Network to cluster masters from backbone 1000TX switched to all nodes

PROCESSING OPTERON PC'S

PROCESSORS	8 Processing OPTERON PCs
REAL MEMORY	64 bit, 2.0 GHz x 2 CPU
DISKS	32 Gigabytes with ECC
NETWORK	DFS, 42 Terabytes RAID Storage

PROCESSING PC'S

PROCESSORS	30 Dual AMD 1800 / 2000 CPUs
REAL MEMORY	88 Gigabytes with ECC
DISKS	Axus BR-1200U2 Dual Channel SCSI 160 44.8 Terabytes RAID storage
NETWORK	Hi-Speed Gigabit to Servers

1 X HEWLETT PACKARD KITTYHAWK K460

PROCESSORS	4 PA-RISC 8200 CPU's
REAL MEMORY	4 Gigabytes
DISKS	810 Gigabytes of Ultra SCSI Disk RAID 5
TAPES	4 IBM Magstar 3590 cartridge drives 2 X 3480 cartridge drives 1 X 3490E cartridge drive 1 X Exabyte drive 1 X Dual 8705 Cybernetics 8mm drive

2 X HEWLETT PACKARD KITTYHAWK K460

PROCESSORS	4 PA-RISC 8200 CPU's
REAL MEMORY	4 Gigabytes
DISKS	880 Gigabytes of Fast/Wide SCSI Disk RAID 5
TAPES	4 IBM Magstar 3590 cartridge drives 2 X 3480 cartridge drives 1 X 3490E cartridge drive 1 X Exabyte drive

Note : RAID ~ Redundancy Array Inexpensive Disk
HIPPI ~ High Performance Parallel Interface

SUN ULTRA 2 MODEL 2200

PROCESSORS	2 X 200 MHz ULTRA SPARC II
REAL MEMORY	0.5 Gigabyte
DISKS	4.2 Gigabytes Internal, 100 Gigabytes External Disk, Ultra SCSI-2 disk
TAPES	2 x 3590 IBM Magstar Tape Drives 1 Exabyte 8505 2 Fujitsu Round Drives 9 track M2436 200 ips Density Format PE (1600) GCR (6250)

5 X HEWLETT PACKARD C360 SERVERS

PROCESSORS	1 PA-RISC 8500 CPU's
REAL MEMORY	1.5 Gigabytes
DISKS	360 Gigabytes of Fast/Wide SCSI Disk RAID 5

4 X HEWLETT PACKARD C180 SERVERS

PROCESSORS	1 PA-RISC 8200 CPU's
REAL MEMORY	1 Gigabyte
DISKS	180 Gigabytes of Fast/Wide SCSI Disk RAID 5

1 X HEWLETT PACKARD N-4000/9000

PROCESSORS	8 PA-RISC 8600 (550 MHz) CPU's
REAL MEMORY	16 Gigabytes
DISKS	4.7 Terabytes Fiber Channel
TAPES	6 X 3590 Dual Ported

1 X HEWLETT PACKARD N-4000/9000

PROCESSORS	8 PA-RISC 8500 (550 MHz) CPU's
REAL MEMORY	22 Gigabytes
DISKS	5.8 Terabytes Fiber Channel
TAPES	6 X 3590 Dual Ported

1 X HEWLETT PACKARD N-4000/9000

PROCESSORS	8 PA-RISC 8500 (440 MHz) CPU's
REAL MEMORY	16 Gigabytes
DISKS	4.3 Terabytes Fiber Channel
TAPES	6 X 3590 Dual Ported

Note : RAID ~ Redundancy Array Inexpensive Disk
HIPPI ~ High Performance Parallel Interface

1 X SGI OCTANE GRAPHICS

PROCESSORS	2 x 300 MHz
REAL MEMORY	2 Gigabytes
DISKS	700 Gigabytes (Fiber Channel)
TAPES	DLT 7000/ Exabyte 820
OTHERS	Dual Monitors Display 21 inches

PERIPHERALS

PLOTTERS	1 x XEROX 36-inch Scanner 2 x XEROX 36-inch 8830 Printer-Plotter 1 x OYO GS-6x42 42" Thermal Film Plotter 1 x HP1055C Design Jet Plotter with SDI-HP Jet server plot software
PRINTERS	Various laser printers – Epson/NEC/HP
DIGITIZERS	1 Calcomp 9500 flatbed digitizing system
TAPES	1 x Dual 8705 Cybernetics 8mm drive

ANCILLARY EQUIPMENT

TAPE CLEANER	2 x 3590 Tape Cleaners

WORKSTATIONS

4 x Hewlett Packard C360 PA 8500 Dual Head Workstations with 1.5 Gigabytes of Memory and 180 Gigabytes of RAID 5 disk – Dual Monitors
37 x Dell Pentium PC with X emulation
9 x HP Vectra Pentium Pro 200 Hi-Res. PC with X emulation

POWER SYSTEMS

Data Power 3-Phase UPS, Model: DP3220 (220 KVA)

VIDEO CONFERENCING & DATA VISUALIZATION ROOM

Dell Precision Model 340 Dual Monitor Workstation,
1 GB Memory
Pentium 4 2.4 GHz CPU
40GB hard disk

Leadtek GeForce 4 TI4600 128MB AGP high speed 3D graphic card

High speed network with 100 megabit switch
Vega graphics software

Theatre system includes dual digital LCD projectors, speakers, matrix switches. Theatre accommodates up to 12 persons.

Note : RAID ~ Redundancy Array Inexpensive Disk
HIPPI ~ High Performance Parallel Interface

5. PROJECT MANAGEMENT

5.1 REPORTING PROCEDURES

Project meetings were held on a daily basis for the purpose of monitoring progress and planning the project's future requirements.

Microsoft Excel spreadsheet was used to monitor the progress of the project, usage of resources, and to flag upcoming tasks with a Progress chart. The Microsoft Excel spreadsheet was updated once a week.

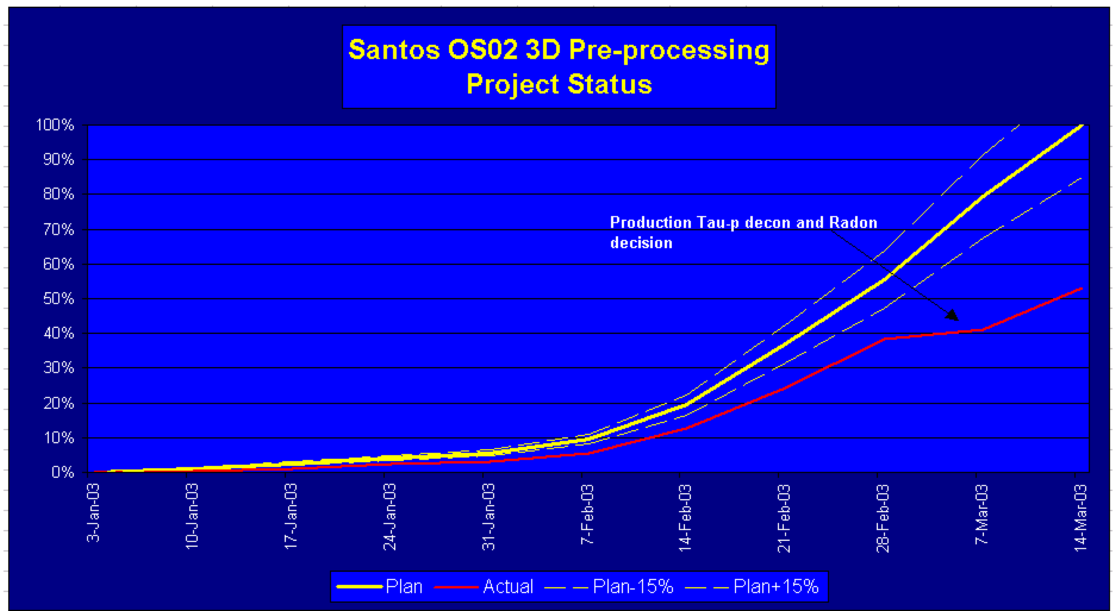
Interactive project tracking database was utilised as the official status reporting format. The interactive project tracking database was updated on a daily basis. The interactive project tracking database covers: 1)- Emails sections 2) - General Information 3) - Meeting Minutes 4) - Production QC 5) - Project Status 6) - Testing Reports 7) - Weekly Reports. Santos can view the updated project status via Veritas DGC's Global Web site. Every Friday, the kilometres processed in the previous week were updated for each of the defined stages. This created a summary report and an overall plan versus actual graph. These figures and graphs were entered in the "Weekly Reports" section in the interactive project tracking database every Friday.

Conference call were held on every Thursday afternoon, a summary notes were entered in the meeting minutes

5.2 OS02 3D PRE PROCESSING PROJECT PLAN & PROGRESS CHART

Project : OS02 VIC P51/52 3D **Client : Santos Ltd**
Status Date :14 March 2003

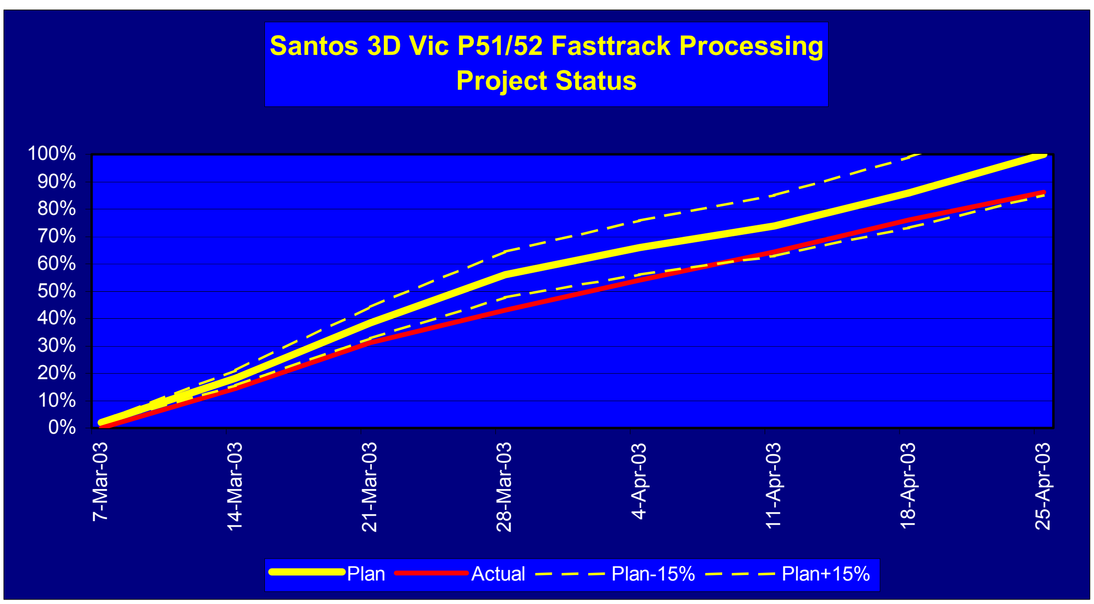
Processing Step	Weight	Total Units	Plan Start Date	Plan End Date	Jan 3, 03 % comp	Jan 10, 03 % comp	Jan 17, 03 % comp	Jan 24, 03 % comp	Jan 31, 03 % comp	Feb 7, 03 % comp	Feb 14, 03 % comp	Feb 21, 03 % comp	Feb 28, 03 % comp	Mar 7, 03 % comp	Mar 14, 03 % comp
Last datadrop (10wks from receipt of data)	0%	1000	Jan 2, 03	Mar 13, 03											
Pre-Processing Testing	10%	1000	Jan 6, 03	Feb 21, 03	0	5	10	25	30	50	60	70	75	80	80
Ref /Nav Merge /Instr dephase /FXEDIT /NTR /Resamp / XRLIN	15%	1000	Feb 5, 03	Feb 21, 03					0	3	25	65	100	100	100
Velocity Analysis 1 create & pick(1km grid)	15%	1000	Feb 13, 03	Feb 26, 03						0	20	50	100	100	100
Velocity Analysis 1 QC	3%	1000	Feb 19, 03	Feb 28, 03						0	0	0	30	100	100
Sphdiv/Exp gain/Tau-p dcn/ATS/XRMULT	20%	1000	Feb 21, 03	Mar 7, 03							0	0	0	0	60
SCAVE /residual SSD /tidal statics /3D Binning 12.5X12.5m	20%	1000	Feb 28, 03	Mar 10, 03									0	0	0
FLOOD 12.5m X 12.5m grid	12%	1000	Mar 7, 03	Mar 12, 03											
Archive of Pre-Processed Gathers	4%	1000	Mar 12, 03	Mar 13, 03											
Pre-processing Report Preparation	1%	1000	Mar 12, 03	Mar 13, 03											



5.3 SANTOS 3D VIC 51-52 FAST TRACK PROJECT PLAN & PROGRESS CHART

Project : VIC P51/52 Client : Santos 3D
Status Date :25 Apr 2003

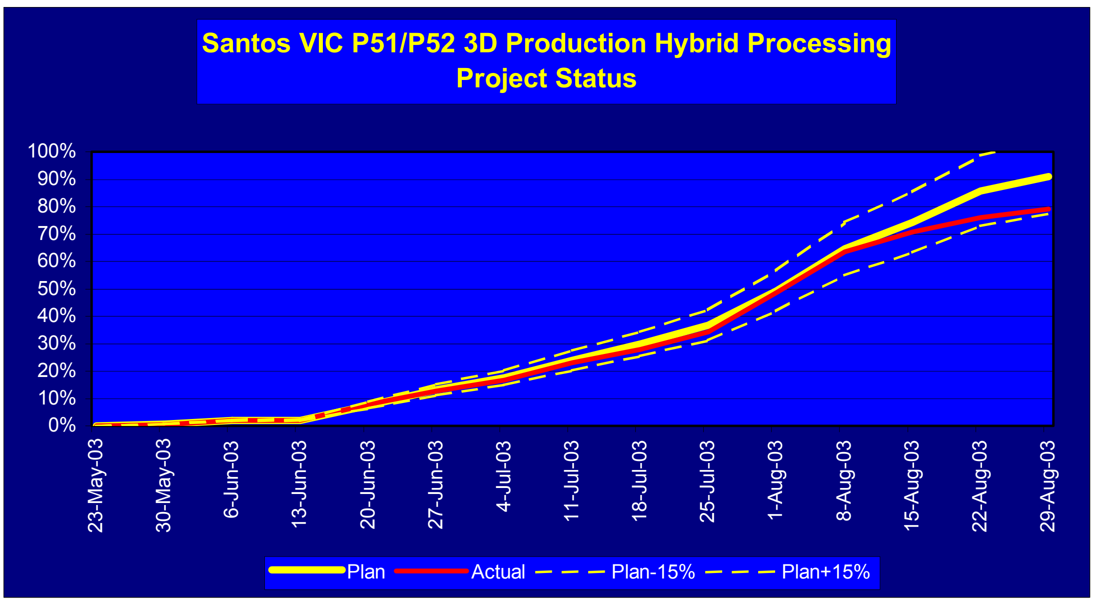
Processing Step	Weight	Total Units	Plan Start Date	Plan End Date	Mar 7, 03 % comp	Mar 14, 03 % comp	Mar 21, 03 % comp	Mar 28, 03 % comp	Apr 4, 03 % comp	Apr 11, 03 % comp	Apr 18, 03 % comp	Apr 25, 03 % comp
Fasttrack - DMO/STK/MIG - target 1st April	0%	760	Mar 7, 03	Apr 1, 03								
Production Tau-p decon and XRMULT	15%	760	Mar 7, 03	Mar 17, 03	0	60	100	100	100	100	100	100
2D DMO Velocity Analysis (V2) create & pick 1.0km	5%	760	Mar 7, 03	Mar 13, 03	0	100	100	100	100	100	100	100
Velocity Analysis V2 QC (inner and outer mute decision)	2%	760	Mar 13, 03	Mar 18, 03		0	100	100	100	100	100	100
3D Binning 25x25m grid	6%	760	Mar 13, 03	Mar 19, 03		10	75	100	100	100	100	100
FLOOD 25X25m grid	5%	760	Mar 17, 03	Mar 21, 03		0	75	100	100	100	100	100
NMO/Mute/DMO stack	10%	760	Mar 18, 03	Mar 26, 03		0	10	100	100	100	100	100
Post Migration	4%	760	Mar 26, 03	Mar 28, 03			0	0	100	100	100	100
Zero-phasing/TVF/TVS/ full stack archive	3%	760	Mar 29, 03	Apr 1, 03				0	100	100	100	100
Fasttrack - HYBRID Migration 25x25m - target 25th April	0%	760	Mar 21, 03	Apr 25, 03								
Input from above FLOOD dataset	0%	760	Mar 21, 03	Mar 21, 03								
SCALEMULT (decision 2 April)	4%	760	Mar 21, 03	Mar 24, 03				0	100	100	100	100
HYBRID Migration 25x25m (wbt to derive from ntr mig)	15%	760	Mar 24, 03	Apr 7, 03				0	0	70	100	100
Velocity Analysis (V3) create & pick 1.0 km	10%	760	Apr 8, 03	Apr 16, 03						0	70	100
Velocity Analysis (V3) QC	3%	760	Apr 11, 03	Apr 16, 03						0	0	100
NMO / Angle mute /Stack (full, near and far)	8%	760	Apr 17, 03	Apr 20, 03						0	0	30
Zero-phasing/TVF/TVS/ full stack archive	6%	760	Apr 21, 03	Apr 22, 03							0	30
Gather archive	4%	760	Apr 21, 03	Apr 25, 03							0	0



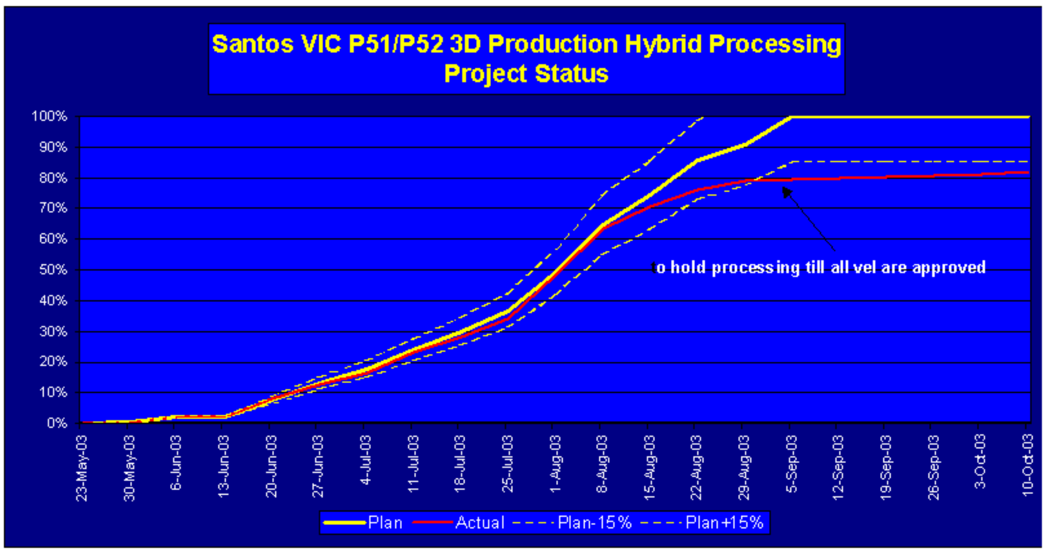
5.4 OS02 3D PRODUCTION PROJECT PLAN & PROGRESS CHART

Project : VIC P51/P52 3D Client : Santos Limited
Status Date :29Aug 2003

Processing Step	Weight	Total Units	Plan Start Date	Plan End Date	May 23, 03 % comp	May 30, 03 % comp	Jun 6, 03 % comp	Jun 13, 03 % comp	Jun 20, 03 % comp	Jun 27, 03 % comp	Jul 4, 03 % comp	Jul 11, 03 % comp	Jul 18, 03 % comp	Jul 25, 03 % comp	Aug 1, 03 % comp	Aug 8, 03 % comp	Aug 15, 03 % comp	Aug 22, 03 % comp	Aug 29, 03 % comp
Fasttrack PSHM 2 residual vel create and picked (V4)	0%	760	May 23, 03	Jun 6, 03	0	40	100	100	100	100	100	100	100	100	100	100	100	100	100
Fasttrack PSHM 2 residual vel QC (V4) - 26 Jun	0%	760	Jun 4, 03	Jun 10, 03			0	0	0	100	100	100	100	100	100	100	100	100	100
Decision to apply Scalemult and Freesurf for Prod Mig	0%	760	Jun 4, 03	Jun 4, 03															
FLOOD (7tr) 12.5m X 12.5m grid	0%	760	Apr 4, 03	Apr 12, 03	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Bad cable edits	2%	760	May 29, 03	Jun 3, 03	0	20	100	100	100	100	100	100	100	100	100	100	100	100	100
Archive of Pre-Processed Gathers	4%	760	Aug 1, 03	Aug 16, 03								0	0	0	0	75	100	100	100
Scalemult /FREESURF- approved 4 Jun	10%	760	Jun 16, 03	Jun 24, 03				0	60	100	100	100	100	100	100	100	100	100	100
Target line Migration aperture - more tests	3%	760	Jun 26, 03	Jun 30, 03						25	100	100	100	100	100	100	100	100	100
De-striping - approved 2 July	8%	760	Jul 2, 03	Jul 10, 03							20	100	100	100	100	100	100	100	100
UTMOST(Hybrid) Production i/p12.5m grid o/p 25m grid	25%	760	Jul 11, 03	Aug 8, 03								0	20	45	75	100	100	100	100
Archive of UTMOST Gathers	3%	760	Aug 15, 03	Aug 31, 03												0	0	0	0
Velocity Analysis 0.25km grid - create & residual (V5)	25%	760	Jul 25, 03	Aug 22, 03										0	27	50	75	90	100
AOK Tests on inline 8130 2nd Hybrid dataset	0%	760	Jul 25, 03	Jul 31, 03										0	100	100	100	100	100
Velocity Analysis 0.25km grid QC (V5)	6%	760	Aug 1, 03	Aug 29, 03											0	0	0	25	35



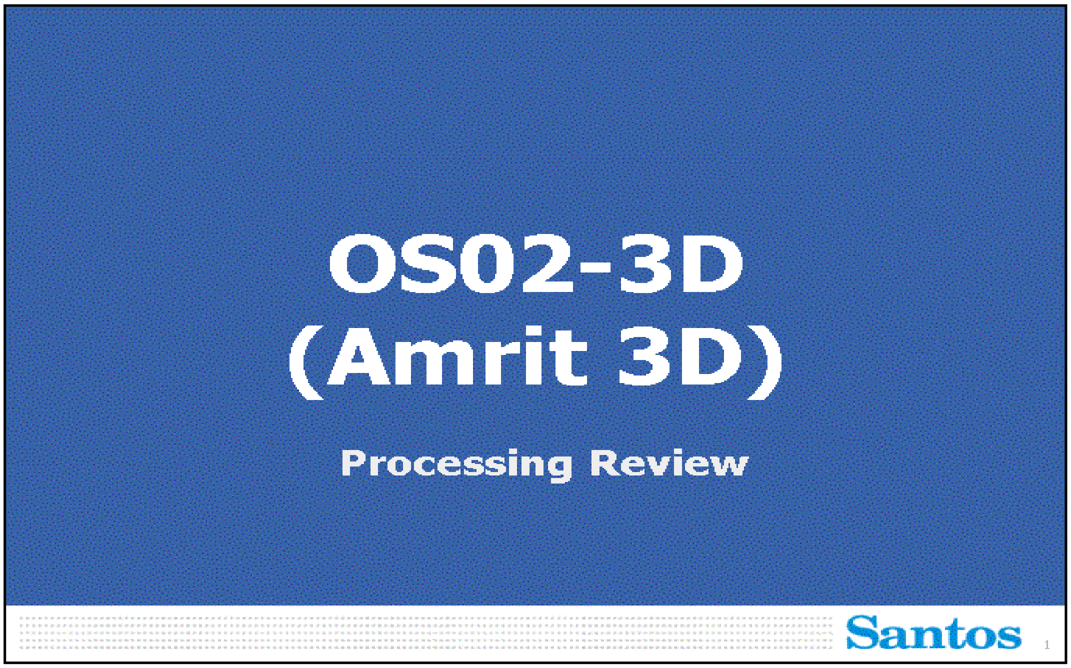
Project : VIC P51/P52 3D Client : Santos Limited Status Date :10 Oct 2003					May 23, 03	May 30, 03	Jun 6, 03	Jun 13, 03	Jun 20, 03	Jun 27, 03	Jul 4, 03	Jul 11, 03	Jul 18, 03	Jul 25, 03	Aug 1, 03	Aug 8, 03	Aug 15, 03	Aug 22, 03	Aug 29, 03	Sep 5, 03	Sep 12, 03	Sep 19, 03	Sep 26, 03	Oct 3, 03	Oct 10, 03
Processing Step	Weight	Total Units	Plan Start Date	Plan End Date	% comp	% comp	% comp	% comp	% comp	% comp	% comp	% comp	% comp	% comp	% comp	% comp	% comp	% comp	% comp	% comp	% comp	% comp	% comp	% comp	% comp
Fasttrack PSHM 2 residual vel create and picked (V4)	0%	760	May 23, 03	Jun 6, 03	0	40	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Fasttrack PSHM 2 residual vel QC (V4) - 26 Jun	0%	760	Jun 4, 03	Jun 10, 03			0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Decision to apply Scalemult and Freesurf for Prod Mig	0%	760	Jun 4, 03	Jun 4, 03																					
FLOOD (7tr) 12.5m X 12.5m grid	0%	760	Apr 4, 03	Apr 12, 03	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Bad cable edits	2%	760	May 29, 03	Jun 3, 03	0	20	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Archive of Pre-Processed Gathers	4%	760	Aug 1, 03	Aug 16, 03								0	0	0	0	75	100	100	100	100	100	100	100	100	100
Scalemult /FREESURF- approved 4 Jun	10%	760	Jun 16, 03	Jun 24, 03				0	60	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Target line Migration aperture - more tests	3%	760	Jun 26, 03	Jun 30, 03						25	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
De-striping - approved 2 July	8%	760	Jul 2, 03	Jul 10, 03							20	100	100	100	100	100	100	100	100	100	100	100	100	100	100
UTMOST(Hybrid) Production i/p12.5m grid o/p 25m grid	25%	760	Jul 11, 03	Aug 8, 03								0	20	45	75	100	100	100	100	100	100	100	100	100	100
Archive of UTMOST Gathers	3%	760	Aug 15, 03	Aug 31, 03												0	0	0	0	0	0	0	0	0	0
Velocity Analysis 0.25km grid - create & residual (V5)	25%	760	Jul 25, 03	Aug 22, 03										0	27	50	75	90	100	100	100	100	100	100	100
AOK Tests on inline 8130 2nd Hybrid dataset	0%	760	Jul 25, 03	Jul 31, 03										0	100	100	100	100	100	100	100	100	100	100	100
Velocity Analysis 0.25km grid QC (V5)	6%	760	Aug 1, 03	Aug 29, 03											0	0	0	25	35	41	46	51	58	70	81
NMO /angle mute /stack (full, near & far)	6%	760	Aug 15, 03	Aug 31, 03															0	0	0	0	0	0	0
Post stack - Noise Attenuation	4%	760	Sep 1, 03	Sep 3, 03																					
TVF /TVS/Archive	4%	760	Sep 3, 03	Sep 5, 03																					

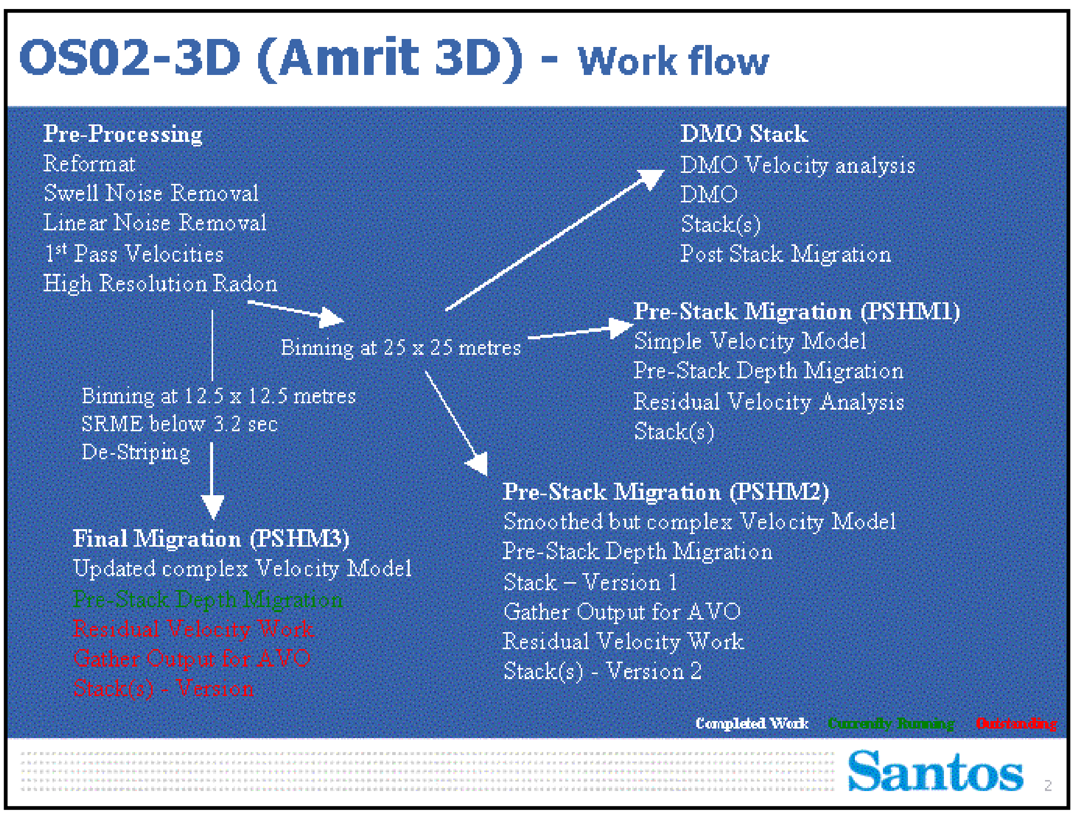


Awaiting on residual velocity approval for gather archive and stacking

6. TESTING

6.1 PRE-PROCESSING TESTS



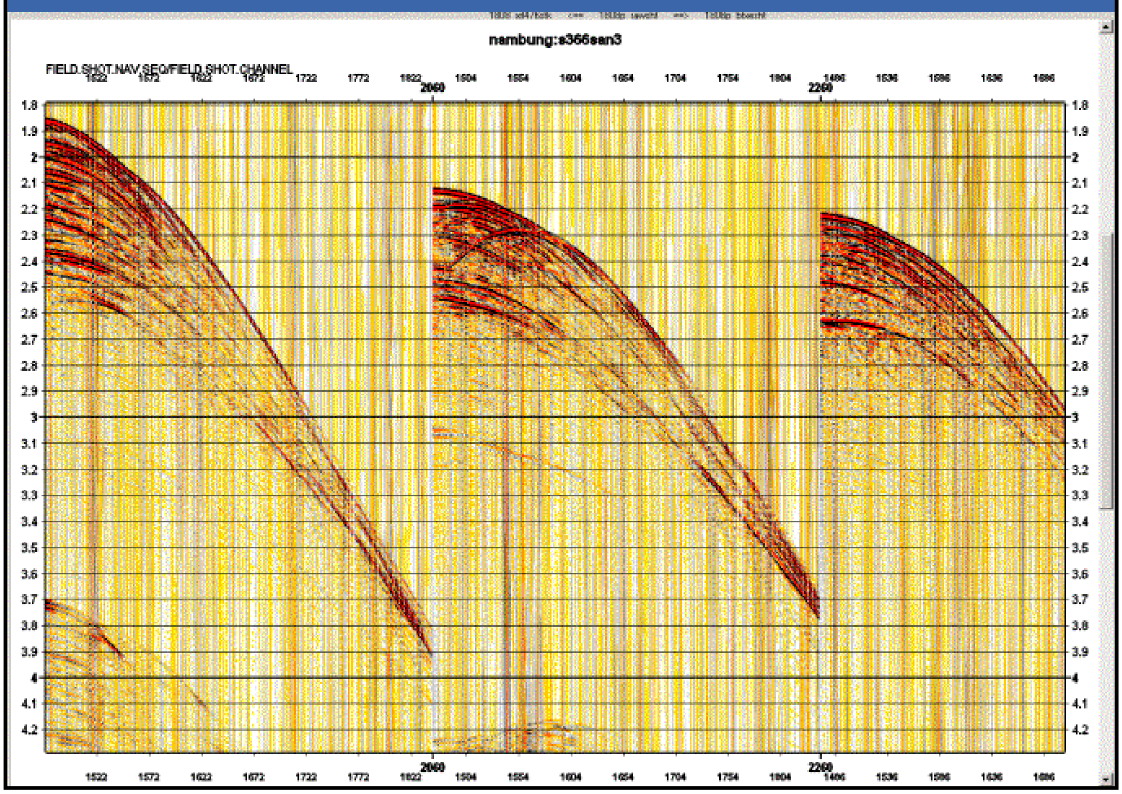


OS02-3D (Amrit 3D) - Pre-Processing

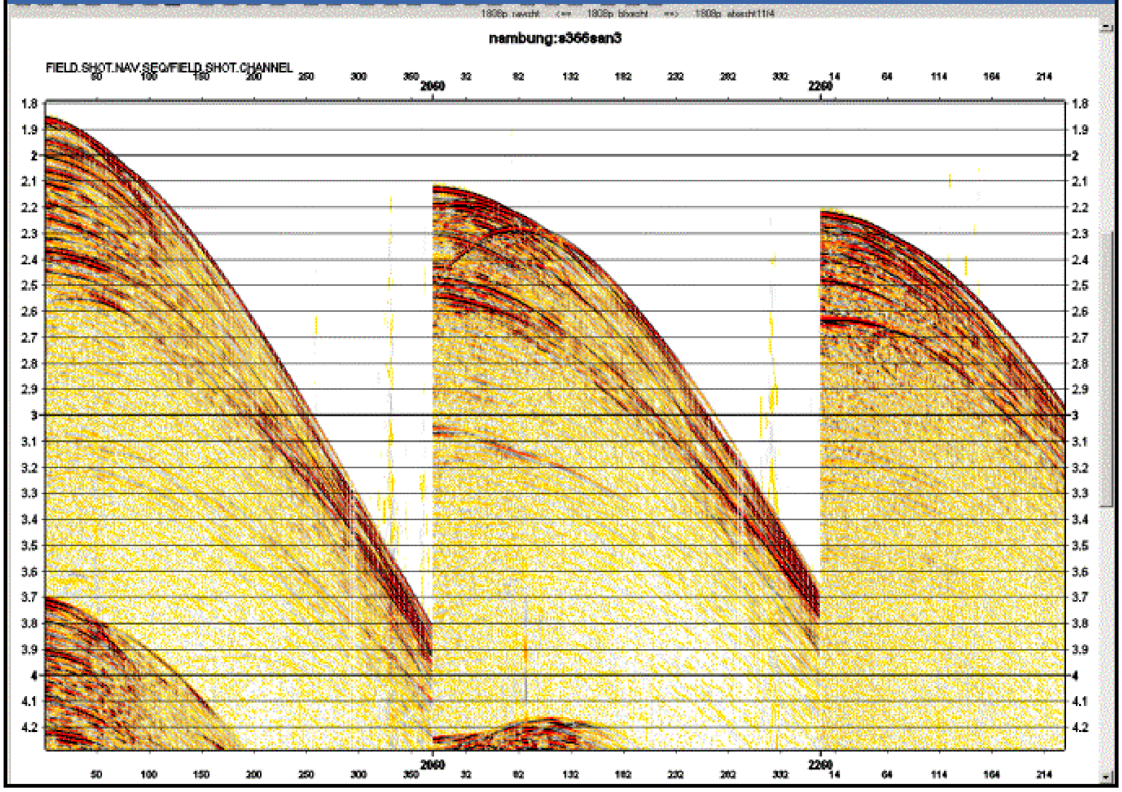
1. **Reformat** to Tango internal format - 2ms; 6.5sec; 12.5m groups, 37.5m shots flip flop (2 guns 8 cables)
2. **Shot and trace edits**
3. **Instrument Dephase** (no gun and no cable ghost) - to output minimum phase
4. **3Hz Low cut filter** (zero phase)
5. **Spherical divergence** V**2T using 1 average velocity function
6. **Swell Noise Attenuation** (FXEDIT) - 2passes
7. **Resample to 4ms** (zero phase aafilt tests)
8. XRLIN 2100m/s
9. Velocity 1 (with mild Radon)
10. Remove and reapply spherical divergence with V1 velocities.
11. Tau-p Deconvolution on data with wbt less than 300ms, ramp to wbt 400ms and no decon for wbt deeper than 400ms
12. Radon demultiple using XRMULT 300ms cut

Santos 3

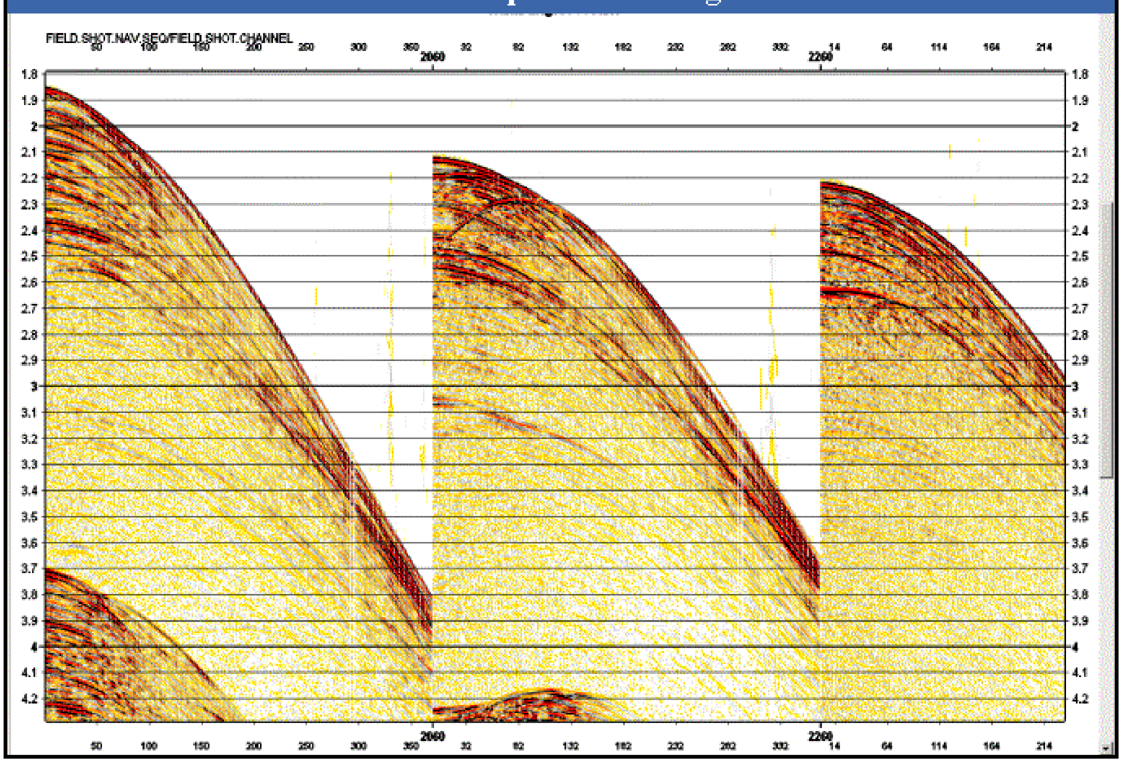
Sail Line 1808 Selected Raw Shots

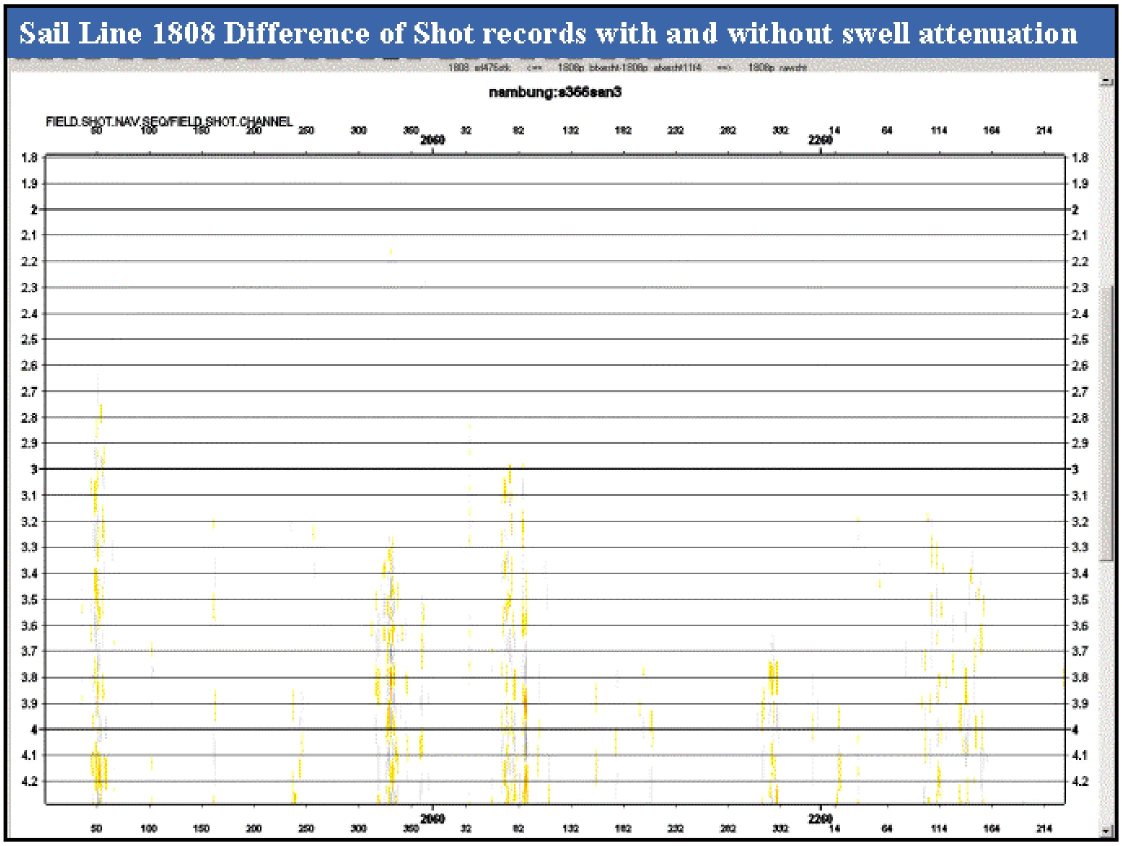


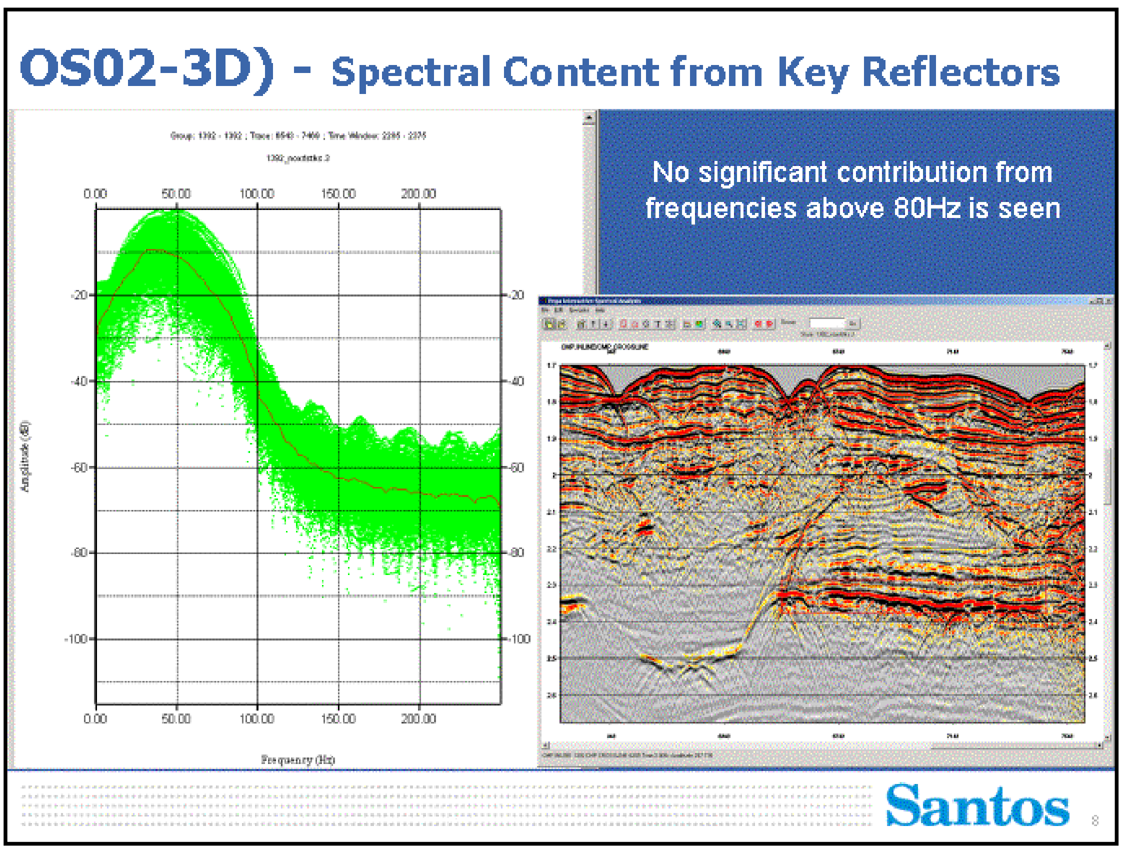
Sail Line 1808 Shots with 3Hz Low Cut Filter and Spherical Divergence



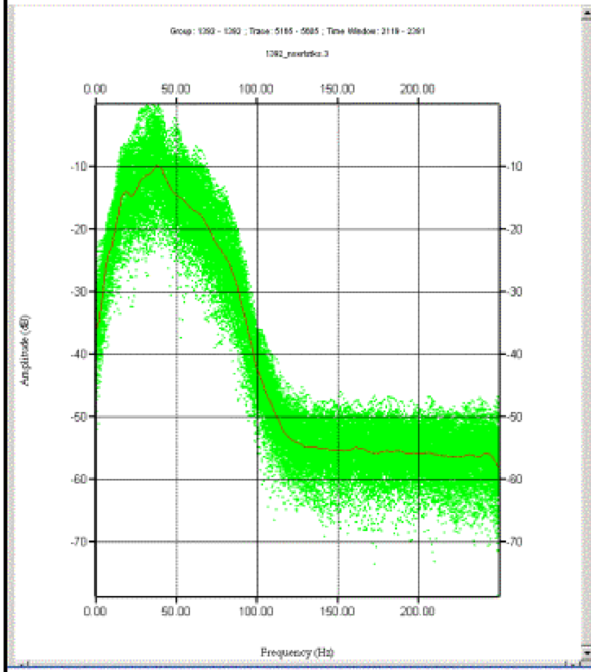
Sail Line 1808 Shots with Swell Noise Attenuation in Channel and Shot Domain after Low Cut filter and Spherical Divergence

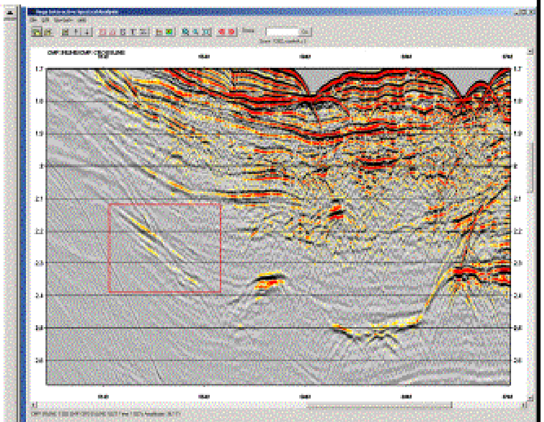



Sail Line 1808 Difference of Shot records with and without swell attenuation
nambung:s366san3
FIELD.SHOT.NAV.SEQ/FIELD.SHOT.CHANNEL
2060
2260


OS02-3D) - Spectral Content from Key Reflectors
No significant contribution from frequencies above 80Hz is seen
Amplitude (dB)
Frequency (Hz)
Santos

OS02-3D) - Spectral Content from Key Reflectors





As such 4hz resampling was approved

Santos 9

OS02-3D (Amrit 3D) - Pre-Processing

1. **Reformat** to Tango internal format - 2ms; 6.5sec; 12.5m groups, 37.5m shots flip flop (2 guns 8 cables)
2. **Shot and trace edits**
3. **Instrument Dephase** (no gun and no cable ghost) - to output minimum phase
4. **3Hz Low cut filter** (zero phase)
5. **Spherical divergence** V**2T using 1 average velocity function
6. **Swell Noise Attenuation** (FXEDIT) - 2passes
7. **Resample to 4ms** (zero phase aafilt tests)
8. XRLIN 2100m/s
9. Velocity 1 (with mild Radon)
10. Remove and reapply spherical divergence with V1 velocities.
11. Tau-p Deconvolution on data with wbt less than 300ms, ramp to wbt 400ms and no decon for wbt deeper than 400ms
12. Radon demultiple using XRMULT 300ms cut

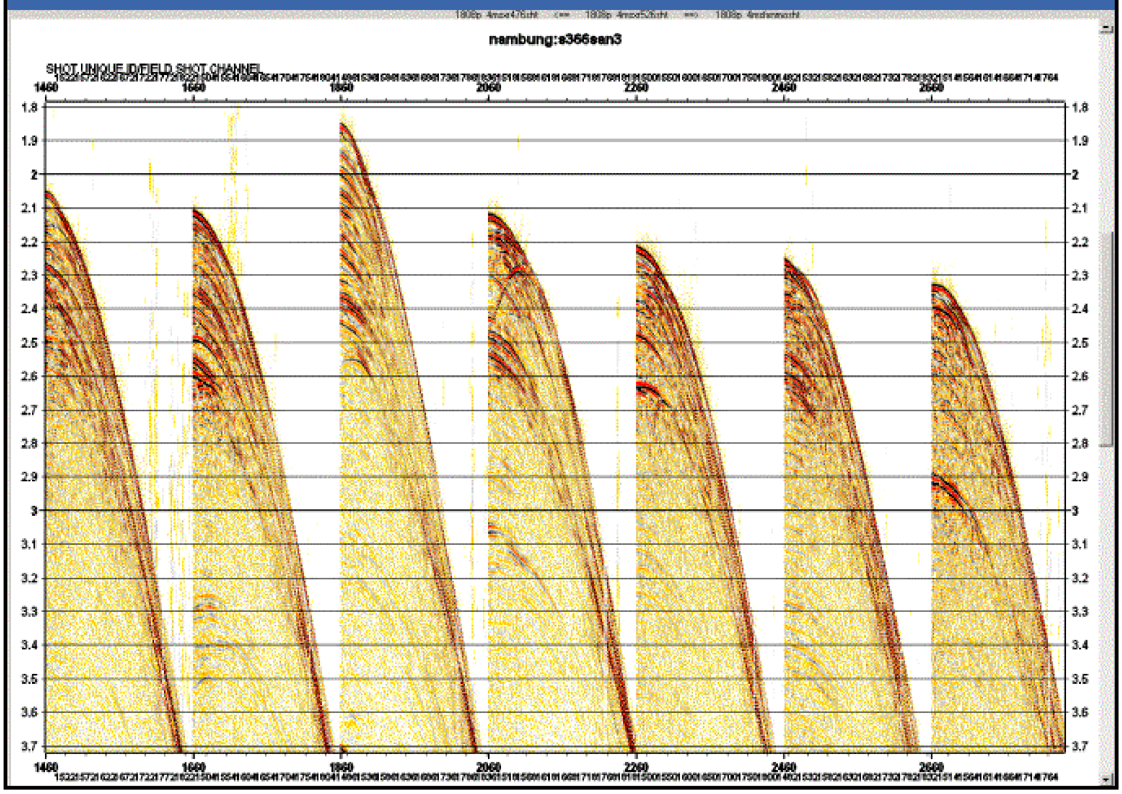
Santos 10

OS02-3D (Amrit 3D) - Pre-Processing

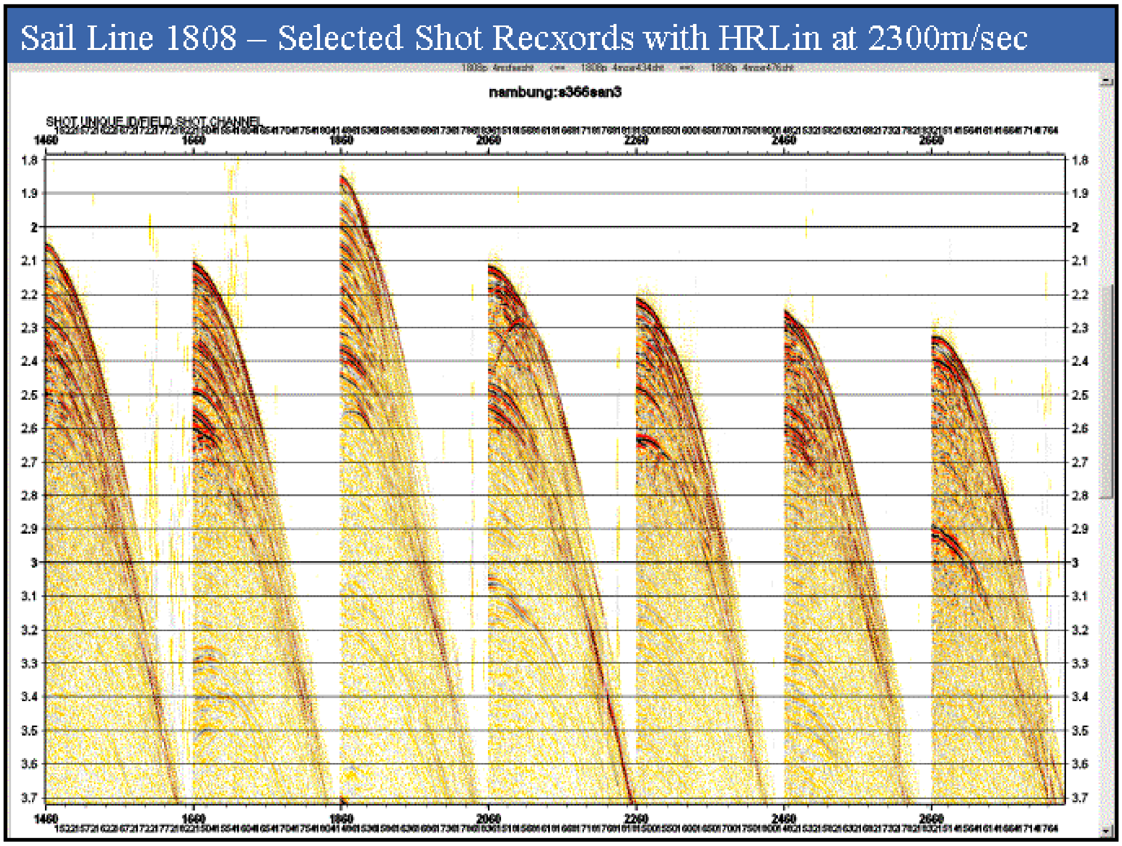
HRLin Tests
A "High Resolution" Tau-P transform and attenuation of Linear Noise Trains as applied on data without NMO applied.

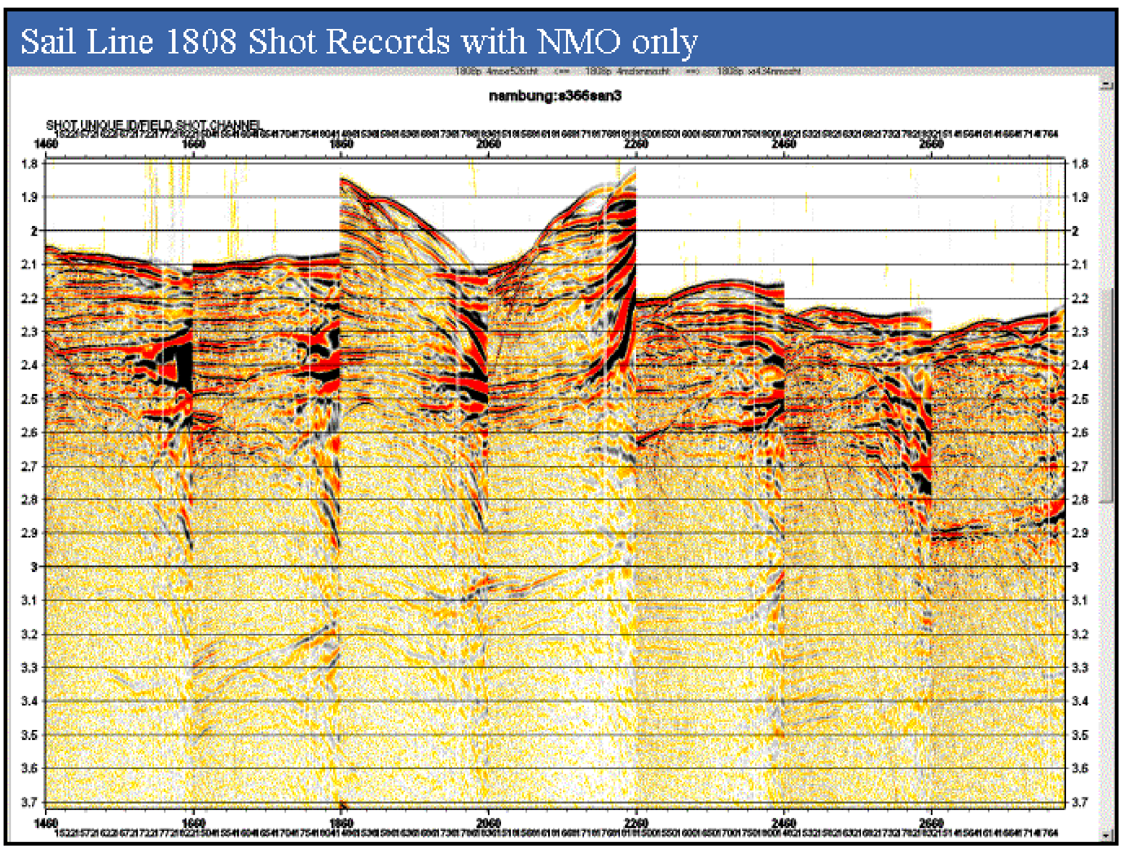
Santos 11

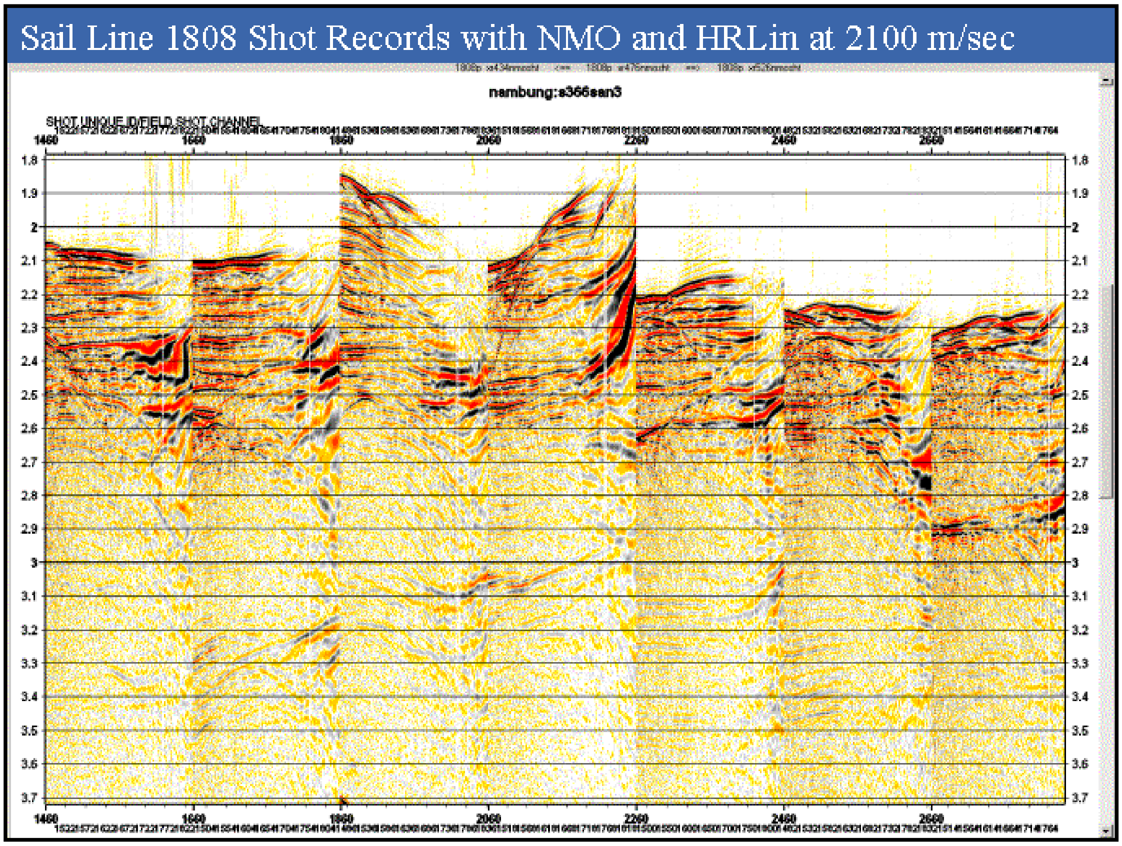
Sail Line 1808 Shot Records with NMO and HRLin at 1900 m/sec

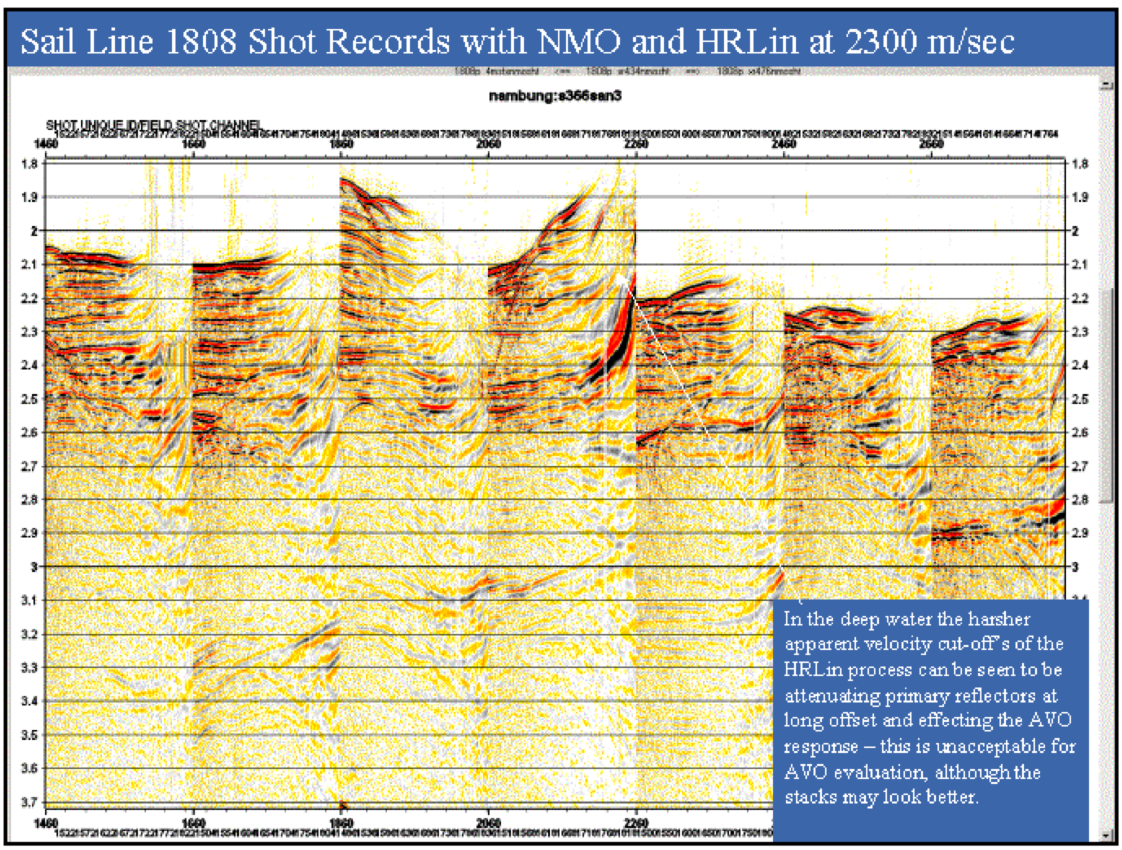


VERITAS

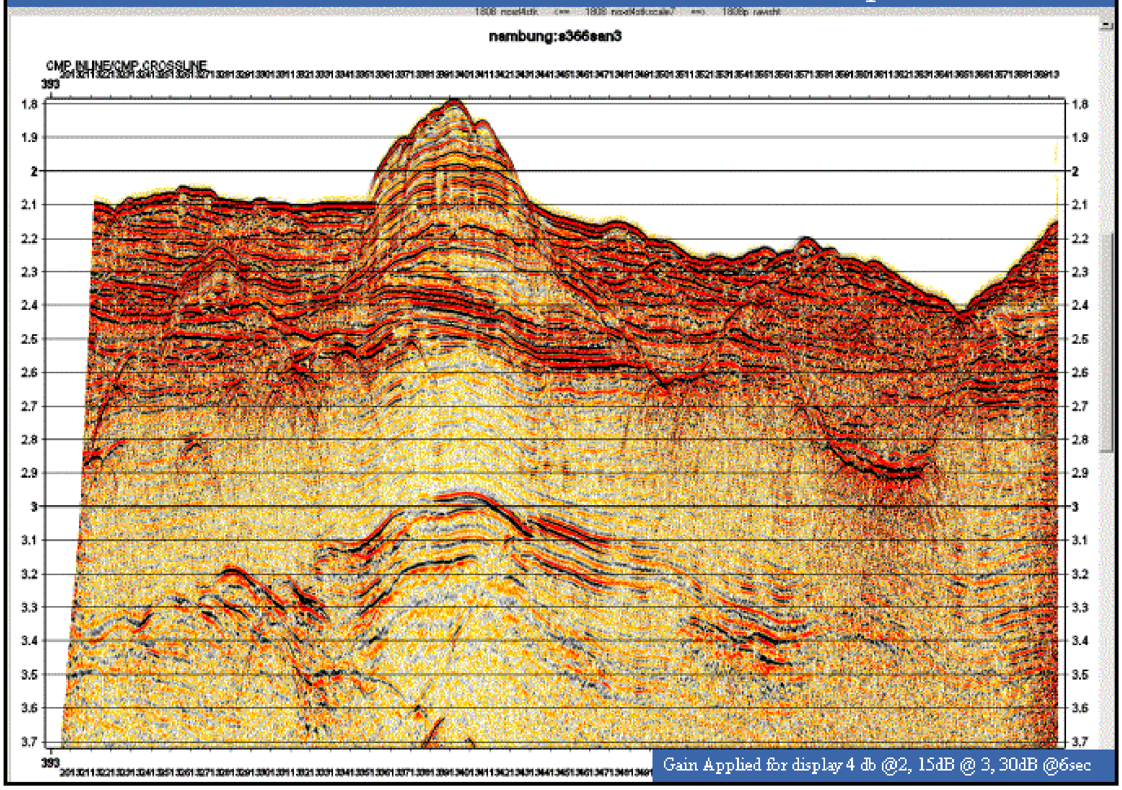

Sail Line 1808 – Selected Shot Recxords with HRLin at 2300m/sec
nambung:s366san3
SHOT UNIQUE ID/FIELD SHOT CHANNEL


Sail Line 1808 Shot Records with NMO only
nambung:s366san3
SHOT UNIQUE ID/FIELD SHOT CHANNEL

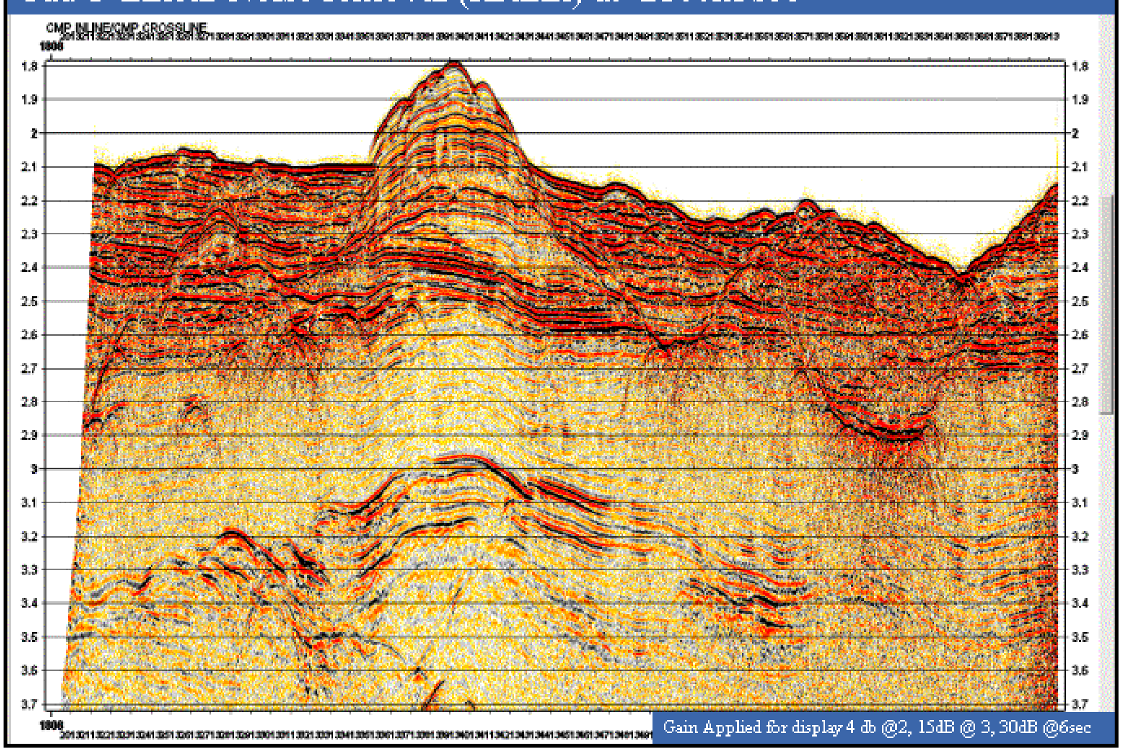

Sail Line 1808 Shot Records with NMO and HRLin at 2100 m/sec
nambung:s366san3
SHOT UNIQUE ID/FIELD SHOT CHANNEL

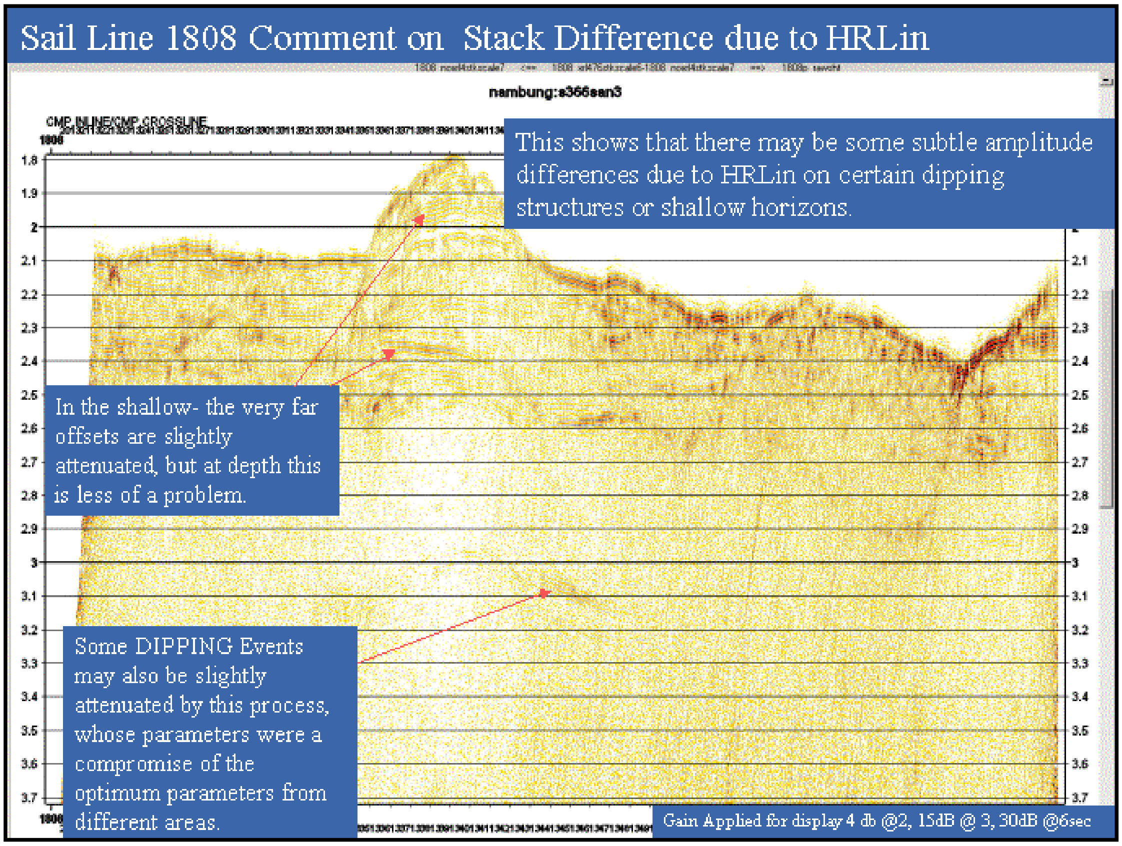

Sail Line 1808 Shot Records with NMO and HRLin at 2300 m/sec
nambung:s366san3
SHOT UNIQUE ID/FIELD SHOT CHANNEL
In the deep water the harsher apparent velocity cut-off's of the HRLin process can be seen to be attenuating primary reflectors at long offset and effecting the AVO response – this is unacceptable for AVO evaluation, although the stacks may look better.

Sail Line 1808 Stack With FXedit no HRLin and Resampled to 4 msec



Sail Line 1808 Stack With FXedit and Linear Noise Removal using Tau-P Linear Noise removal (HRLin) at 2100m/sec





HRLIn with a cut of 2100m/sec is cleaning up the data, but has the capacity to affect the AVO response at far offsets of events within 500 msec of the sea floor.

This is a potential problem if there are any very shallow hydrocarbons, but this is still considered an acceptable compromise.

Given the complex nature of primary events, an NMO'd FK process will have the same problems

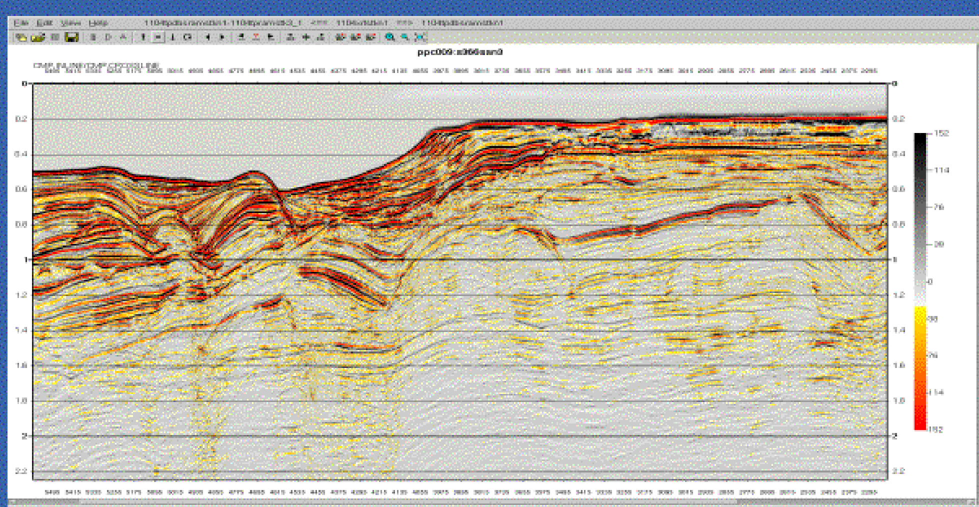
Santos 20

OS02-3D (Amrit 3D) - Pre-Processing

1. **Reformat** to Tango internal format - 2ms; 6.5sec; 12.5m groups, 37.5m shots flip flop (2 guns 8 cables)
2. **Shot and trace edits**
3. **Instrument Dephase** (no gun and no cable ghost) - to output minimum phase
4. **3Hz Low cut filter** (zero phase)
5. **Spherical divergence** V**2T using 1 average velocity function
6. **Swell Noise Attenuation** (FXEDIT) - 2passes
7. **Resample to 4ms** (zero phase aafilt tests)
8. XRLIN 2100m/s
9. Velocity 1 (with mild Radon)
10. Remove and reapply spherical divergence with V1 velocities.
11. Tau-p Deconvolution on data with wbt less than 300ms, ramp to wbt 400ms and no decon for wbt deeper than 400ms
12. Radon demultiple using XRMULT 300ms cut

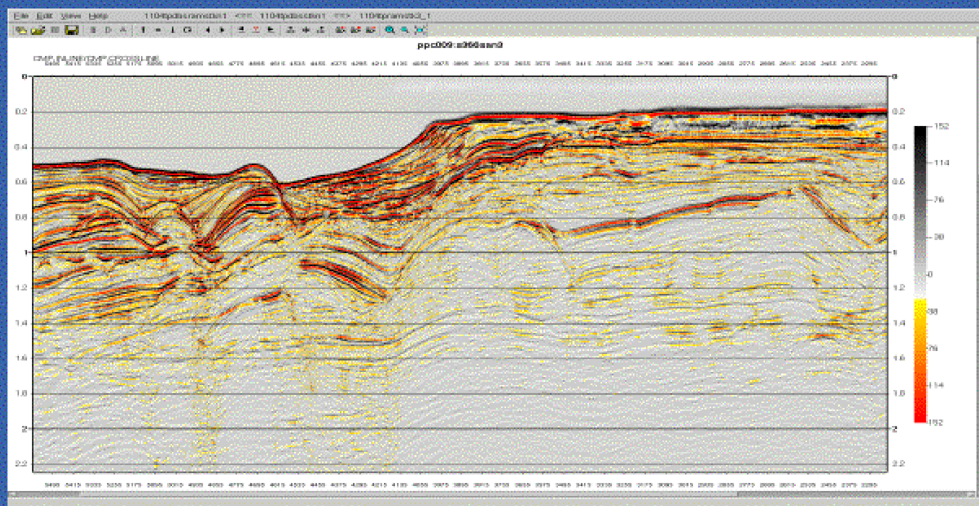
Santos 21

Line 1104 no decon



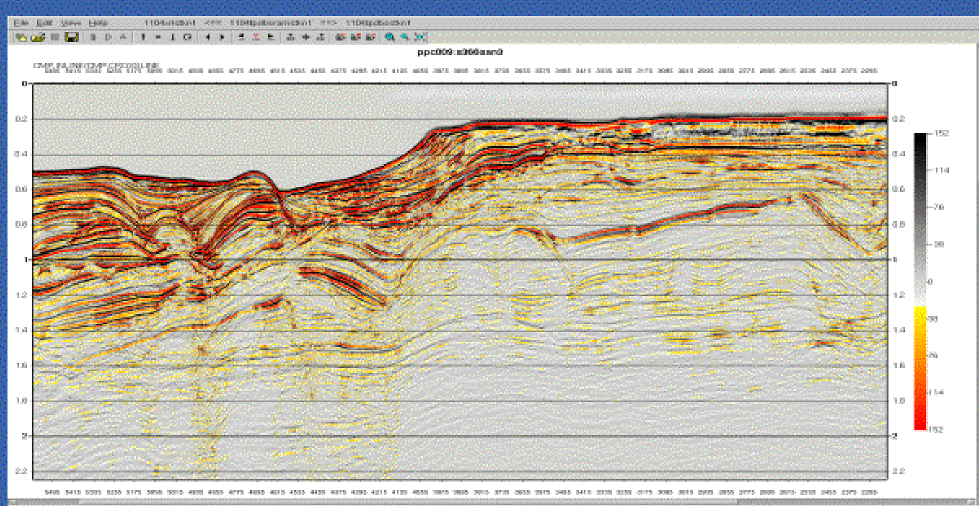
Santos 22

Line 1104 Taup decon

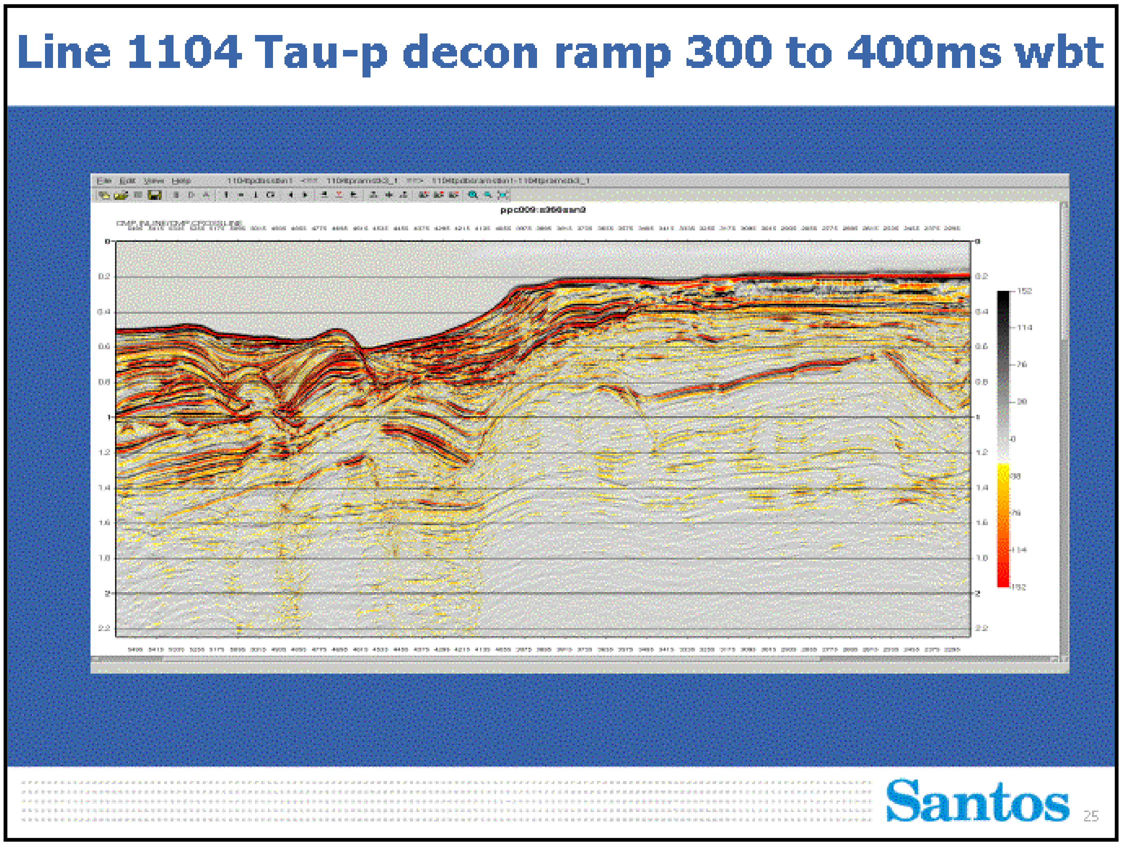


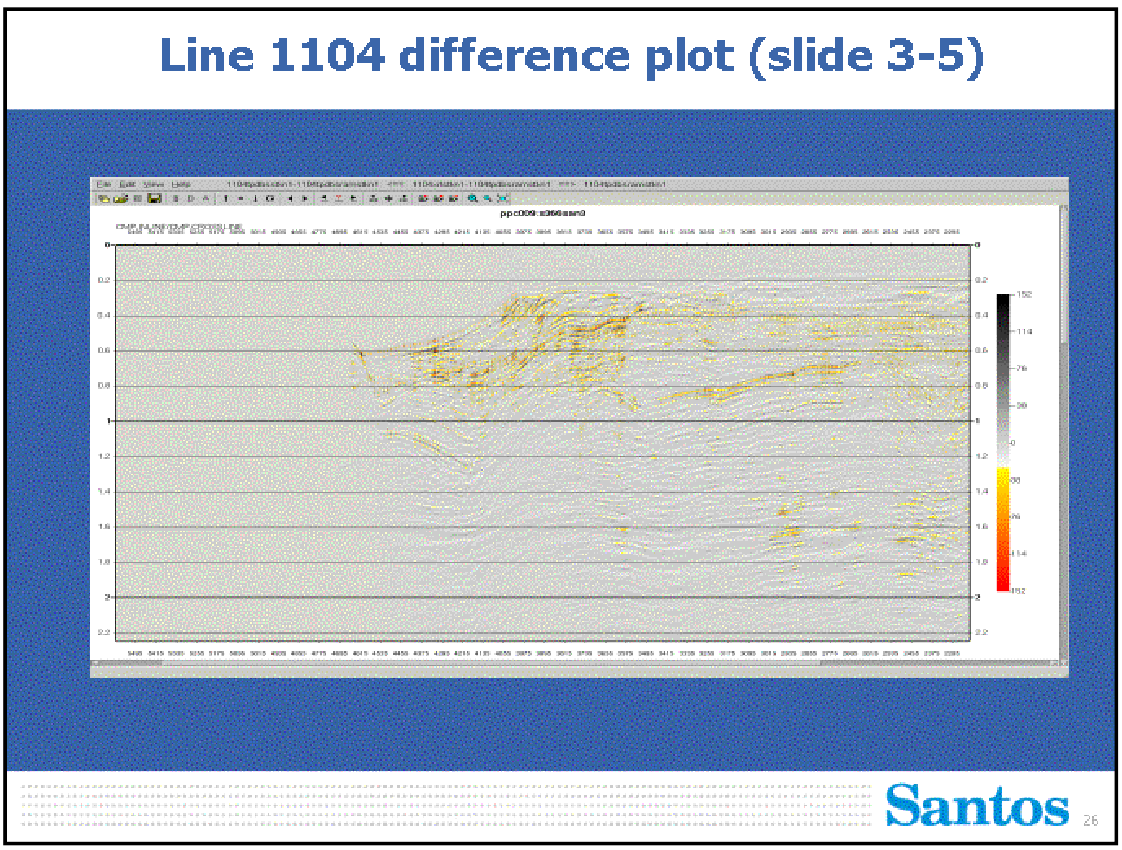
Santos 23

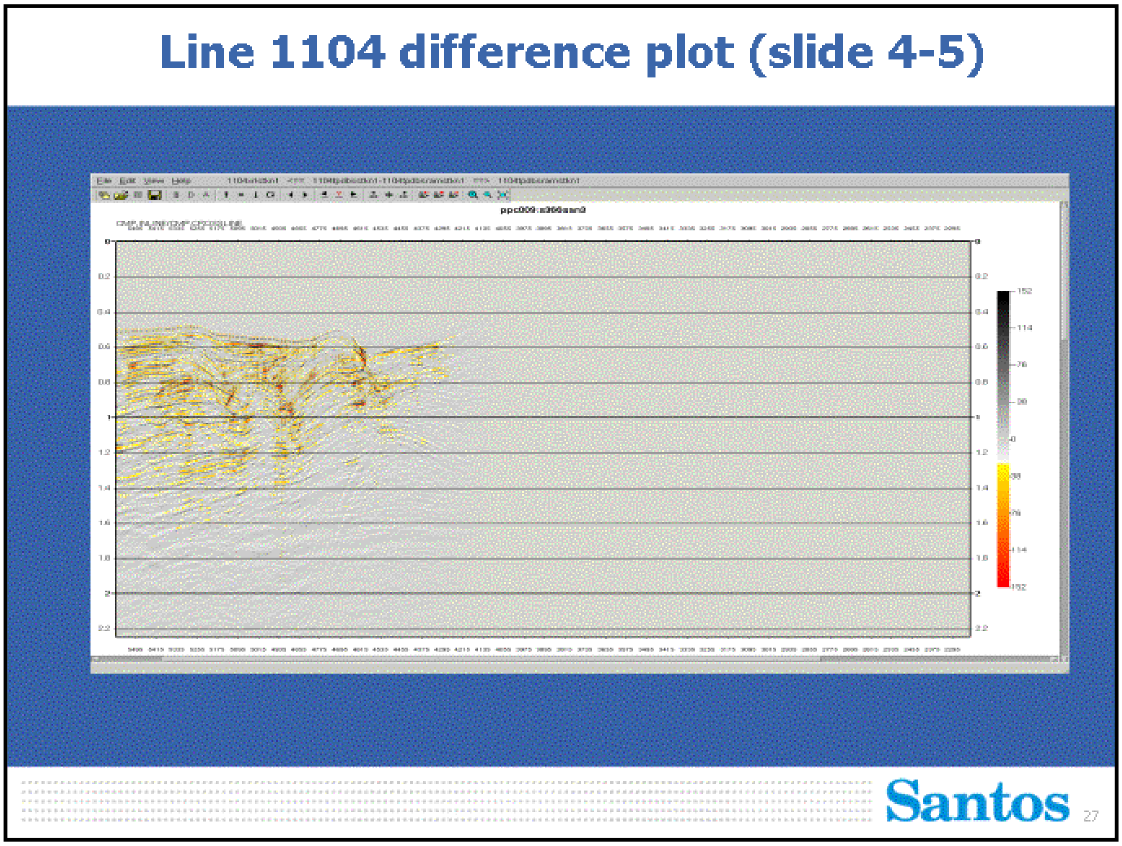
Line 1104 Tau-p decon ramp 300 to 600ms wbt

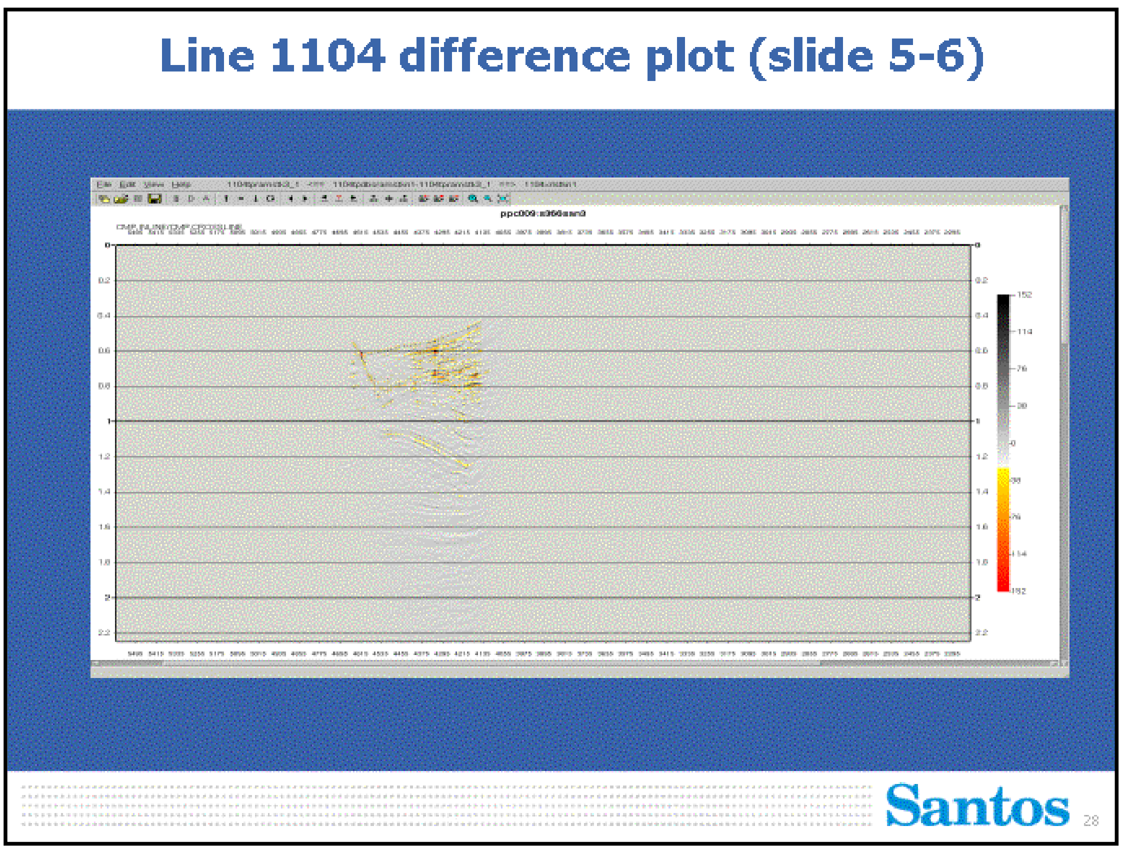


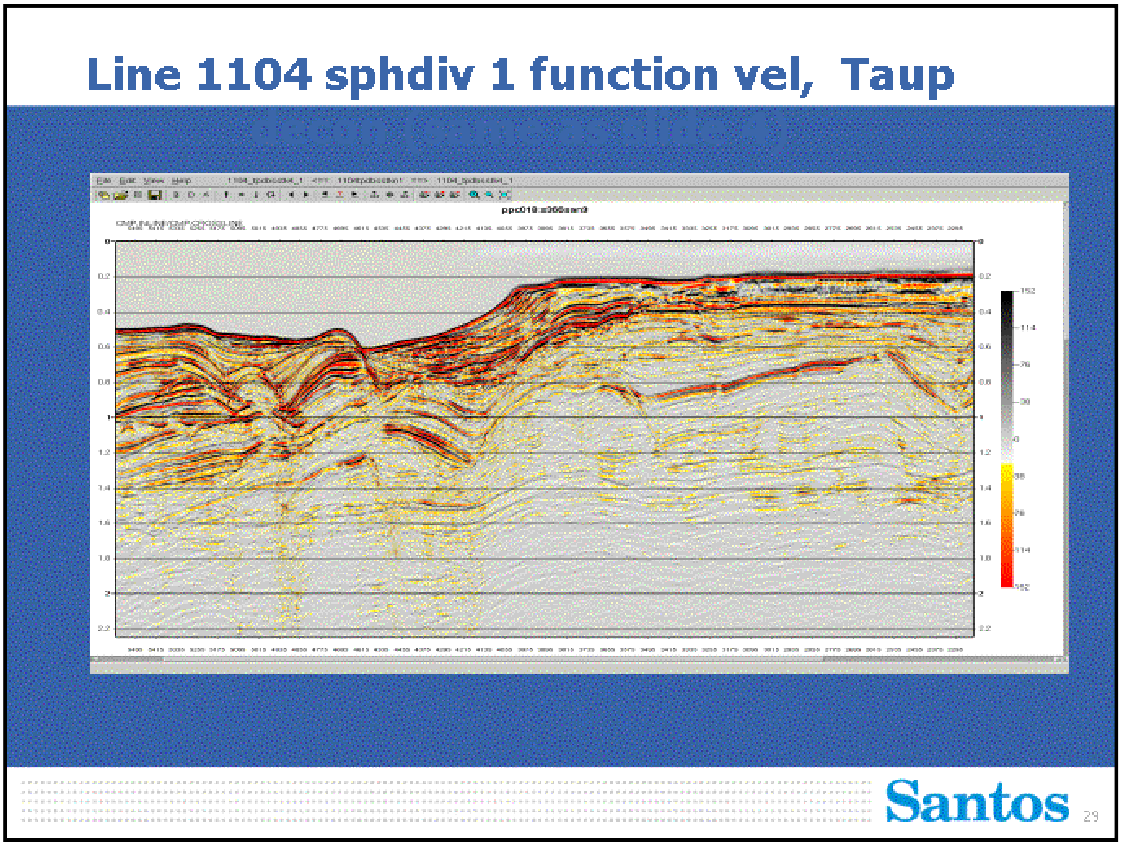
Santos 24

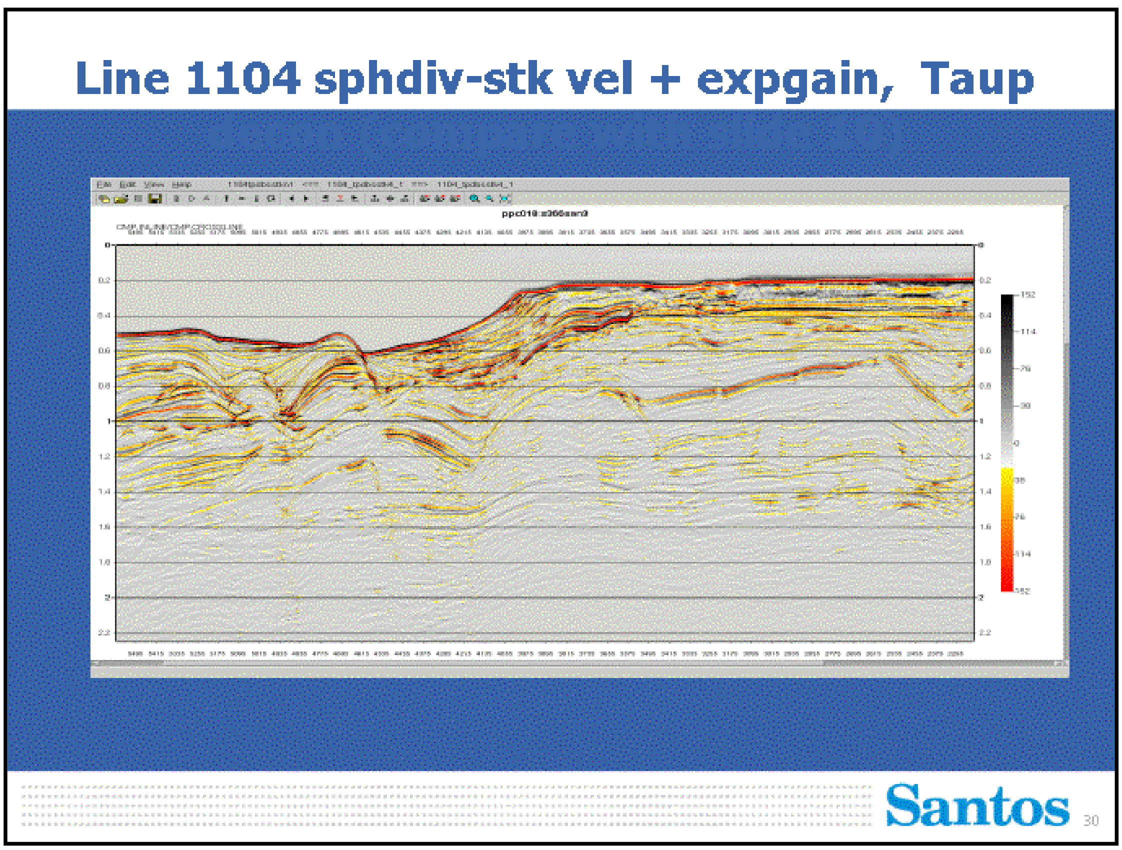

Line 1104 Tau-p decon ramp 300 to 400ms wbt
Santos
25


Line 1104 difference plot (slide 3-5)
Santos
26


Line 1104 difference plot (slide 4-5)
Santos
27


Line 1104 difference plot (slide 5-6)
Santos
28


Line 1104 sphdiv 1 function vel, Taup
Santos
29

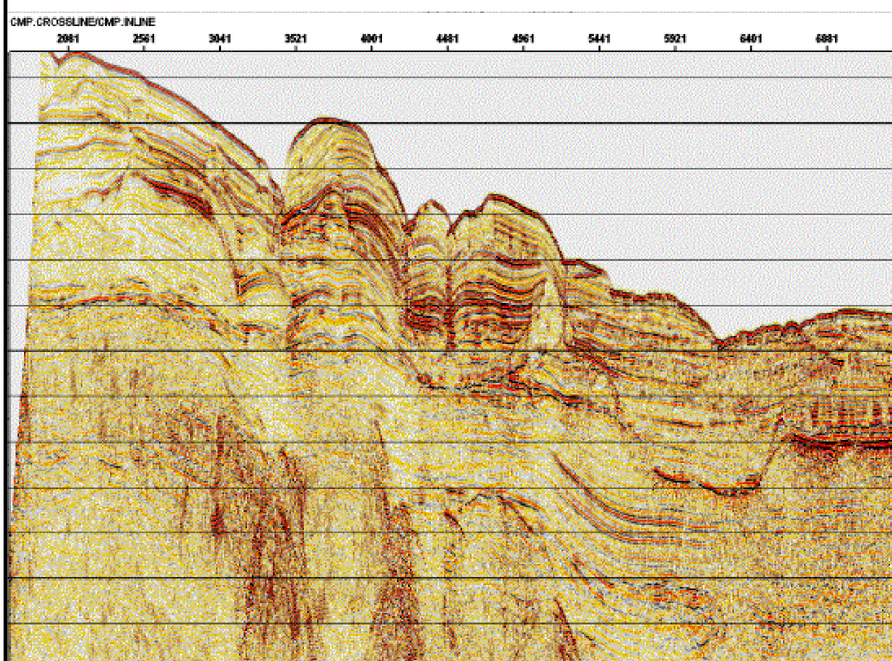

Line 1104 sphdiv-stk vel + expgain, Taup
Santos
30

OS02-3D (Amrit 3D) - Pre-Processing

1. **Reformat** to Tango internal format - 2ms; 6.5sec; 12.5m groups, 37.5m shots flip flop (2 guns 8 cables)
2. **Shot and trace edits**
3. **Instrument Dephase** (no gun and no cable ghost) - to output minimum phase
4. **3Hz Low cut filter** (zero phase)
5. **Spherical divergence** V**2T using 1 average velocity function
6. **Swell Noise Attenuation** (FXEDIT) - 2passes
7. **Resample to 4ms** (zero phase aafilt tests)
8. XRLIN 2100m/s
9. Velocity 1 (with mild Radon)
10. Remove and reapply spherical divergence with V1 velocities.
11. Tau-p Deconvolution on data with wbt less than 300ms, ramp to wbt 400ms and no decon for wbt deeper than 400ms
12. Radon demultiple using XRMULT 300ms cut

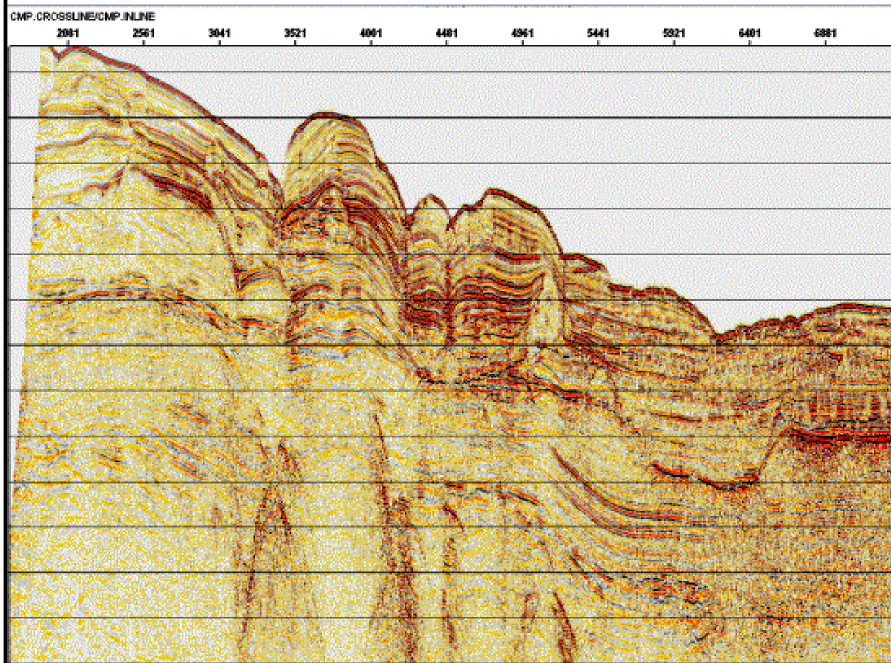
Santos 31

OS02-3D - No Radon Demultiple



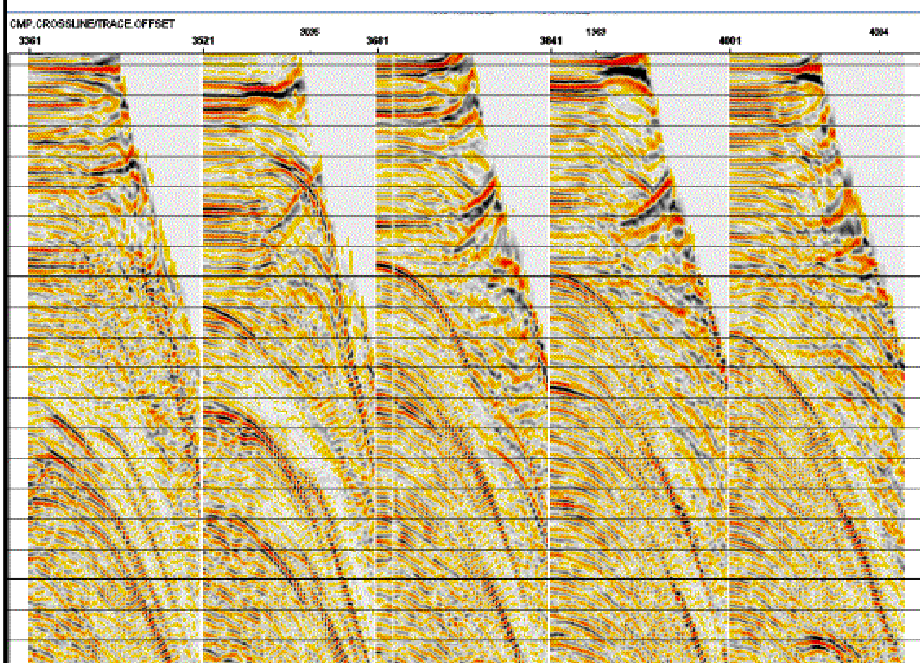
Santos 32

OS02-3D - With Radon Demultiple

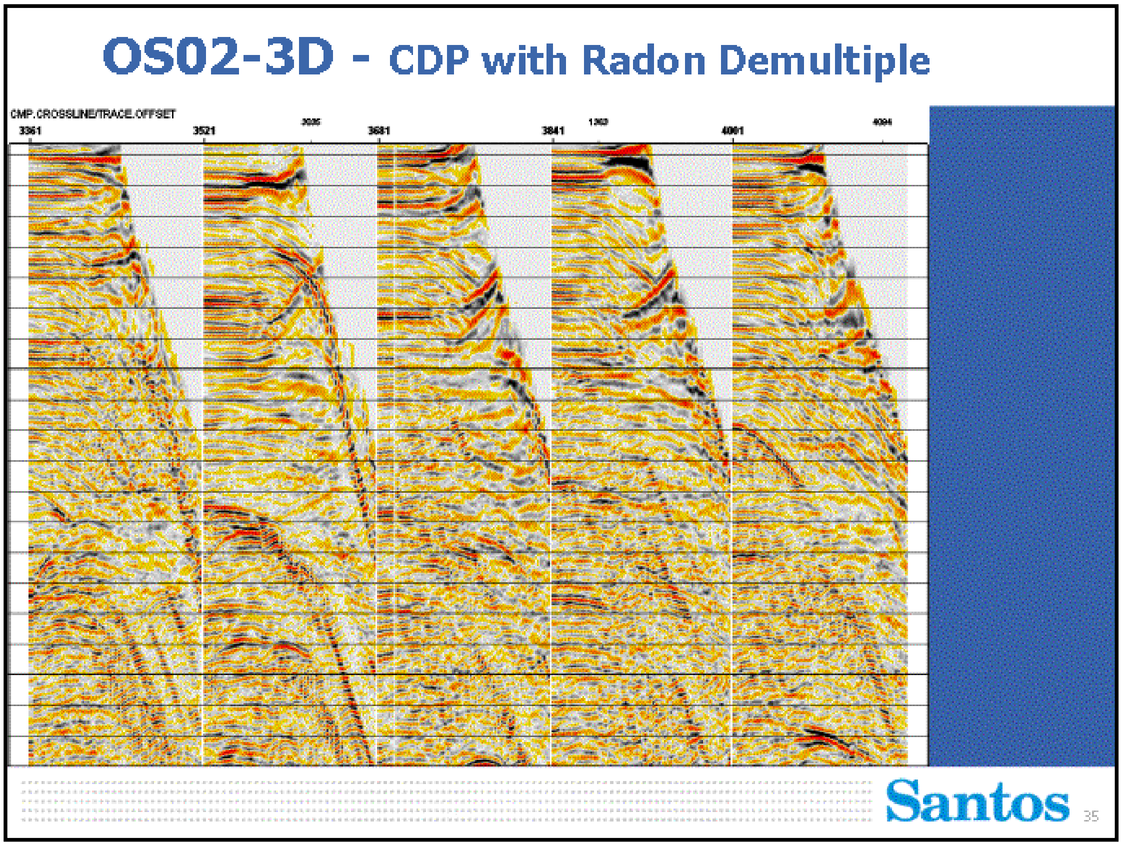


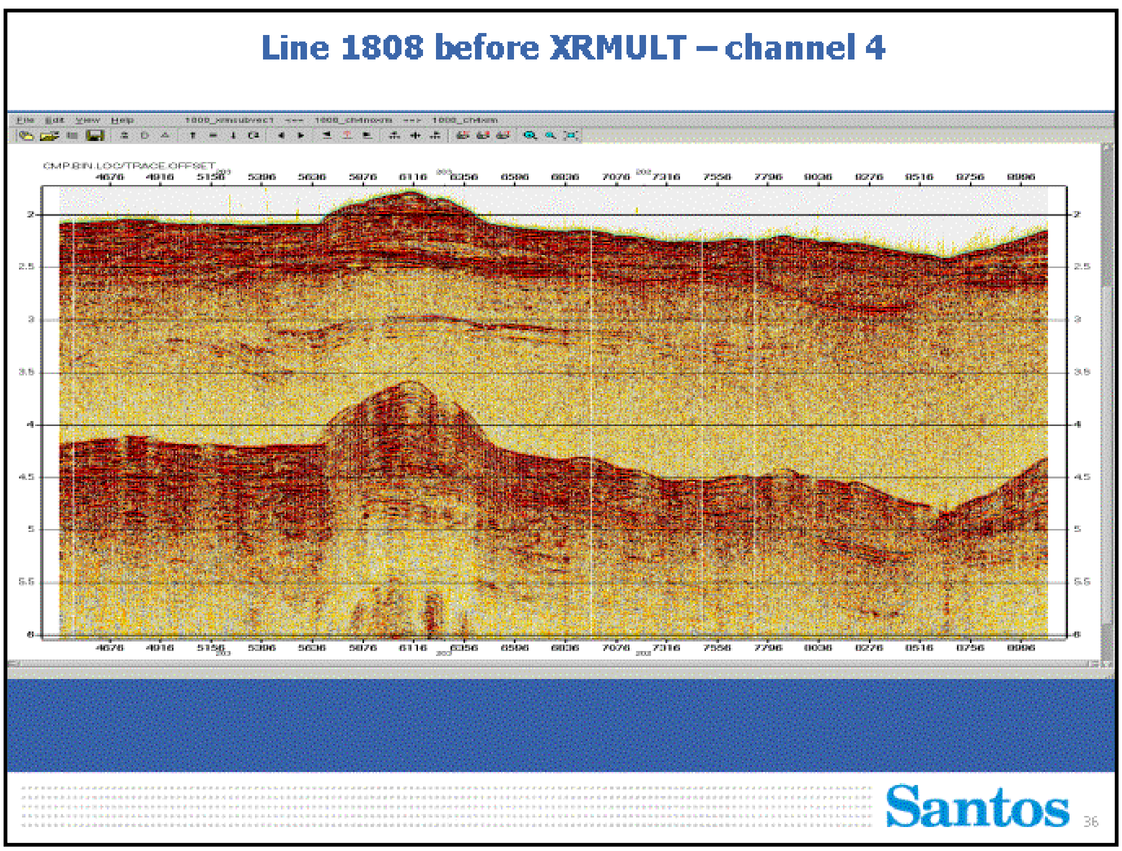
Santos 33

OS02-3D - CDP with No Radon Demultiple

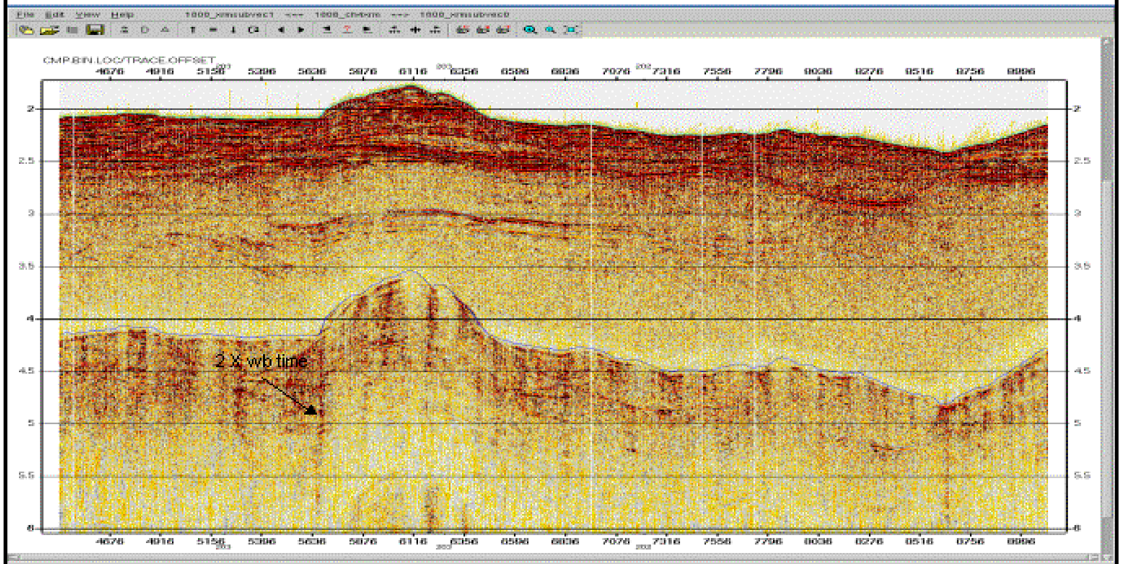


Santos 34


OS02-3D - CDP with Radon Demultiple
CMP.CROSSLINE/TRACE.OFFSET
3361
3521
3681
3841
4001
Santos
35

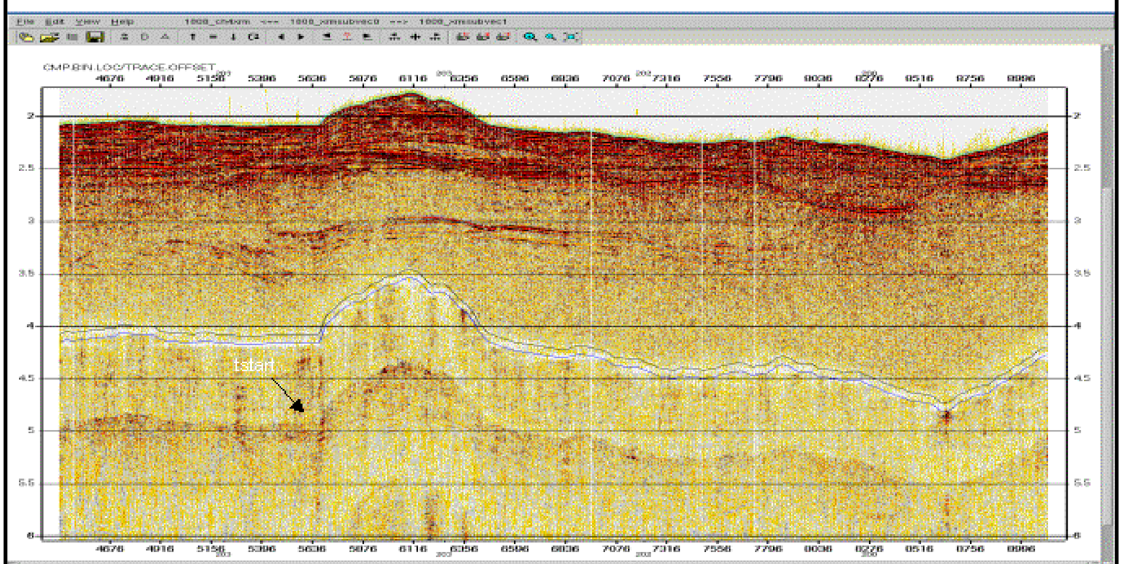

Line 1808 before XRMULT – channel 4
CMP.BIN.LOC/TRACE.OFFSET
Santos
36

Line 1808 after XRMULT – chan 4



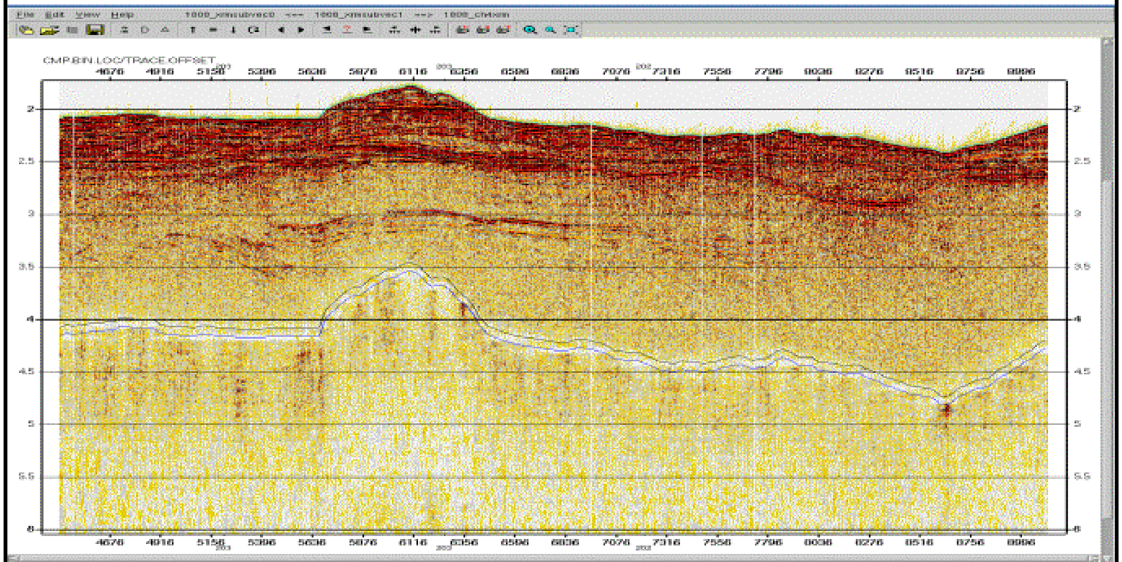
Santos 37

Line 1808 XRMULT + FREESURF (tend: 2Xwbt + 800ms)– chan 4



Santos 38

Line 1808 XRMULT/ FREESURF to tmax



Santos 39

OS02-3D (Amrit 3D) - PSHM2

13. 2D DMO on velocity lines (item 12 above) - generate DMO vels - pick and QC used to generate PSHM1 - **PSHM1 velocity field** defined PSHM 2 velocity
14. **3D Binning and FLOOD** at 25mX25m grid
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18. **Footprint Removal** (also AOK testings)
19. **NMO** with item B.17 velocities
20. Outer and Inner as per A.16, Angle mutes - confirm 50-50 split while QC'ing item 17 velocity gathers
21. Full, Near and Far Angle stacks
22. Zero phasing
23. TVF and exponential gain

Raw Full stack archive on DLT

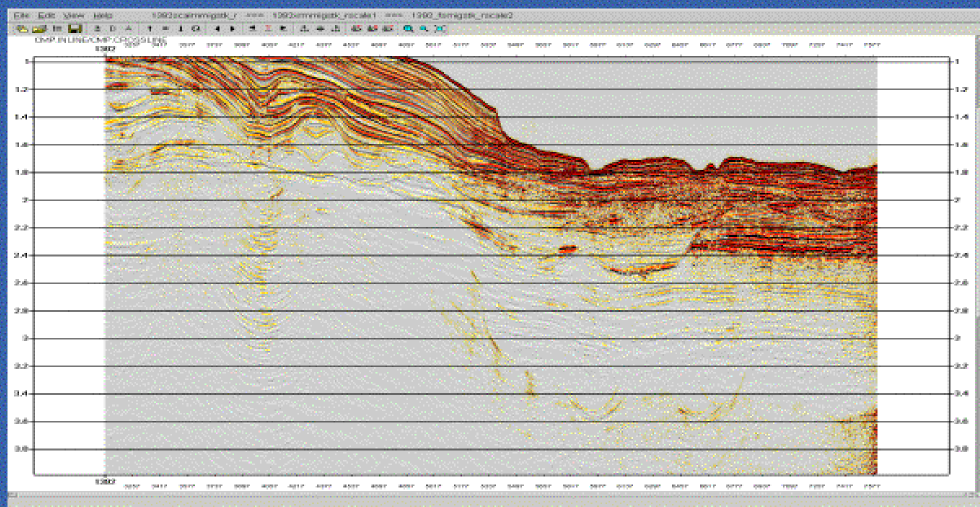
Filtered full stack archive on DLT (sent on 29 April)

Filtered Angle stacks archive on DLT

Gather archives on three 200 GB disks and 3 USB disk caddies

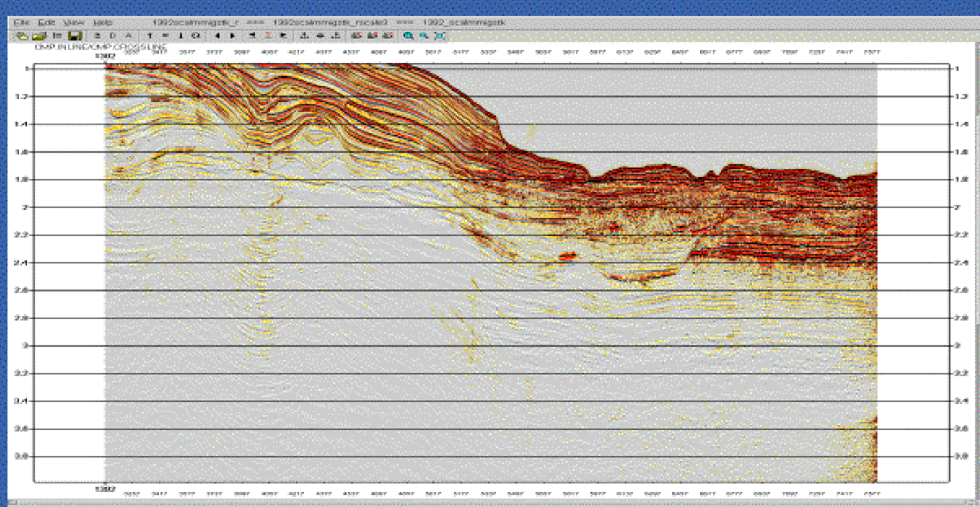
Santos 40

Line 1392 – XRMULT /PreSTM/STK



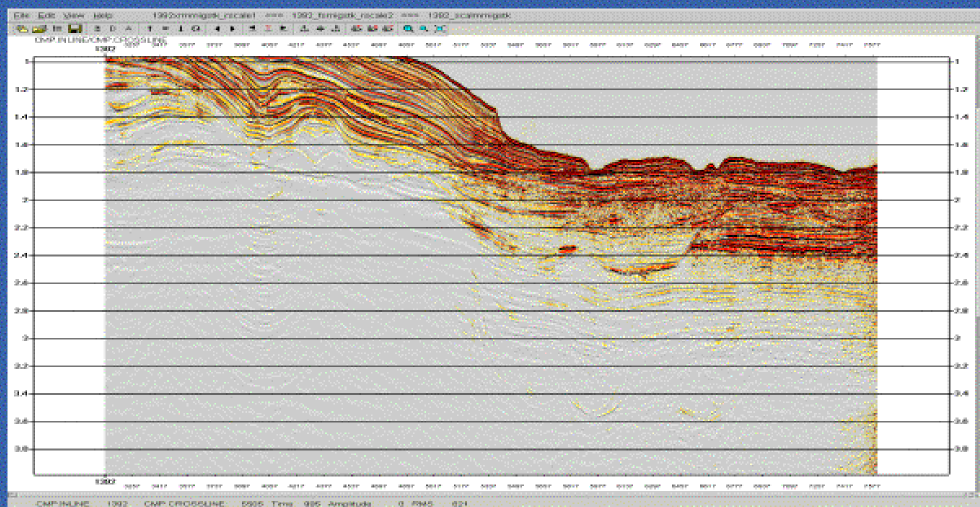
Santos 41

Line 1392 – XRMULT / SCALMULT/



Santos 42

Line 1392 – XRMULT /FREESURF/ PreSTM/STK



Santos 43

OS02-3D (Amrit 3D) - PSHM2

13. 2D DMO on velocity lines (item 12 above) - generate DMO vels - pick and QC used to generate PSHM1 - **PSHM1 velocity field** defined PSHM 2 velocity
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18. **Footprint Removal** (also AOK testings)
19. **NMO** with item B.17 velocities
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21. Full, Near and Far Angle stacks
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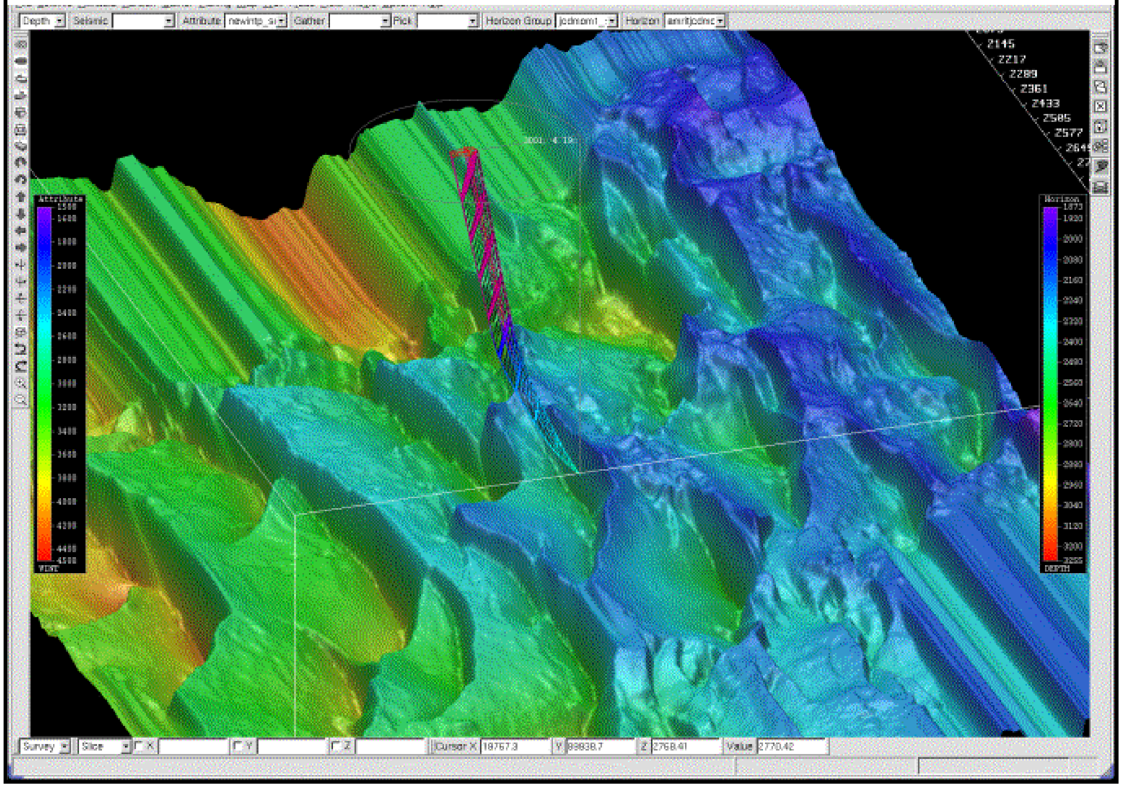
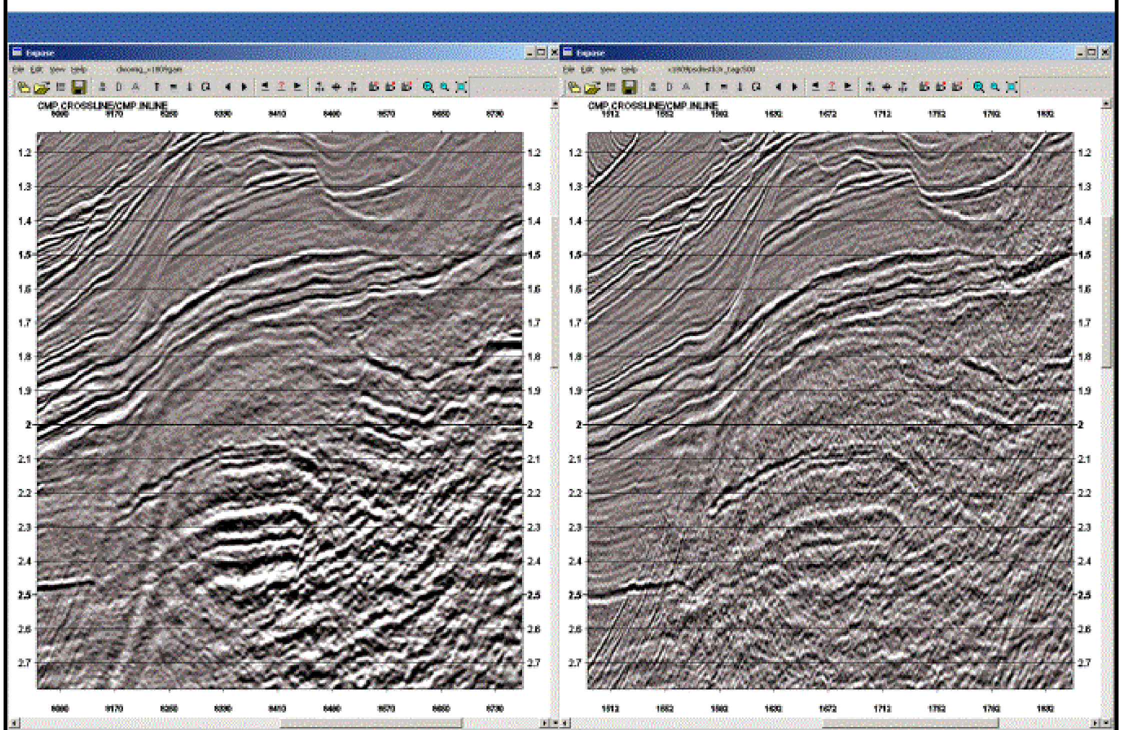
Raw Full stack archive on DLT
Filtered full stack archive on DLT (sent on 29 April)
Filtered Angle stacks archive on DLT
Gather archives on three 200 GB disks and 3 USB disk caddies

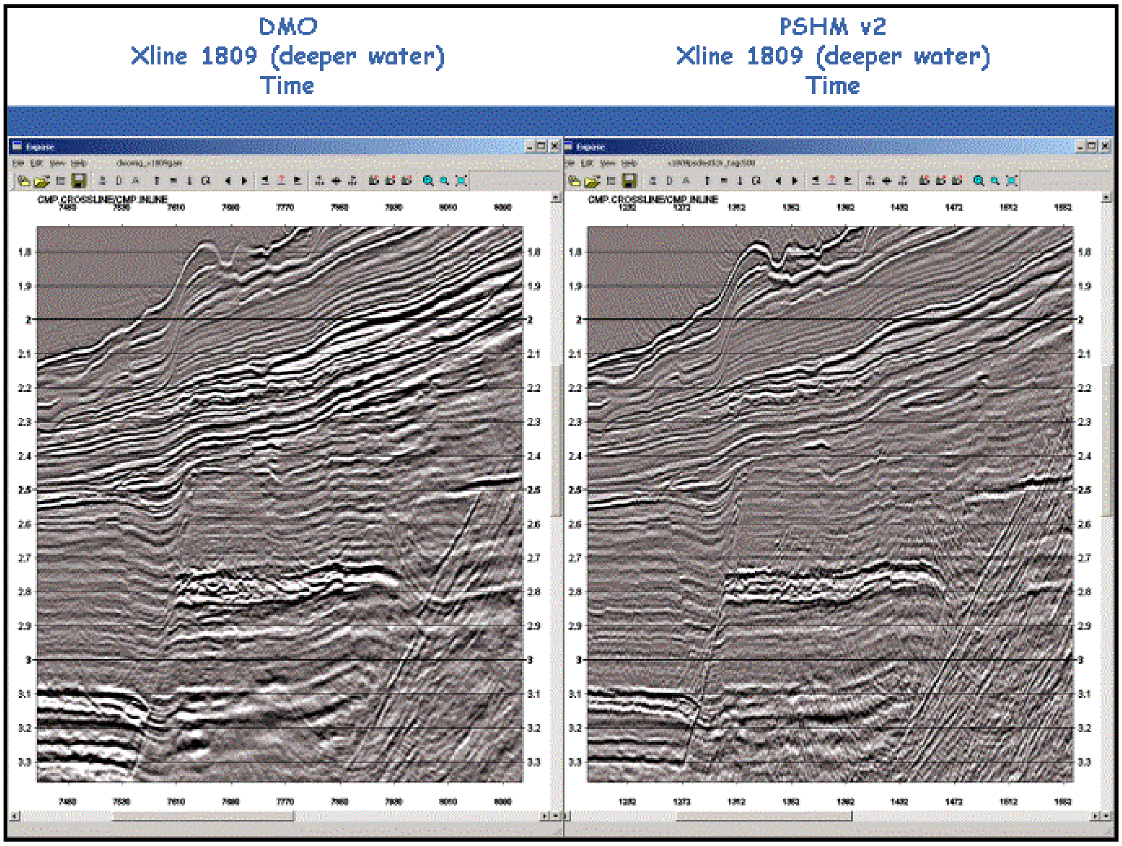
Santos 44

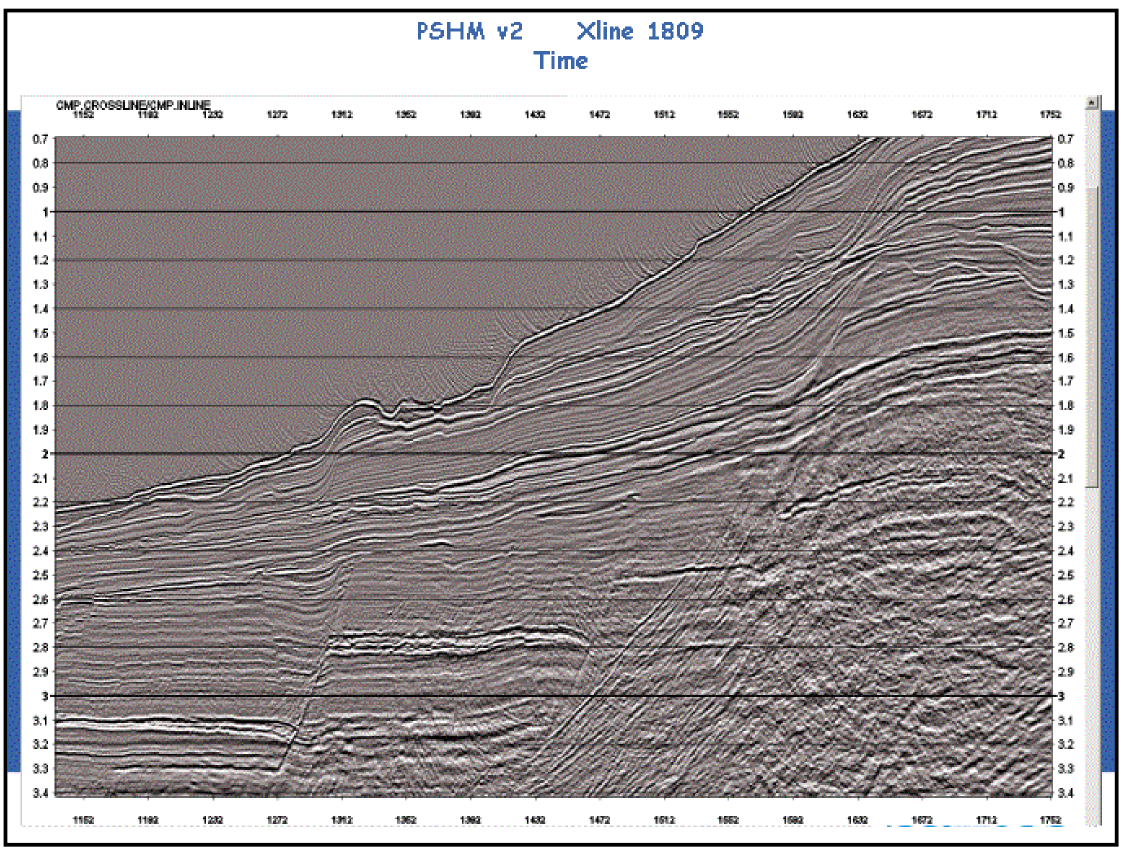
Migration Aperture Analysis based on N.I. Ray-Tracing

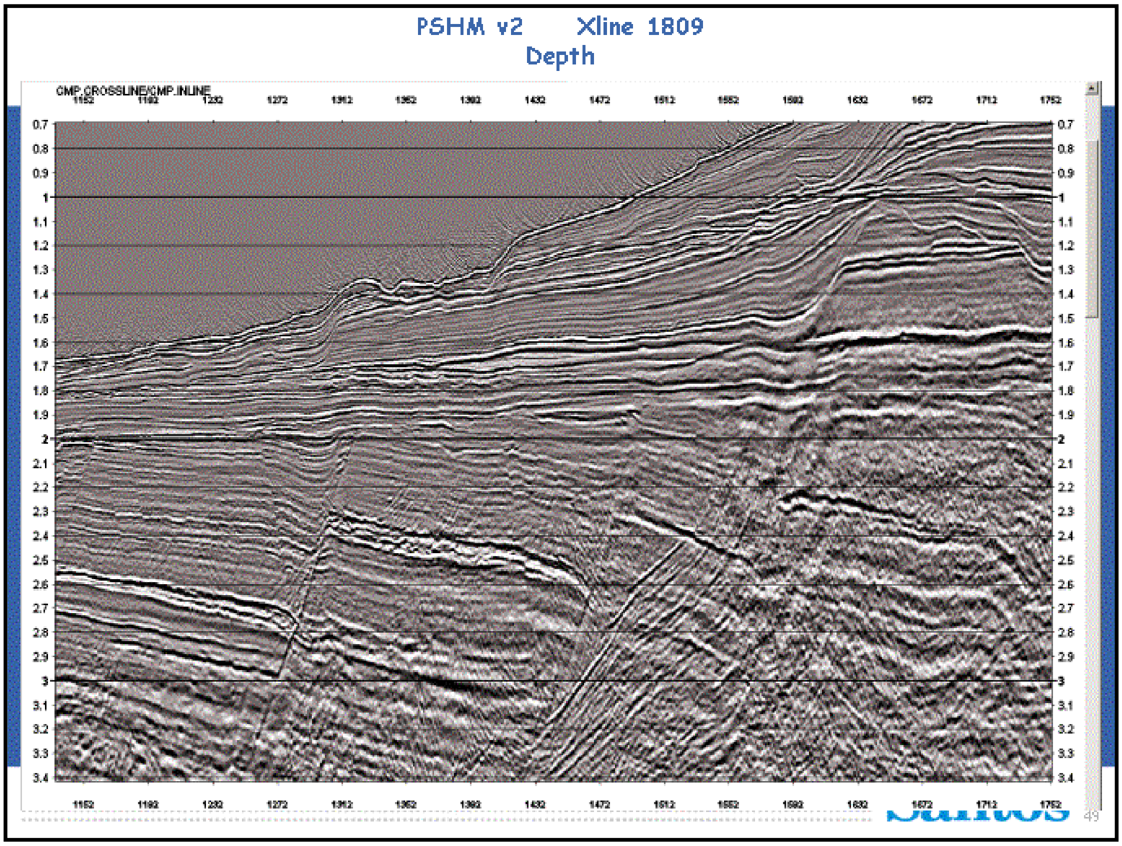


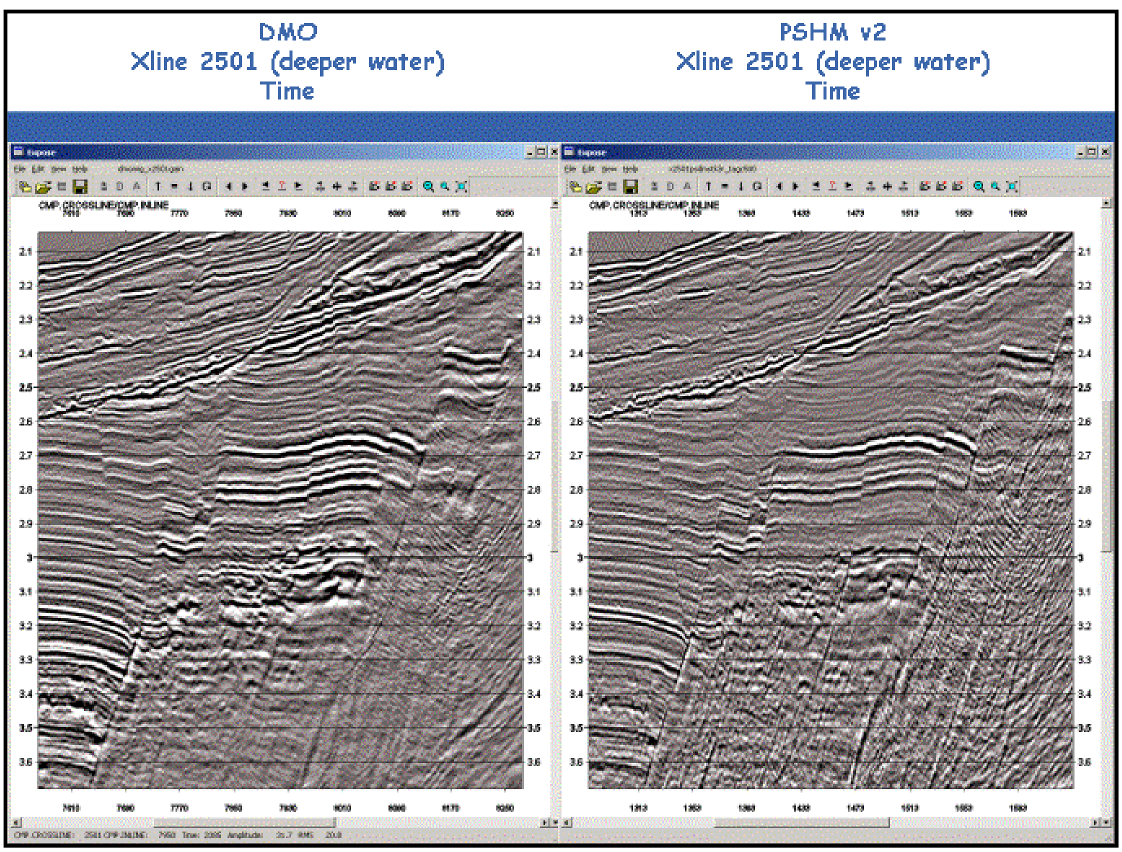
DMO	PSHM v2
Xline 1809	Xline 1809
Time	Time



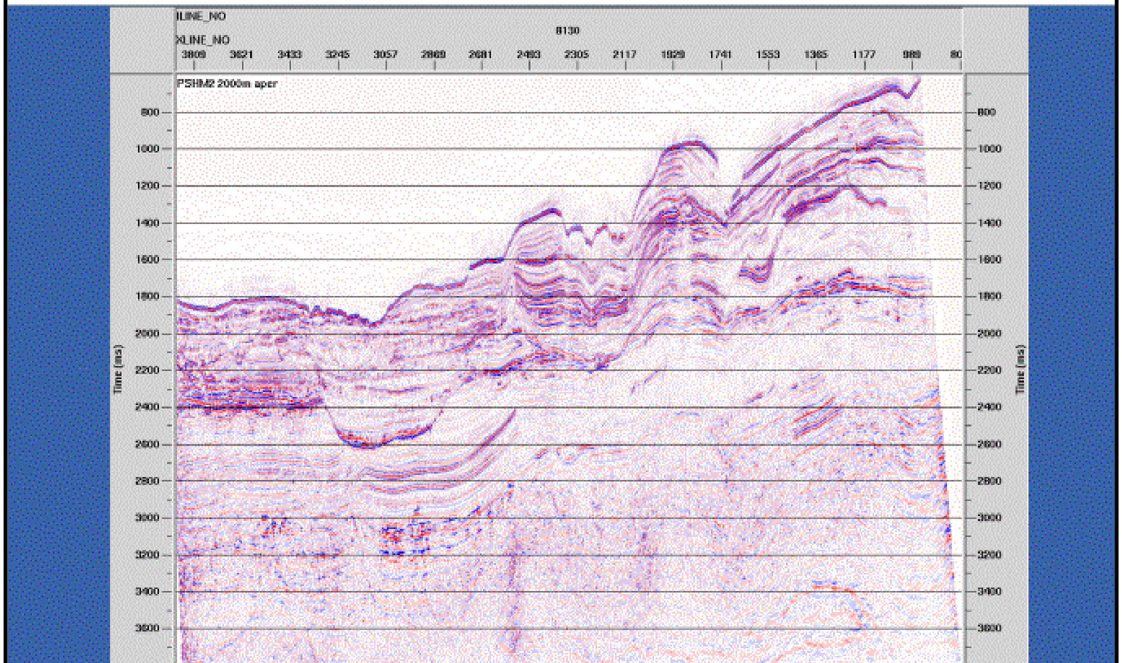

DMO
Xline 1809 (deeper water)
Time
PSHM v2
Xline 1809 (deeper water)
Time


PSHM v2 Xline 1809
Time
CMP CROSSLINE/CMP INLINE


PSHM v2 Xline 1809
Depth

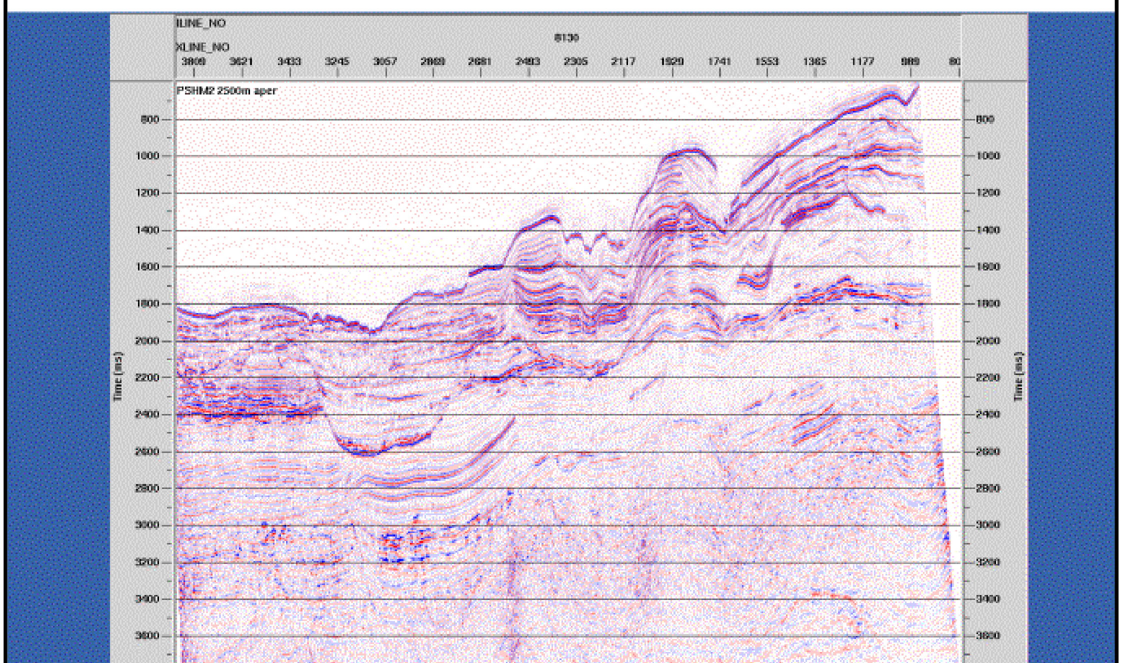

DMO
Xline 2501 (deeper water)
Time
PSHM v2
Xline 2501 (deeper water)
Time

Migration Aperture Tests – 2000metres



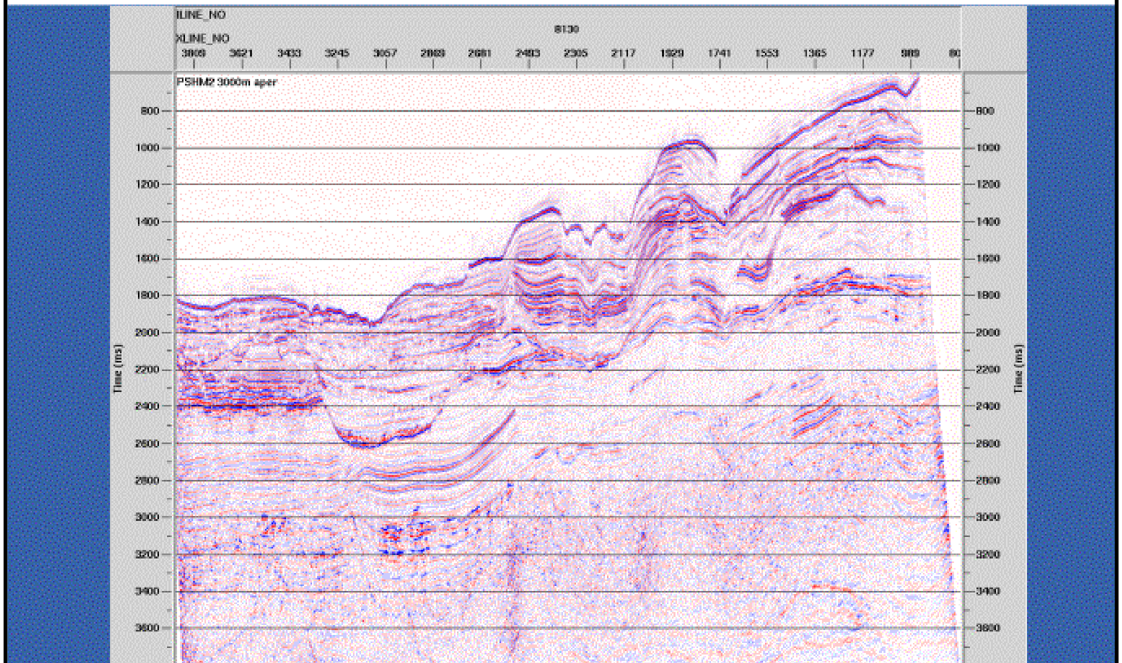
51

Migration Aperture Tests – 2500metres



52

Migration Aperture Tests – 3000metres



Santos 53

OS02-3D (Amrit 3D) - PSHM2

13. 2D DMO on velocity lines (item 12 above) - generate DMO vels - pick and QC used to generate PSHM1 - **PSHM1 velocity field** defined PSHM 2 velocity
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23. TVF and exponential gain

Raw Full stack archive on DLT
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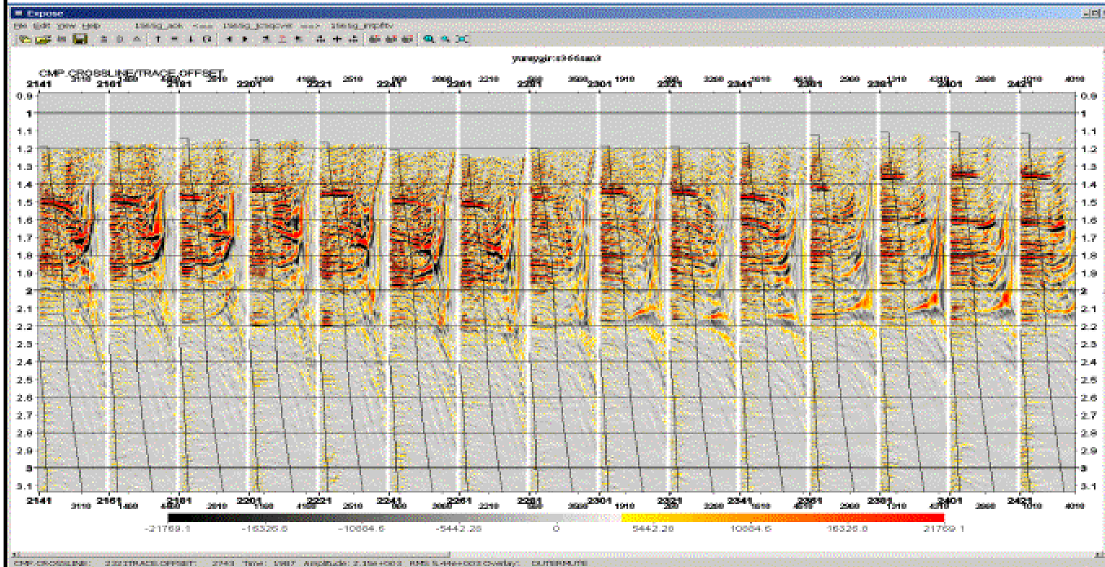
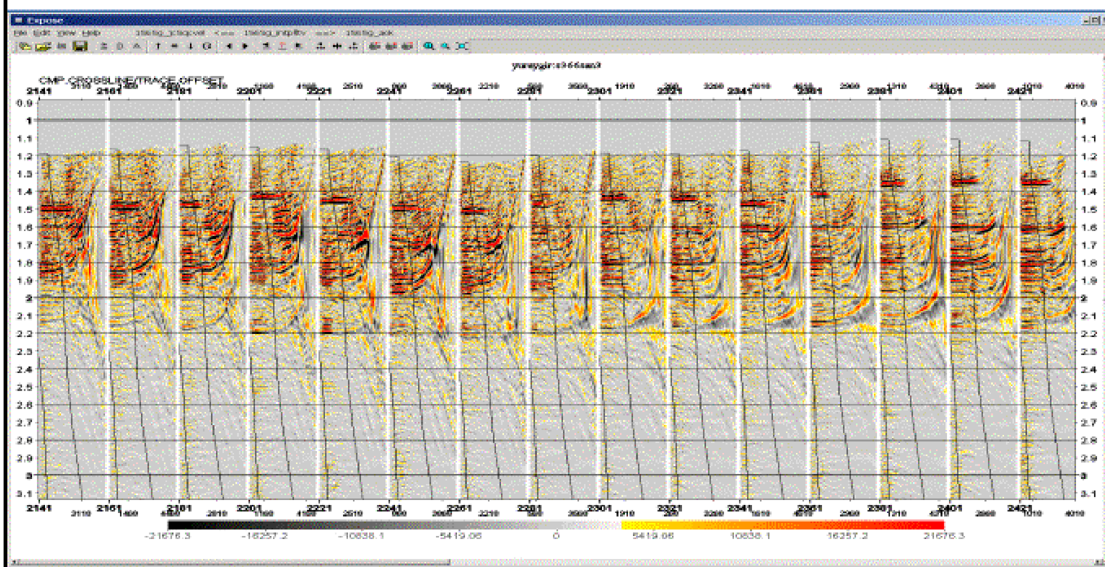
Santos 54

Inline 8130 NMO with Residual vels (1X1km interp)



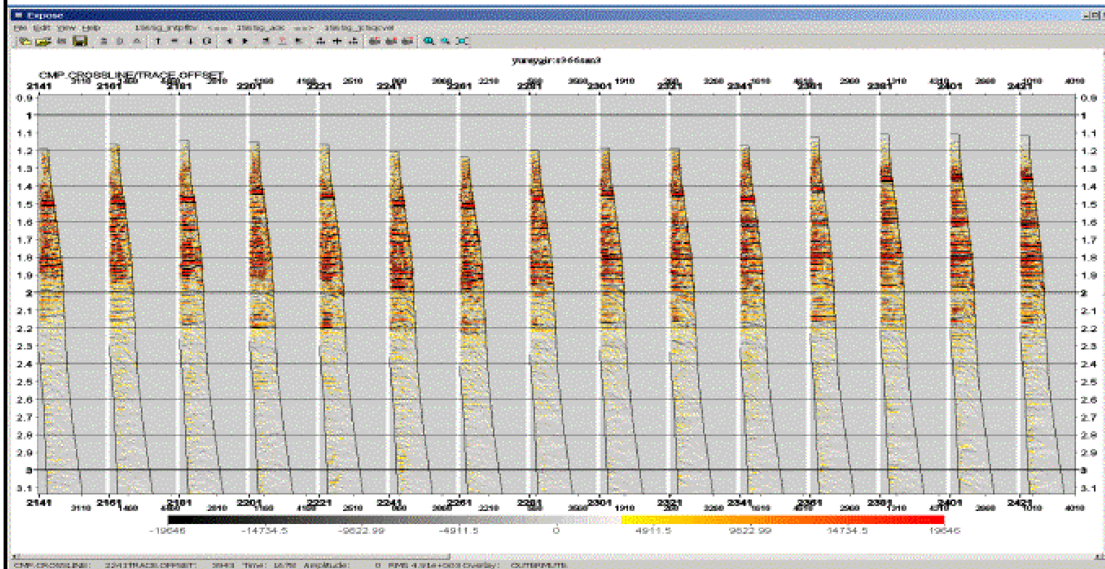
Santos 55

Inline 8130 NMO with resid vel (better interp: 20msX100mX100m)



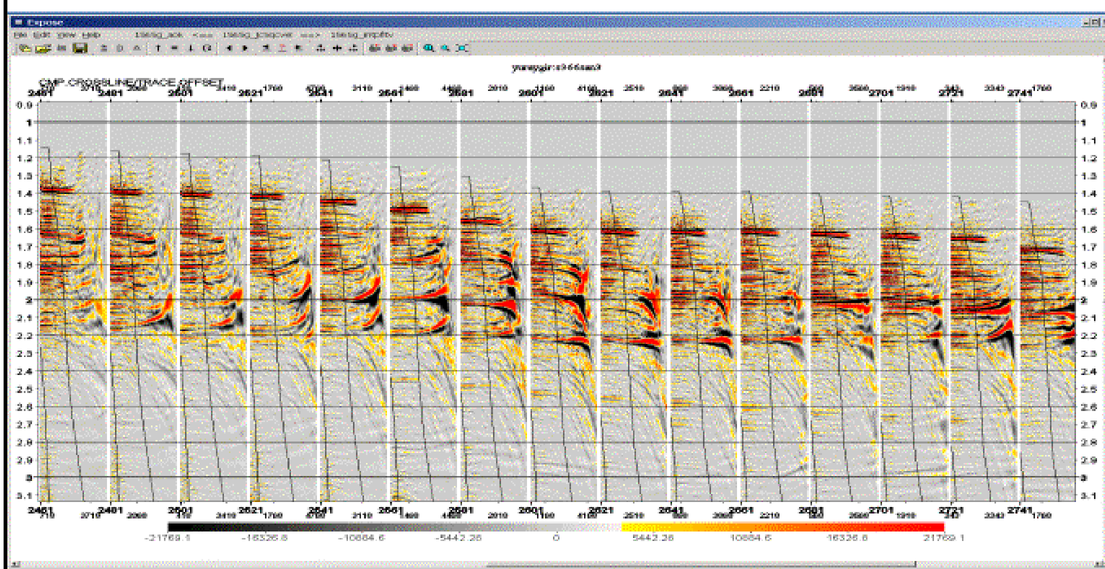
Santos 56

Inline 8130 NMO with resid vel (better interpolation) +AOK

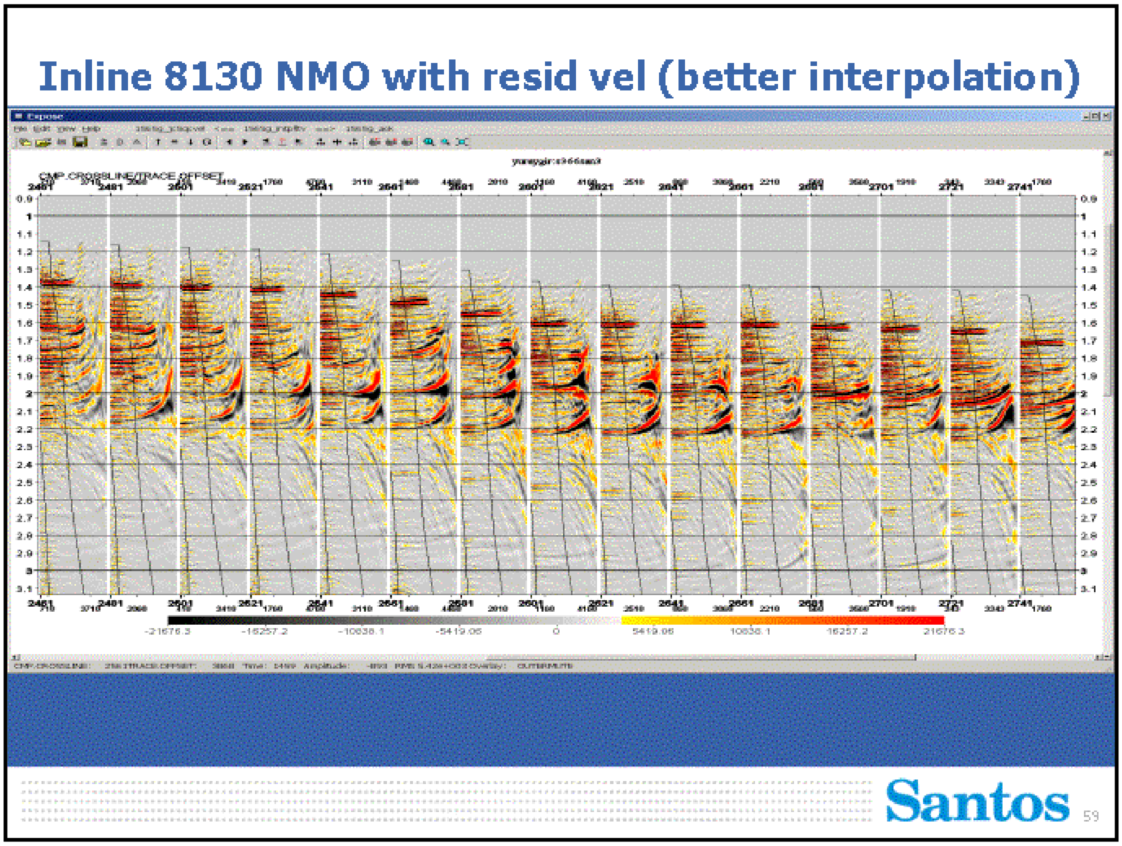


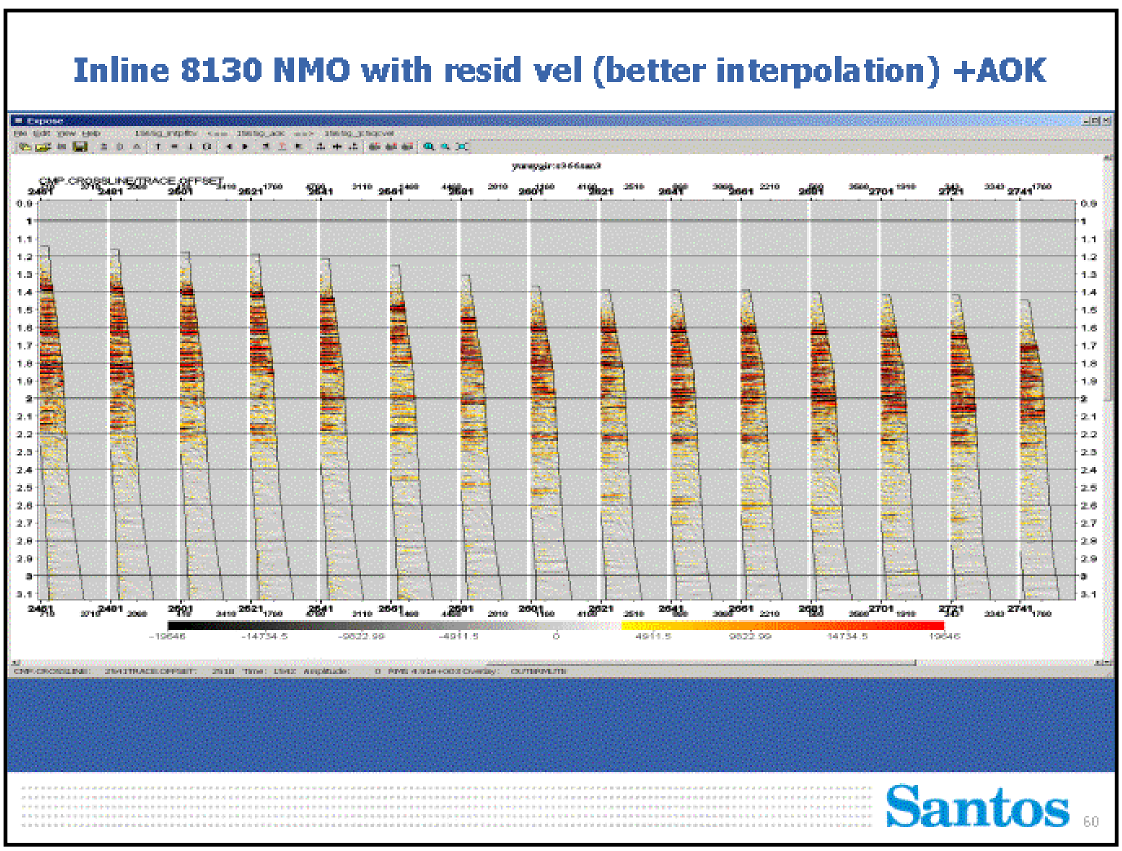
Santos 57

Inline 8130 NMO with resid vel (1X1km interp)

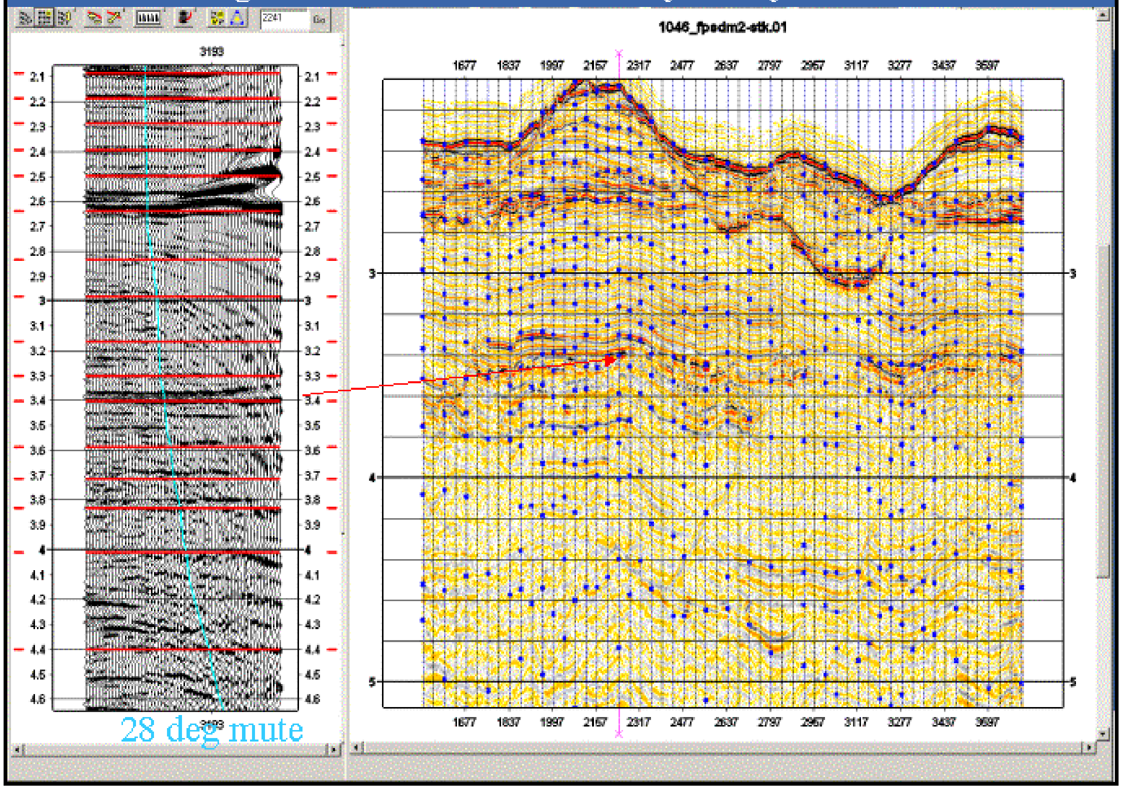


Santos 58


Inline 8130 NMO with resid vel (better interpolation)
Santos
59


Inline 8130 NMO with resid vel (better interpolation) +AOK
Santos
60

Review of Angles Available from Velocity Analysis - Inline 1046



OS02-3D (Amrit 3D) - PSHM2

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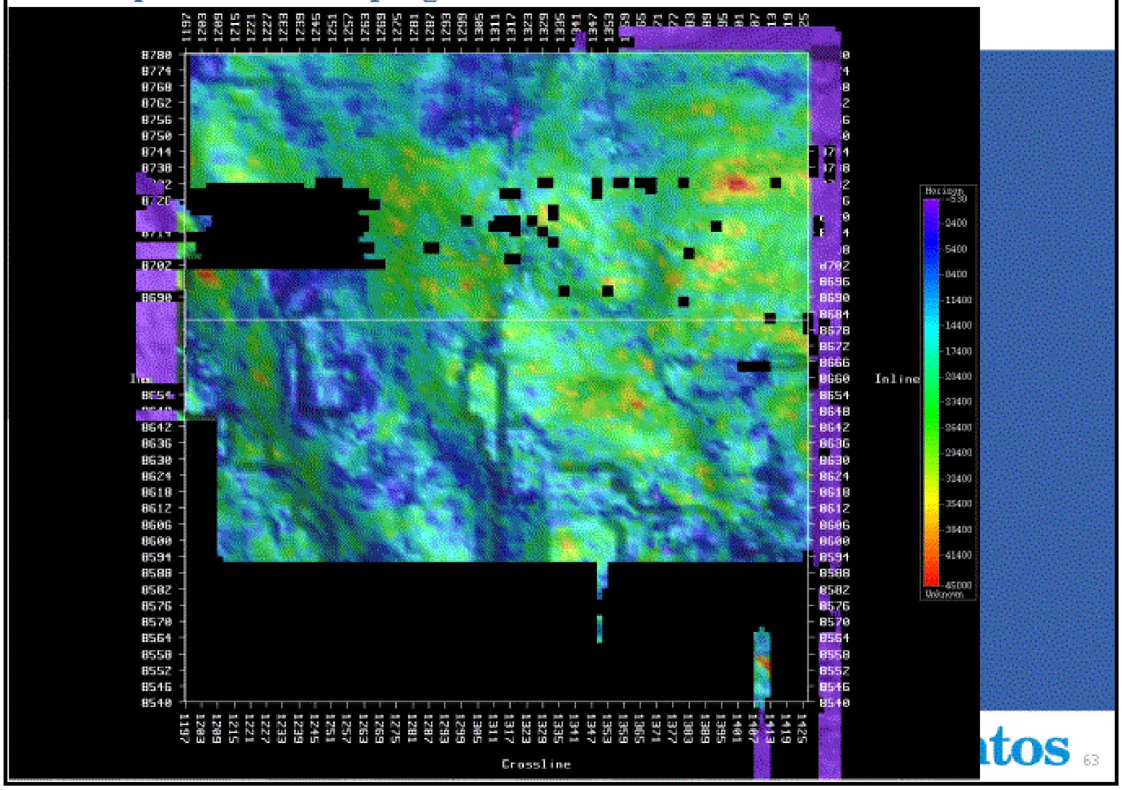
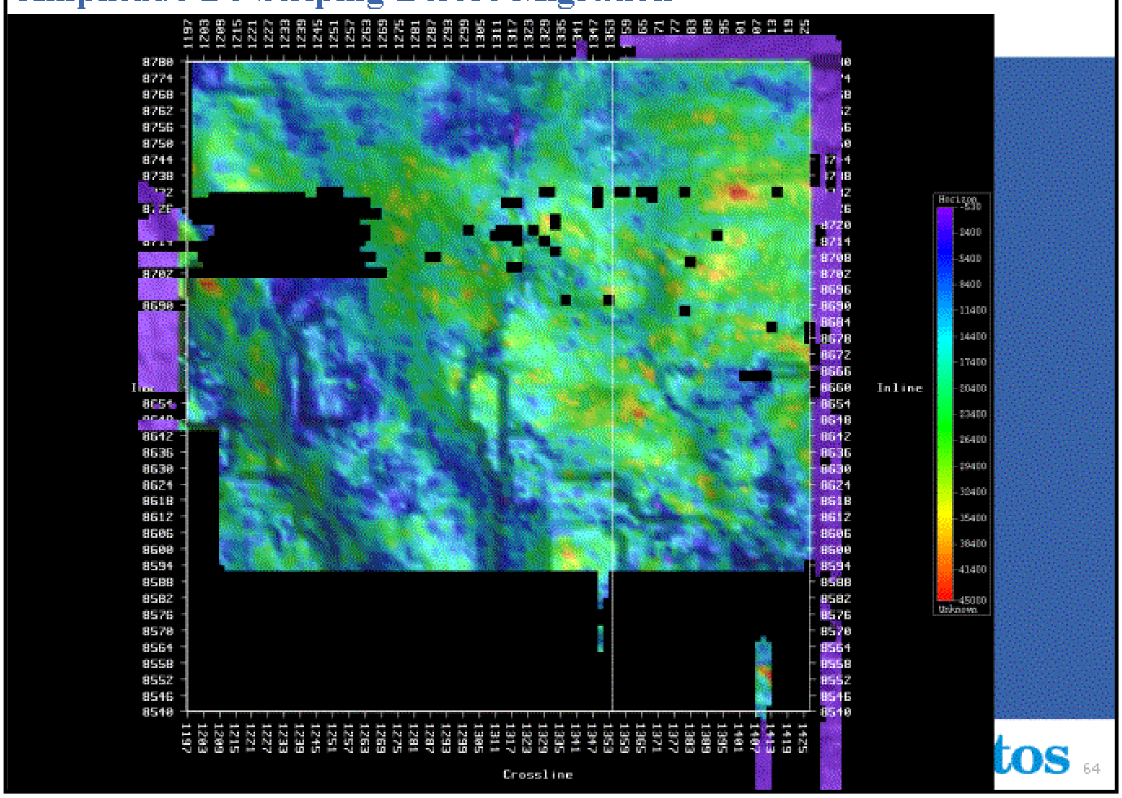
Santos 62

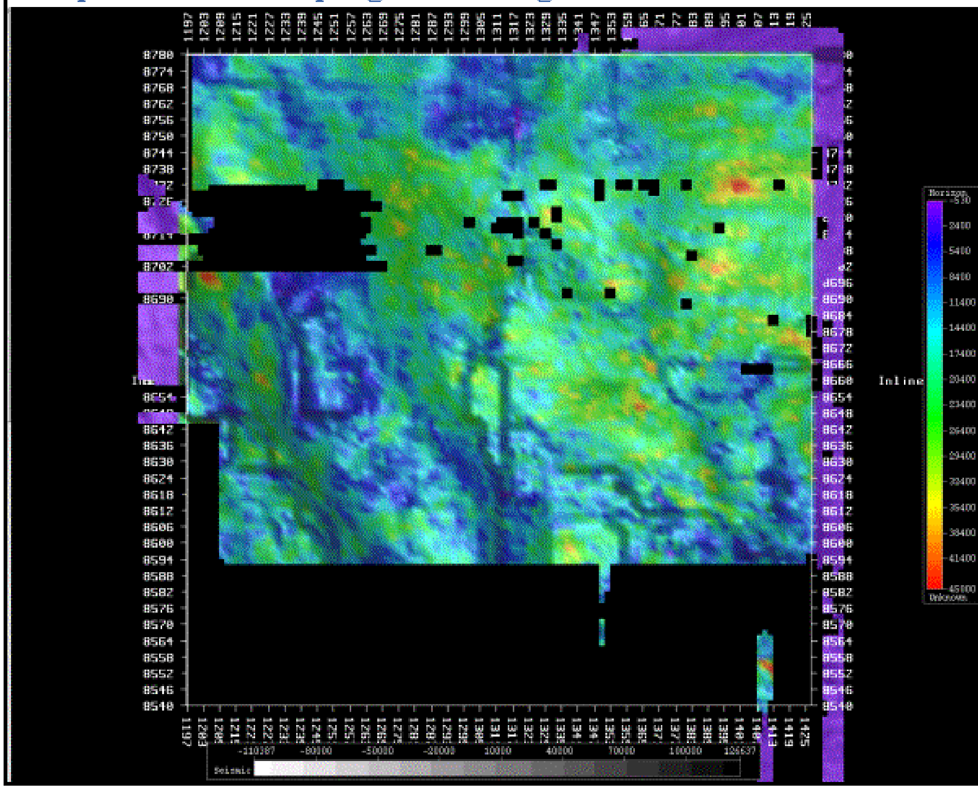
No Amplitude De-Striping



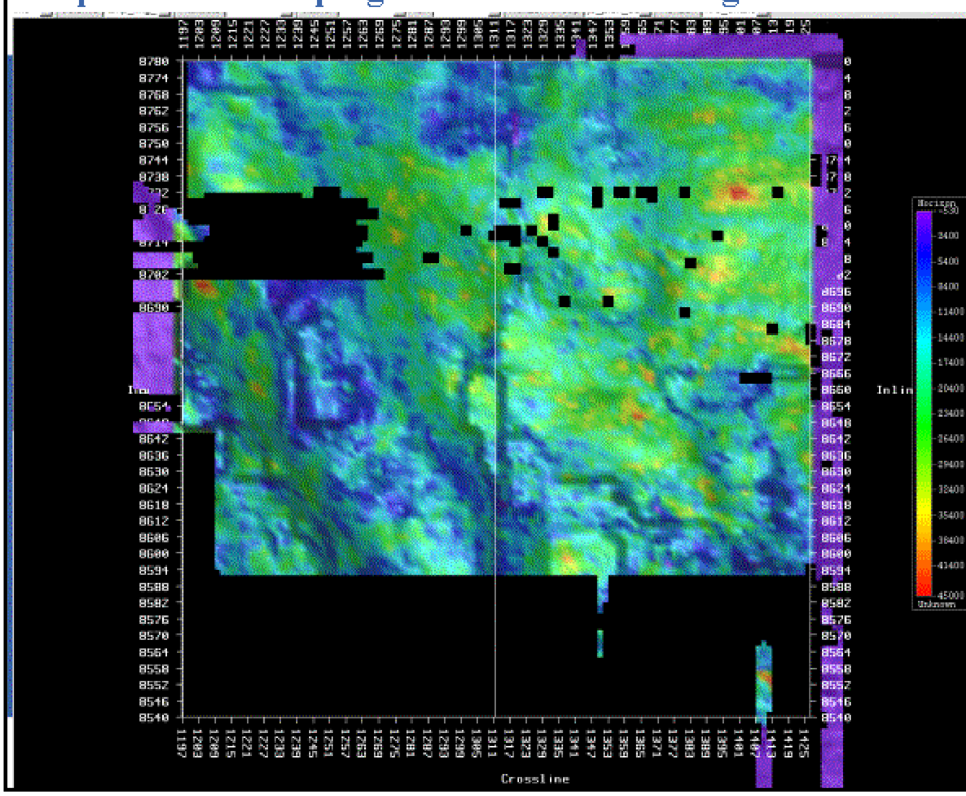
Amplitude De-Striping Before Migration



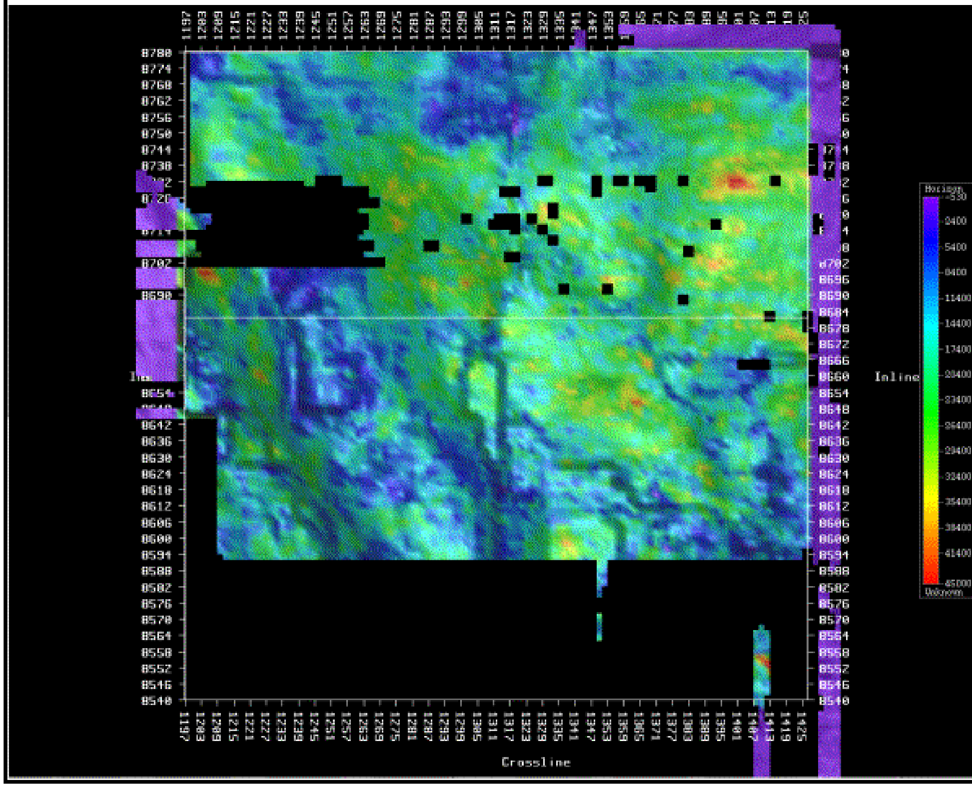
Amplitude De-Striping After Migration



Amplitude De-Striping Before and After Migration



No Amplitude De-Striping



Santos 67

OS02-3D (Amrit 3D) - PSHM2

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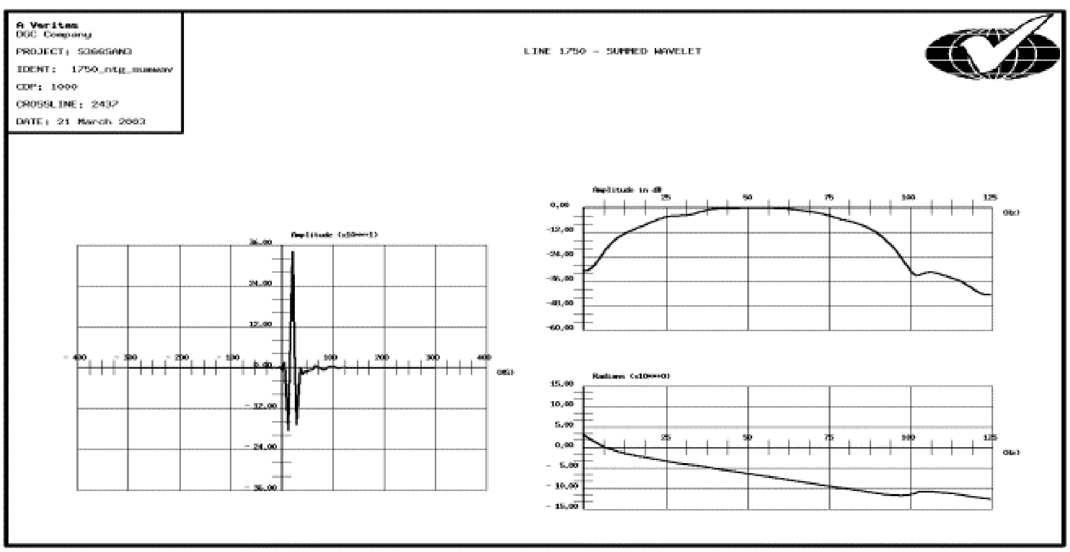
Santos 68

OS02-3D Phase Corrections

- No Deconvolution has been applied to accommodate Source, Streamer or combination ghosts. Instrument response has been removed from the data. As such a minimum phase wavelet is expected that looks like a front loaded zero phase wavelet.
- In deep water no data derived Deconvolution has been applied, in shallow water only a Tau-P deconvolution with a moderately long gap (32msec) has been applied.
- A estimated wavelet has been derived based on an average of the reflection character from a number of points along a number of lines at the sea floor event in deep water. **The zero phasing operator based on this wavelet has been applied to the archive stacks.**
- A Shot and Streamer water depth correction has to be subsequently applied to the data.

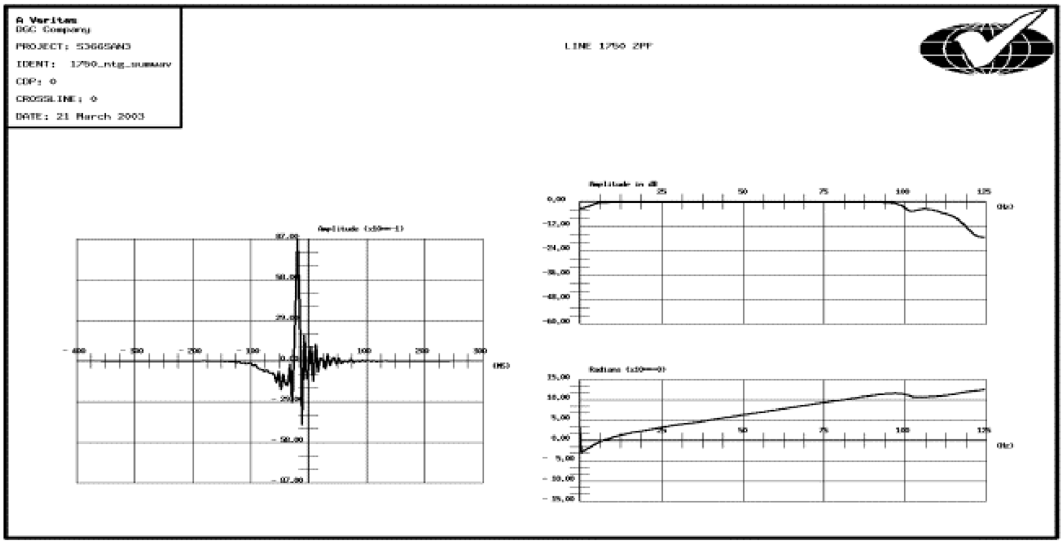
Santos 69

Line 1750 summed wavelet from Sea Floor Event



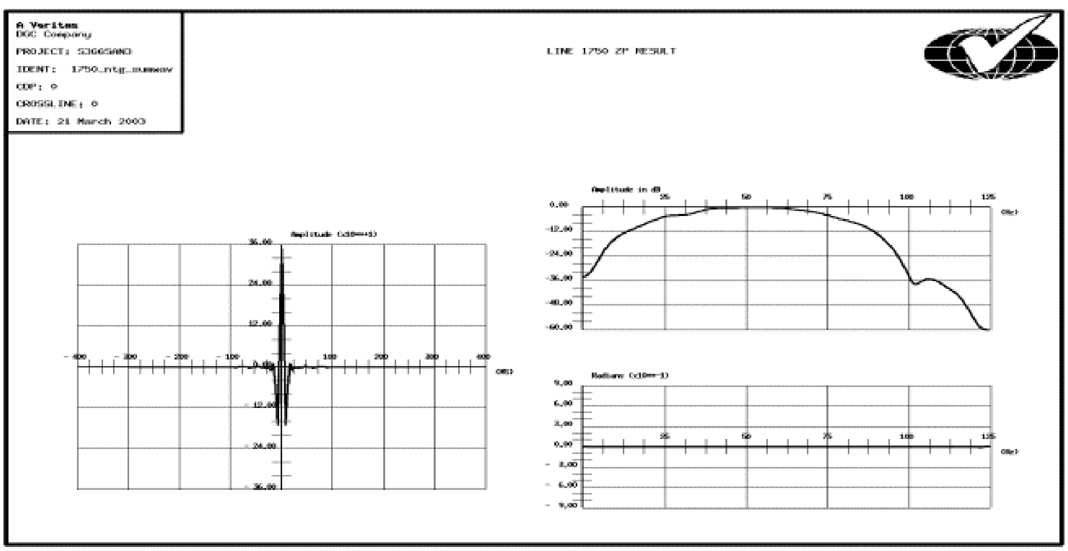
Santos 70

Line 1750 Zero Phasing Filter



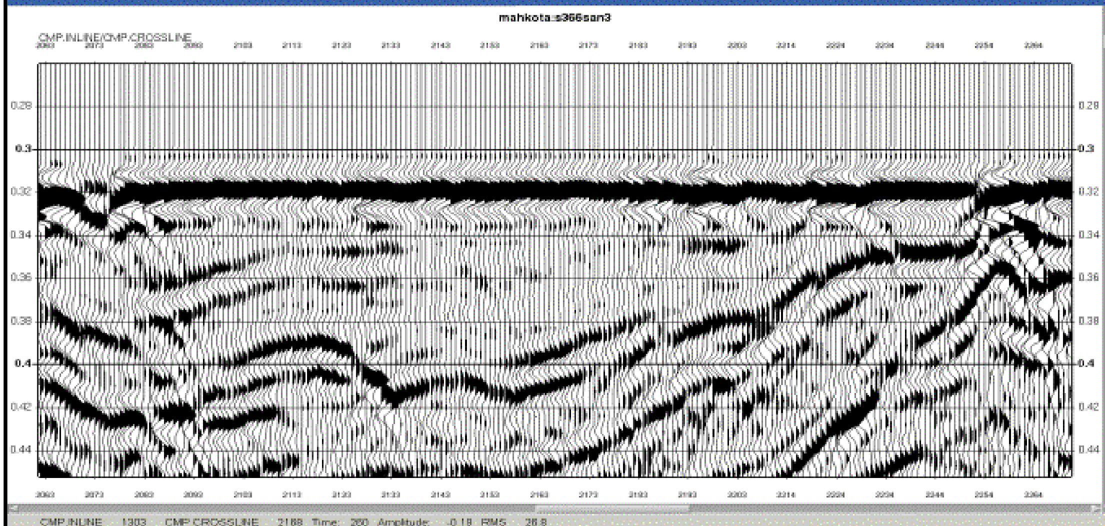
Santos 71

Line 1750 zero-phase result



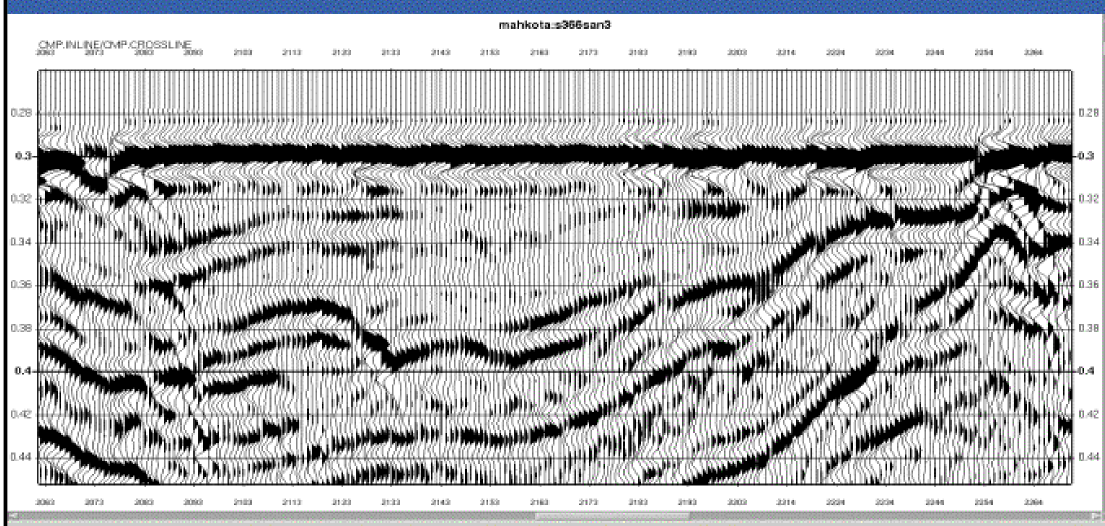
Santos 72

Line 1303 Near Trace section WB flatten at 300ms.



Santos 73

Line 1303 Flattenned sea Floor Event with Zero Phase Filter



Santos 74

OS02-3D (Amrit 3D) - PSHM2

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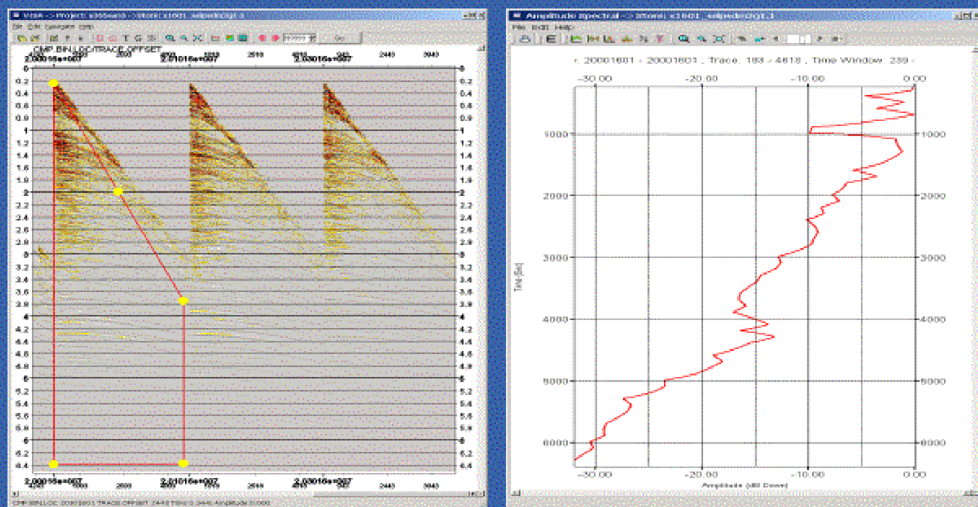
Santos 75

OS02-3D – Gather Gain Corrections

- The early spherical divergence calculated and applied in the pre-processing was removed prior to the Pere-Stack Migration, and the spherical divergence re-calculated within the migration using the ray-path calculations.
- At this stage the PSHM2 gathers have not been corrected for "Q" absorption, in phase or amplitude.
- A gain of 4db/sec was applied from sea floor for the first second below sea floor. Thereafter 3dB/second gain recovery was applied. This gain was applied to gathers without NMO correction.

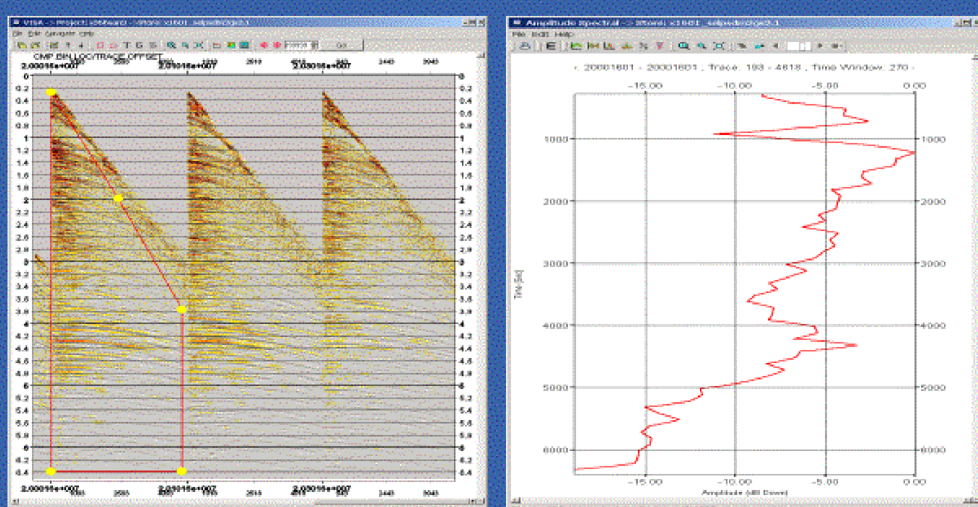
Santos 76

Shallow Water Gather – no transmission loss recovery



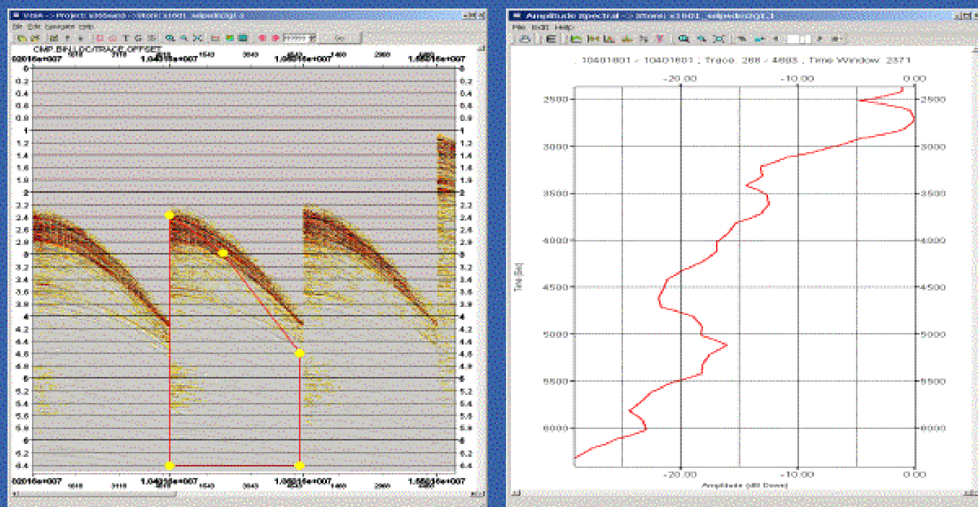
Santos 77

Gather Gain Recovery - aft exp gain 4db/sec @ wbt+1sec & 3dB/sec thereafter to 6.5sec – Shallow Water – Gain applied on data without NMO



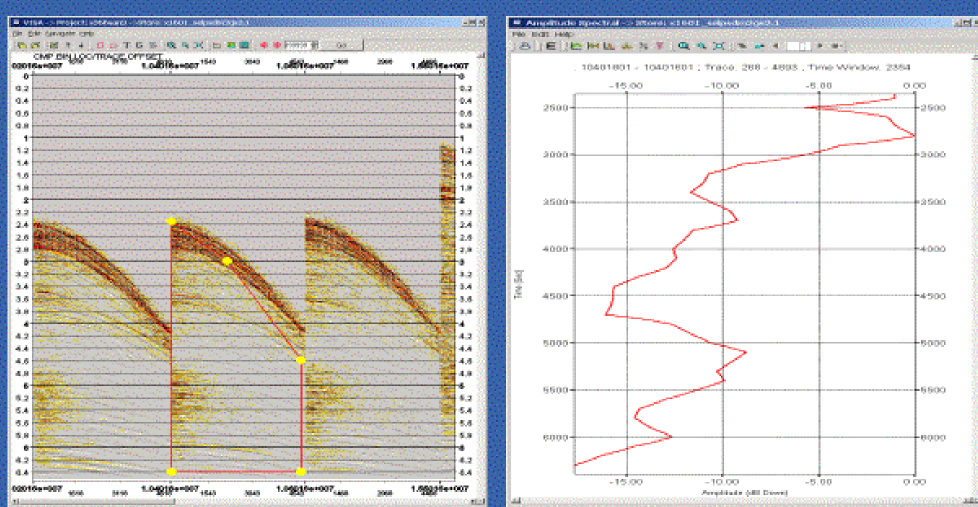
Santos 78

Deep Water Gather – no transmission loss recovery

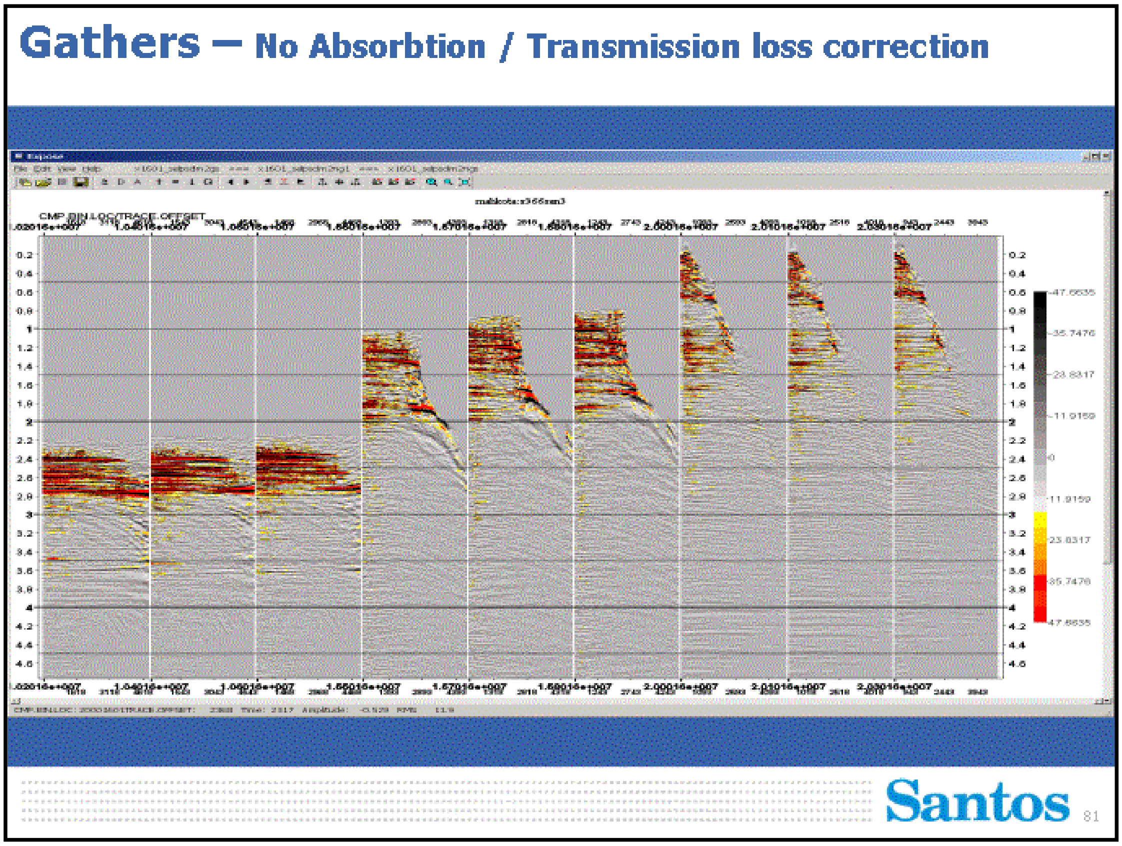


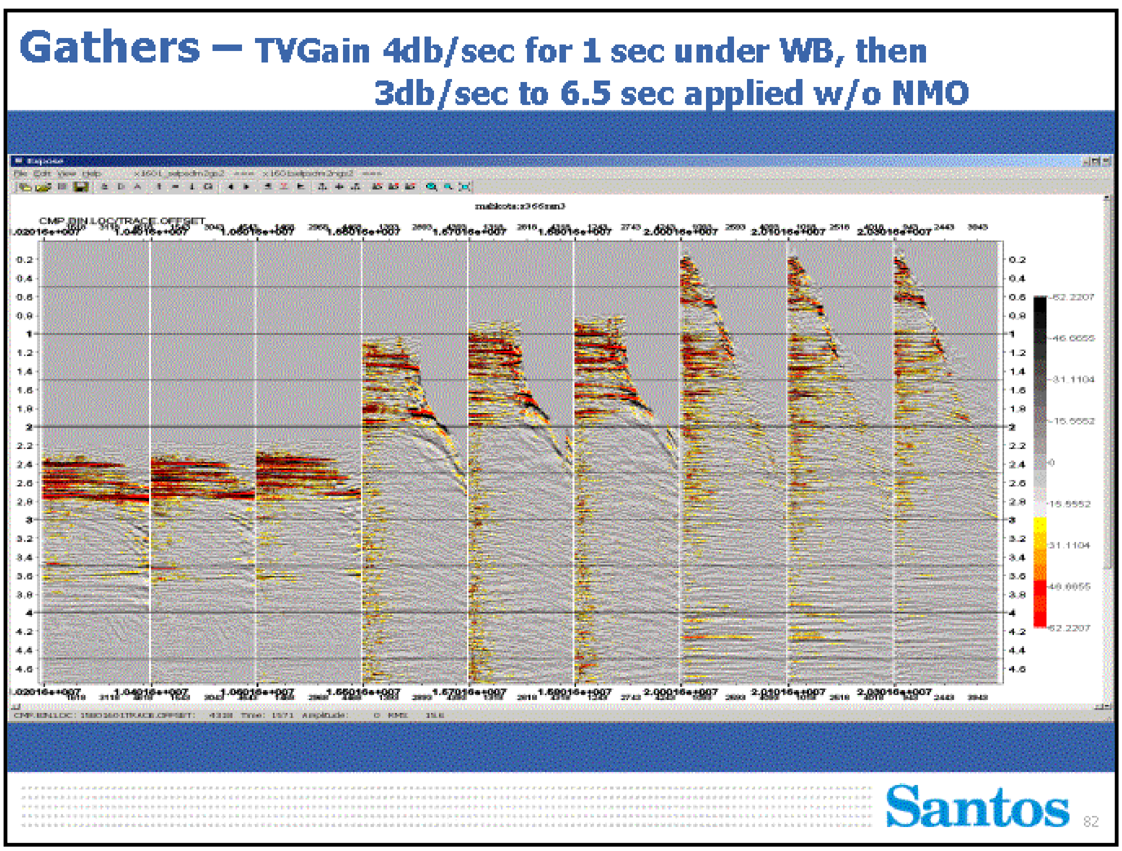
Santos 79

Gather Gain Recovery - aft exp gain 4db/sec @ wbt+1sec & 3dB/sec thereafter to 6.5sec – Deep Water – without NMO applied



Santos 80


Gathers – No Absorbtion / Transmission loss correction
Santos
81


Gathers – TVGain 4db/sec for 1 sec under WB, then
3db/sec to 6.5 sec applied w/o NMO
Santos
82

OS02-3D Conclusions

- The final output data sets are "relative amplitude", but are not corrected to true amplitude.
- The phase of the data sets appears to be very close to Zero Phase (the archive gathers did not have the zero phasing applied, but this was performed subsequently by Santos).
- The data set appears to be good in most areas, although there are some remaining imaging problems under the steepest parts of the shelf, where amplitudes also appear to be affected.

Santos 83

OS02-3D Issues

- Rapid velocity variations due to shallow complexities may require a high density velocity analysis (currently conventional velocity analysis at 250m is scheduled)
- The application of "Q" is still to be determined, as is the requirement for a final Post Migration Radon
- The final data sets are scheduled for delivery in September – with the final migration completing in mid-August.

Santos 84

6.2 PRE-STACK GAIN TESTS FINAL

Pre-Stack Gain Tests

- The following tests are to provide a deterministic gain (that can be recovered later) to apply to the gathers to provide as close as possible to "true gain" for true amplitude gathers.
- The gathers already have spherical divergence applied, but no correction has been made for absorption (transmission losses)
- Determinations of "Q" vary from 130-140 and the gathers are compared with gathers with Q applied (using Q=135) with 20 and 30dB max gain applied for reference.

Gain Functions used in tests

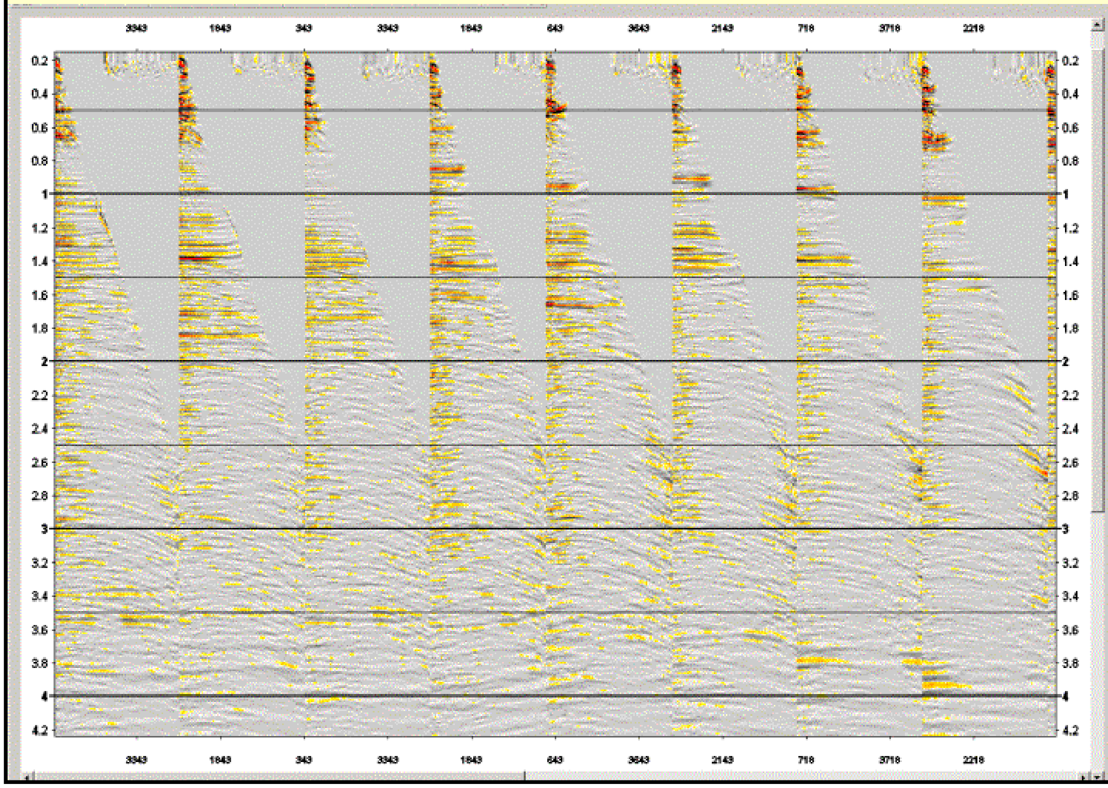
(all gain in dB)

Time sec wrt Sea Floor	VDGC shallow (200msec)	VDGC Deep (1000msec)	JC1	JC2	JC3	JC4	JC5
0	0	0	0	0	0	0	0
1	0	0	3	3	3	8	10
2			6	6			
2.5	5	20			12	20	25
3.5	15	20	18		20	28	35
6	15	15	26	21	26	32	42

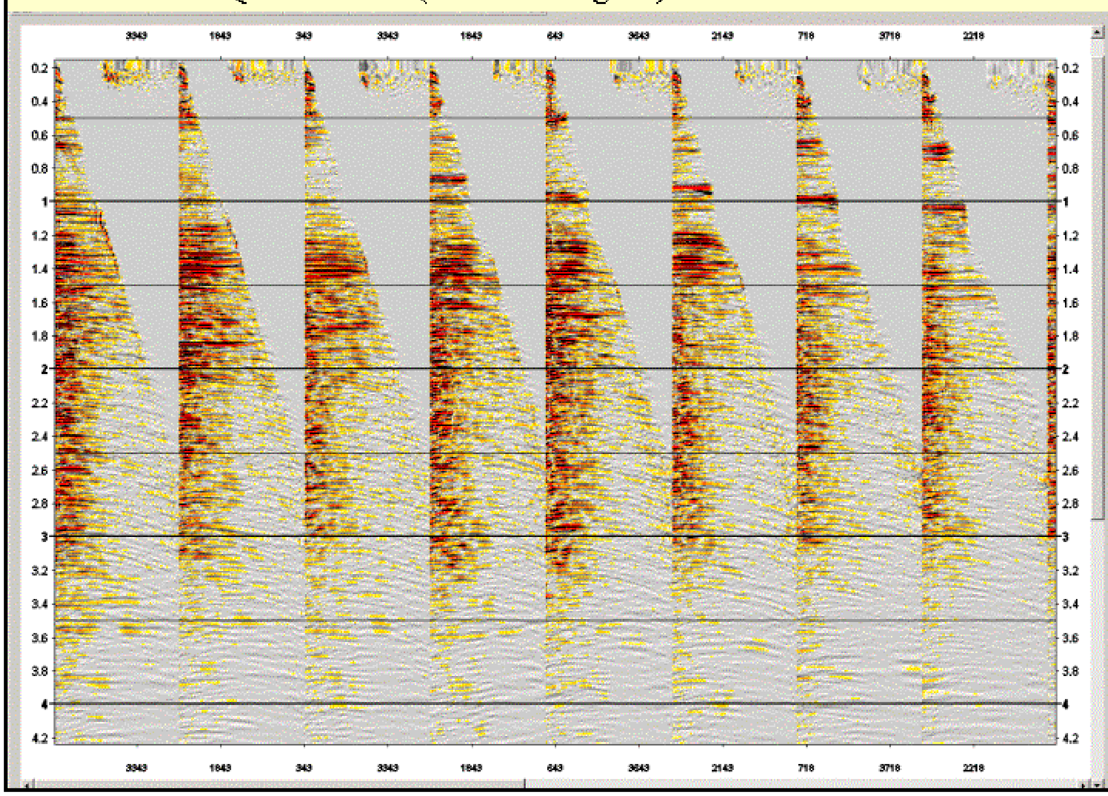
N.B. how VDGC's gain changes with water depth – such a gain difference is not applicable without causing distortions

VERITAS

InLine 8712- VDGC Gain (shallow water case)

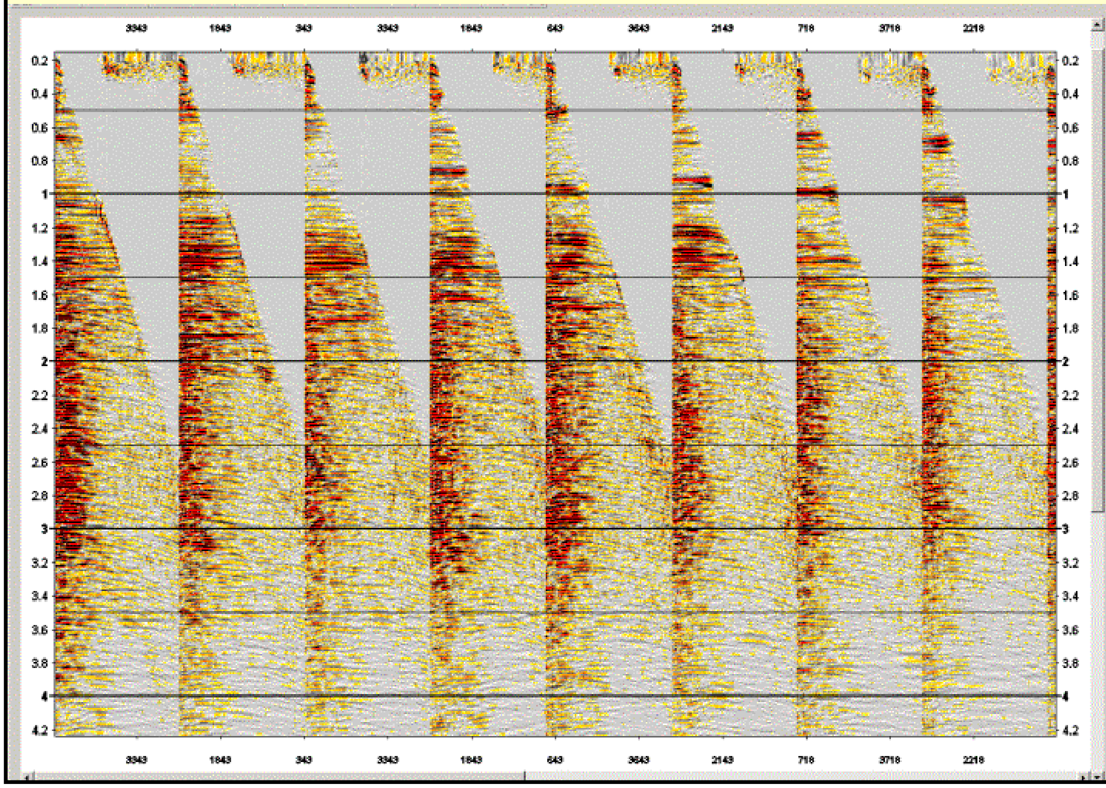


InLine 8712- Q=135 Gain (20dB Max gain)

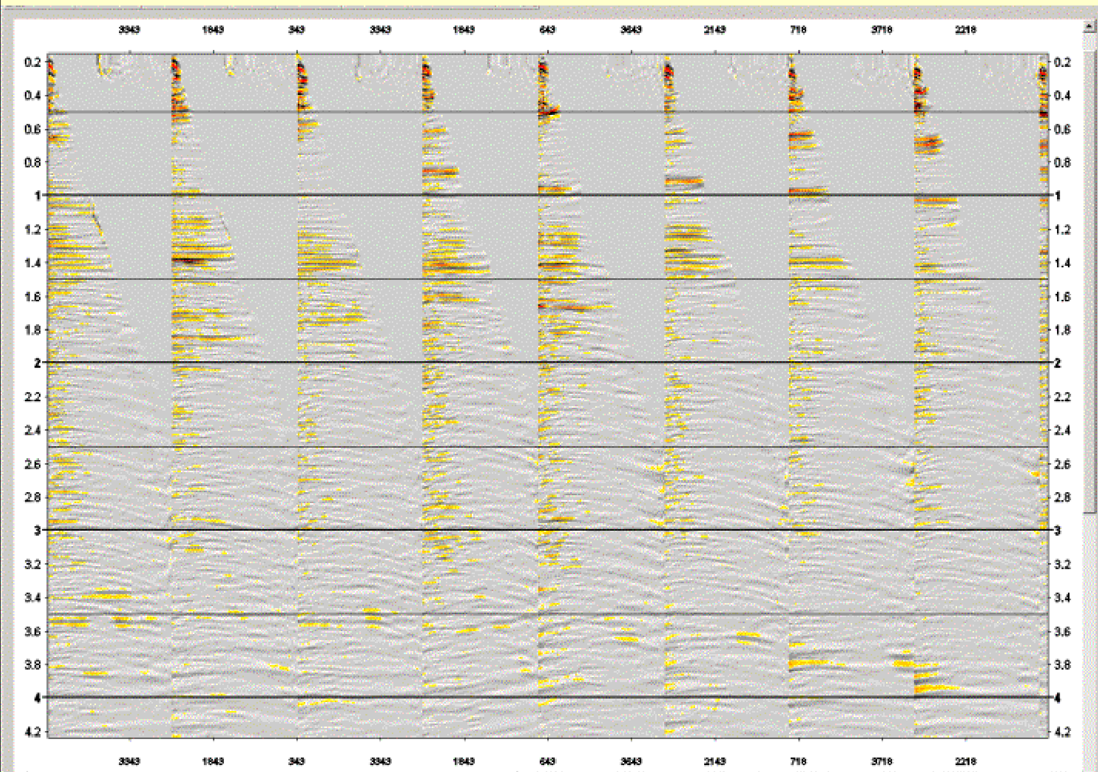


VERITAS

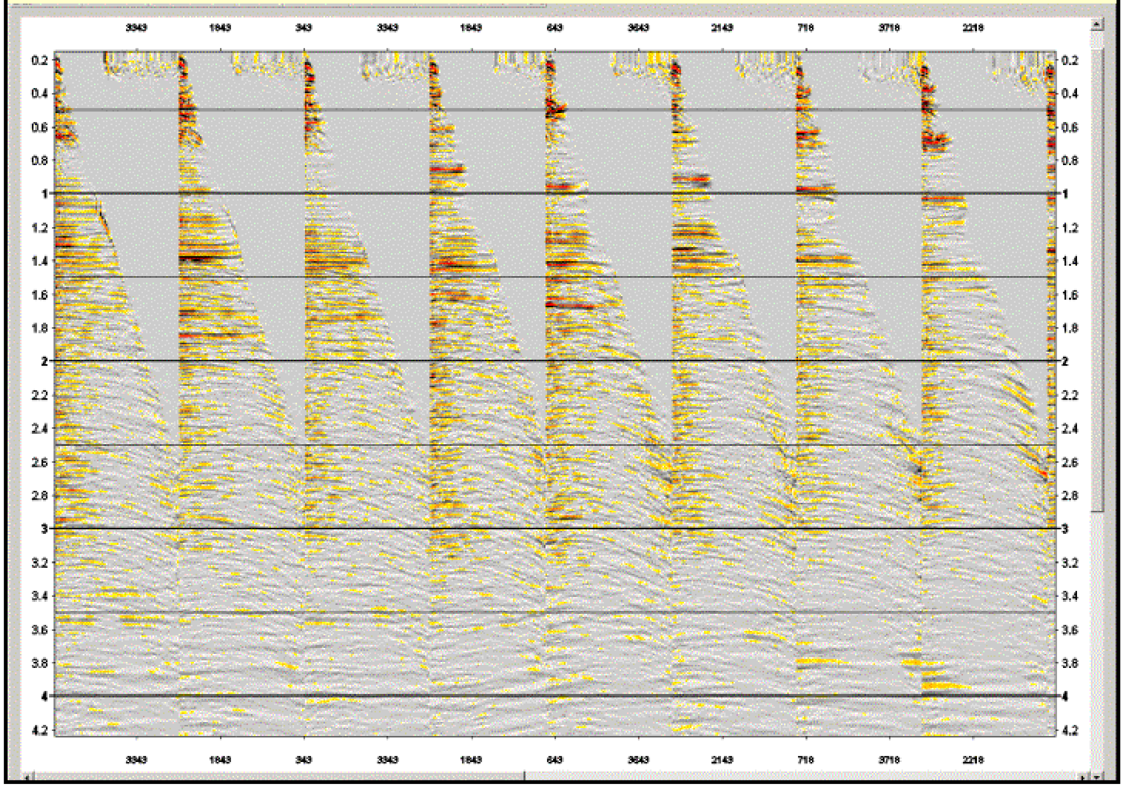
InLine 8712- Q=135 Gain (30dB Max gain)



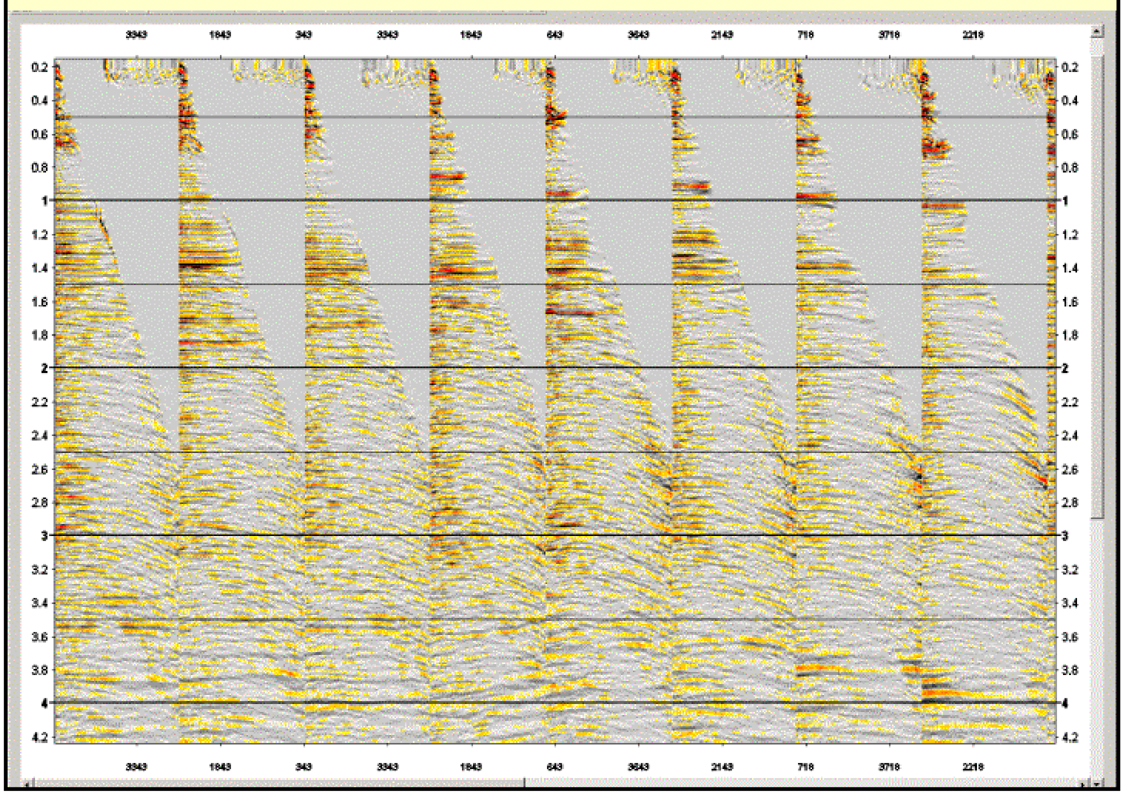
InLine 8712- VDGC Gain (shallow water case)



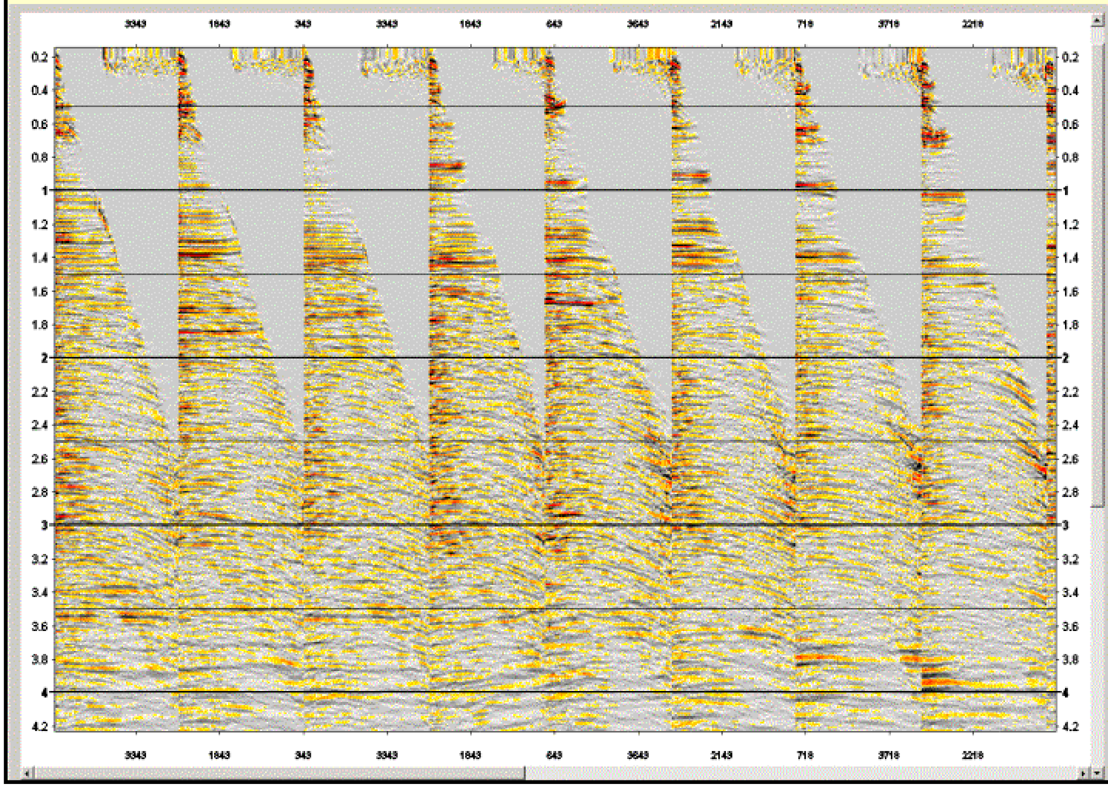
InLine 8712- JC1 Gain



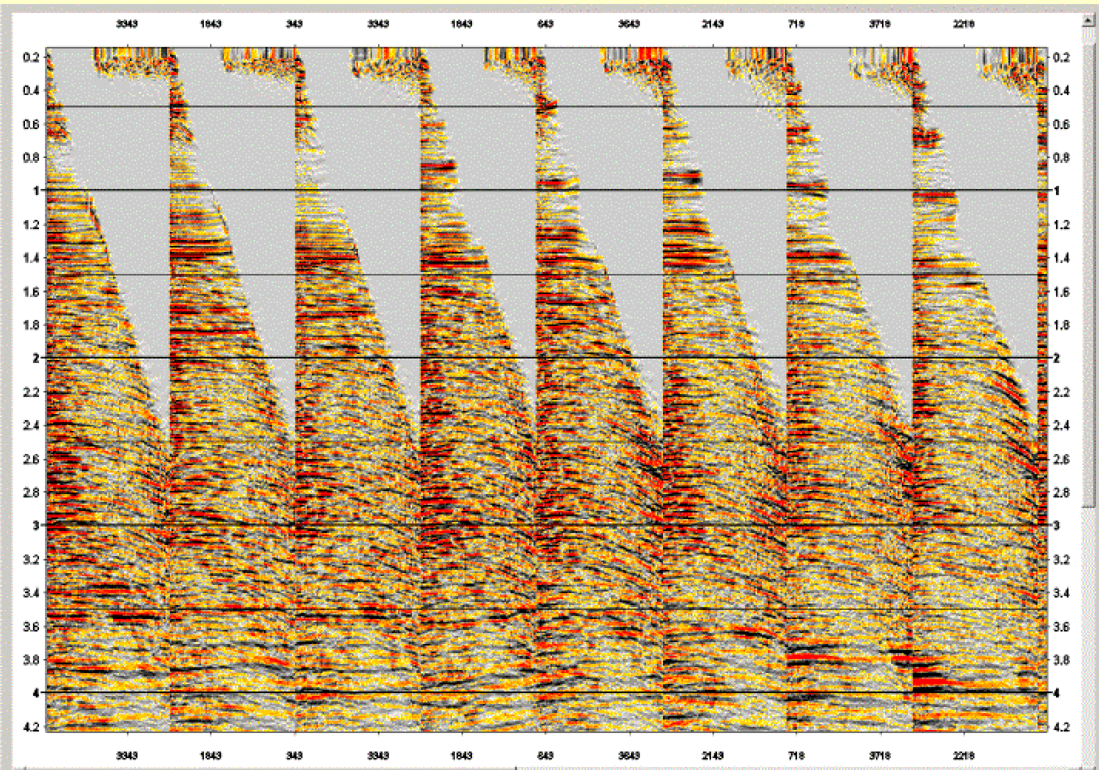
InLine 8712- JC2 Gain



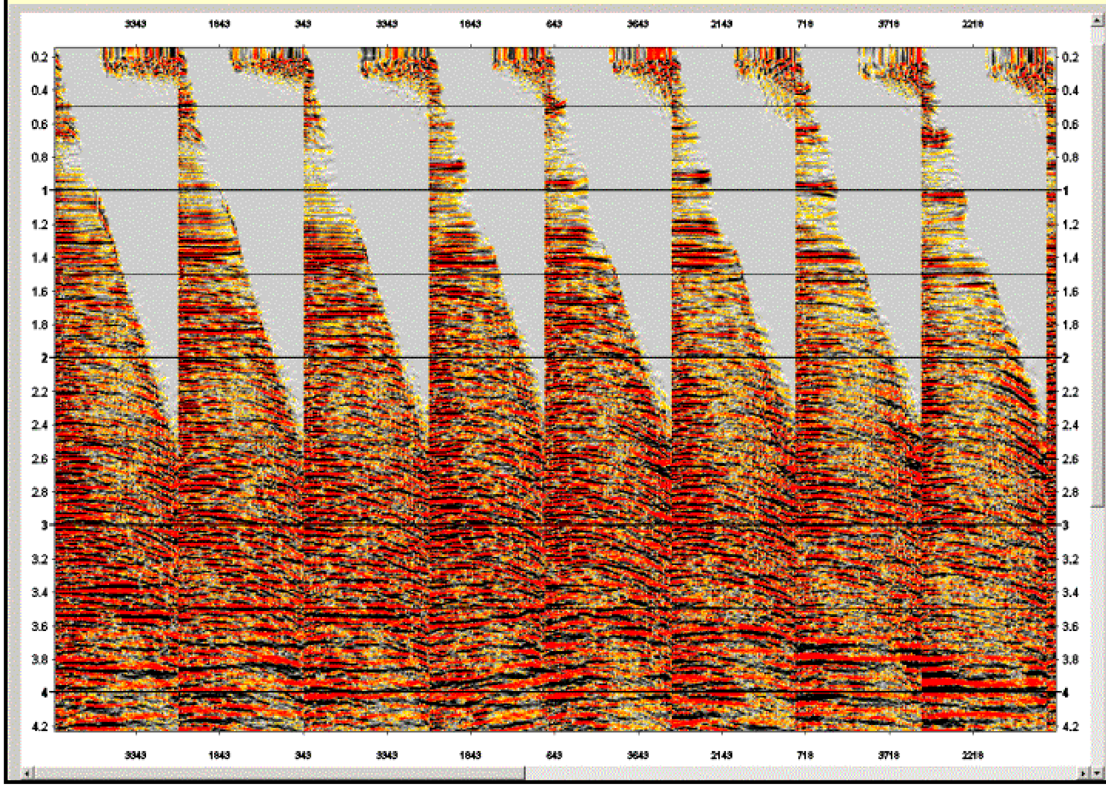
InLine 8712- JC3 Gain



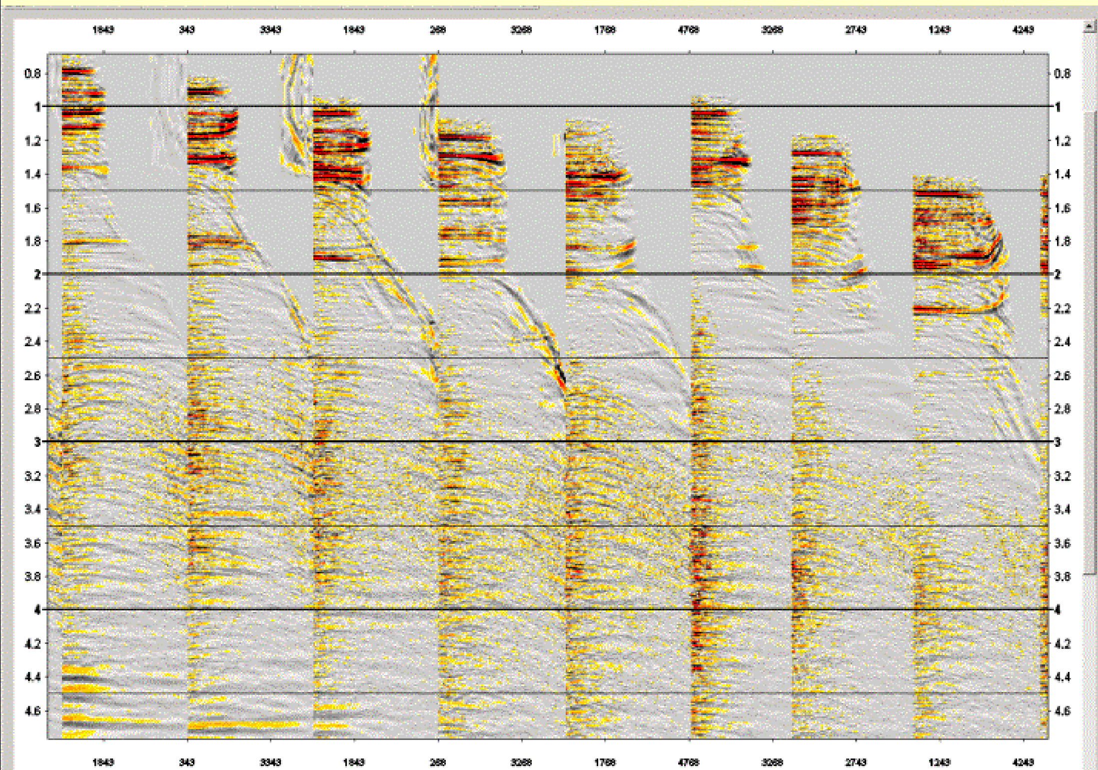
InLine 8712- JC4 Gain



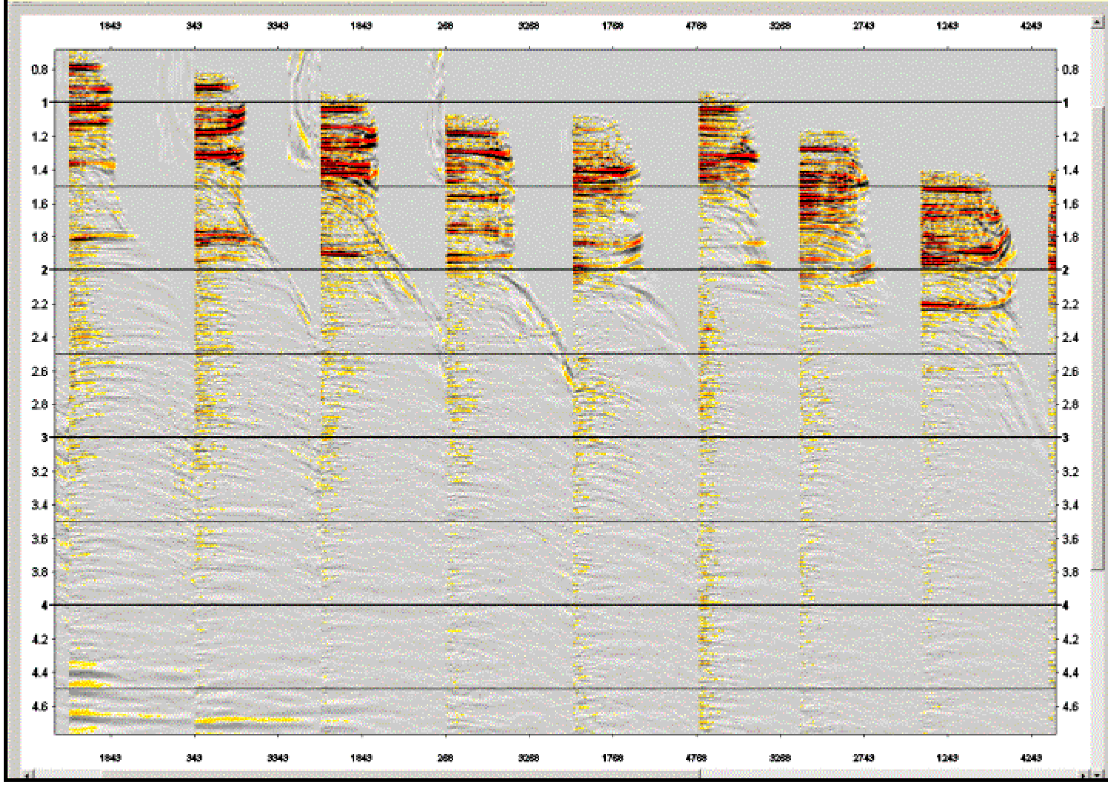
InLine 8712- JC5 Gain



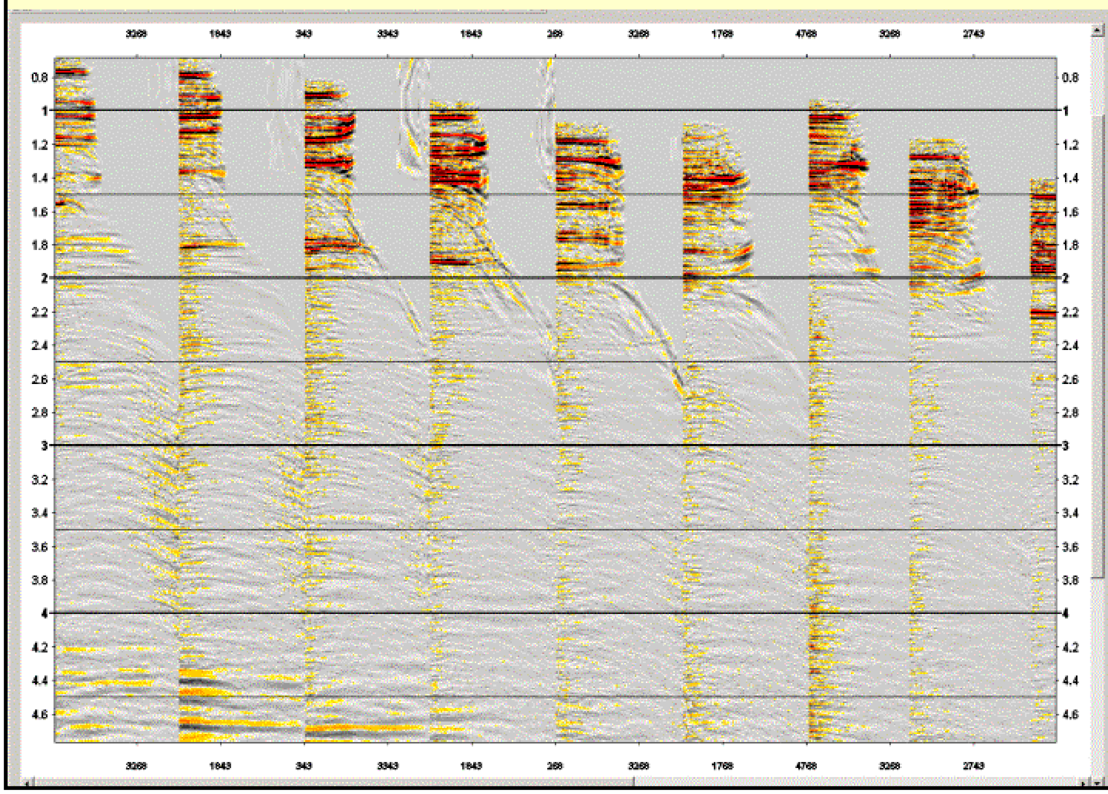
InLine 8112- VDGC Gain (Medium-Deep water case)



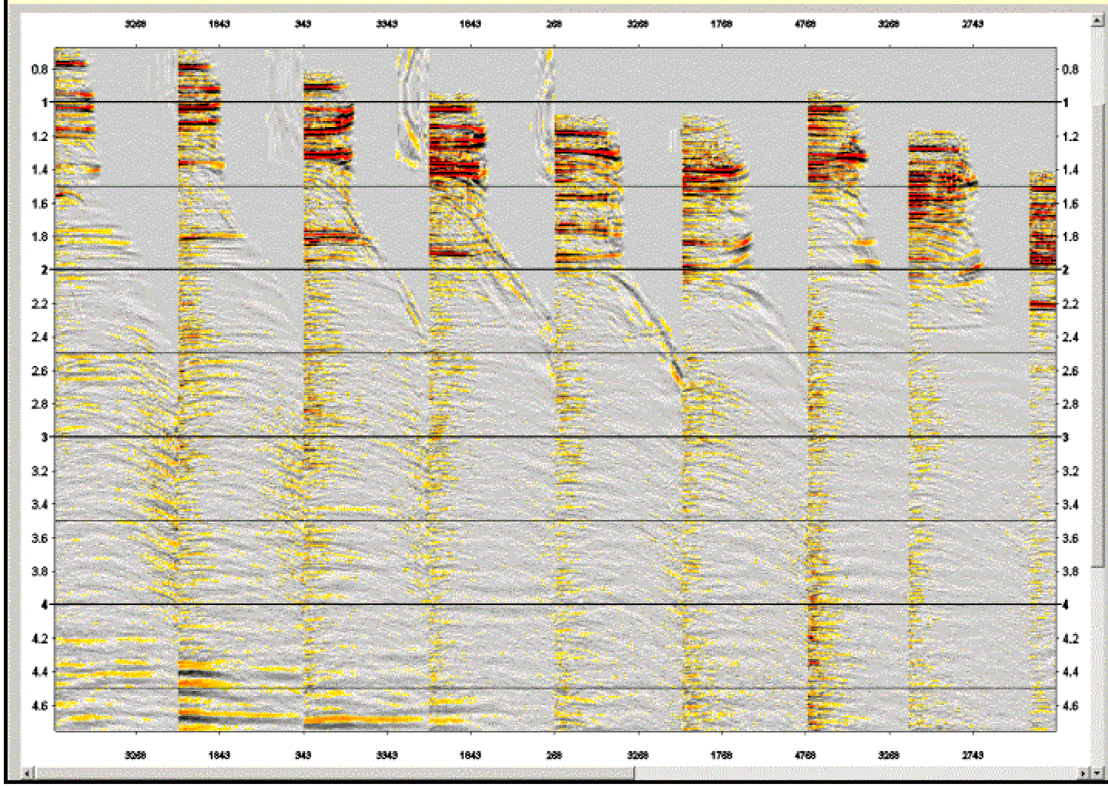
InLine 8112- JC1 Gain



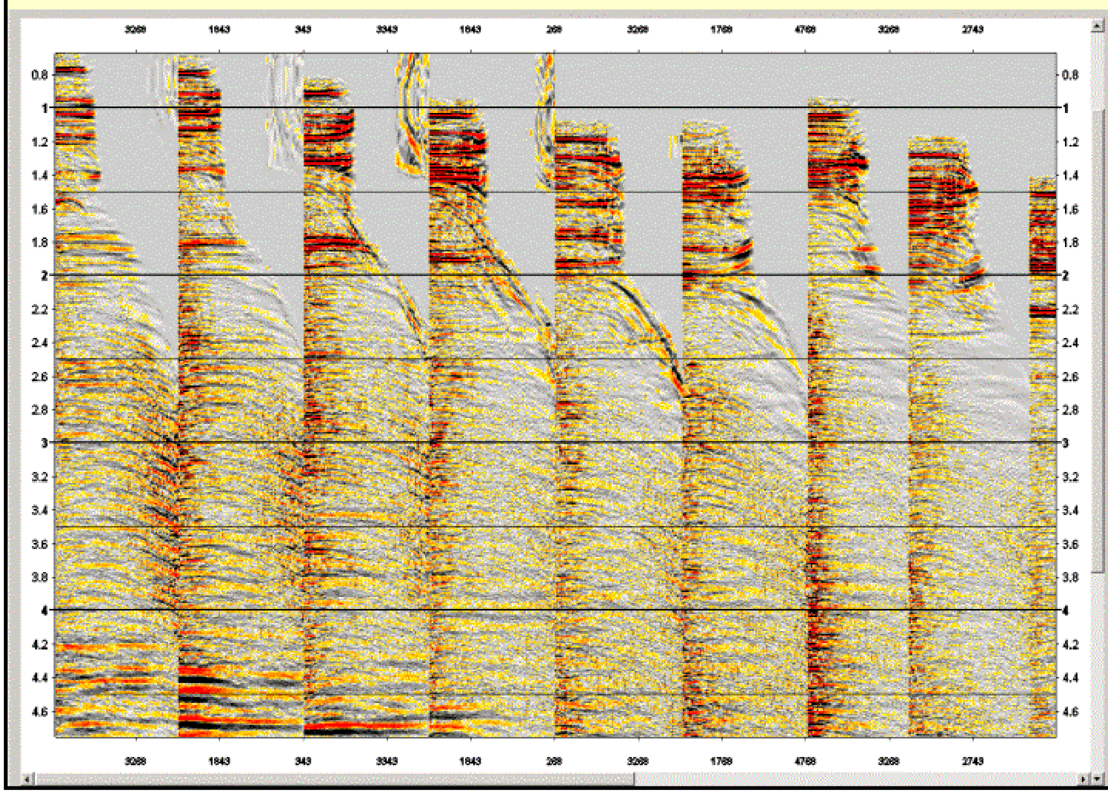
InLine 8112- JC2 Gain



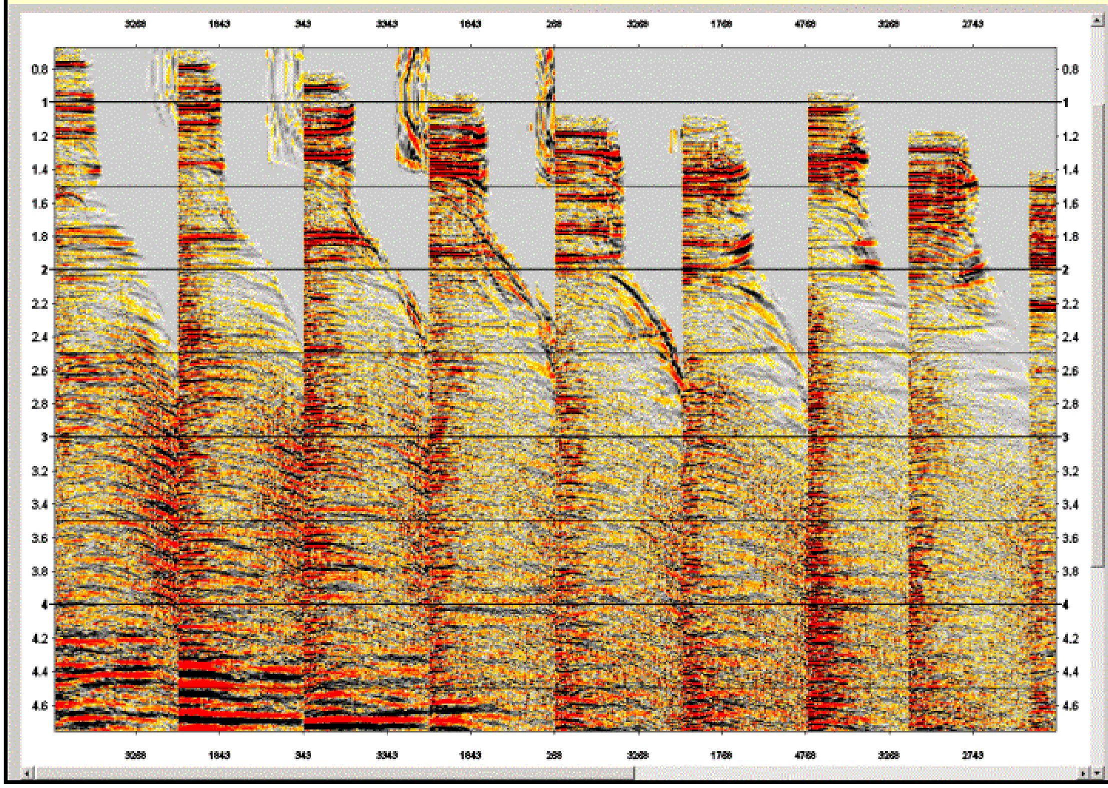
InLine 8112- JC3 Gain



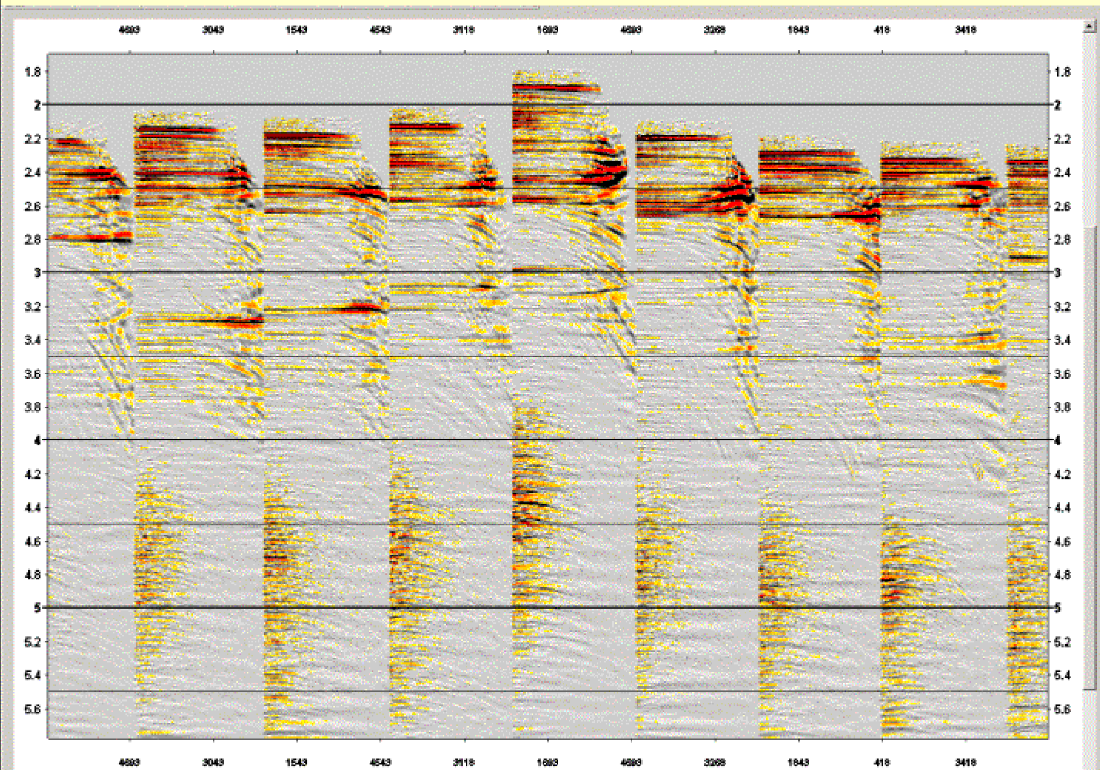
InLine 8112- JC4 Gain



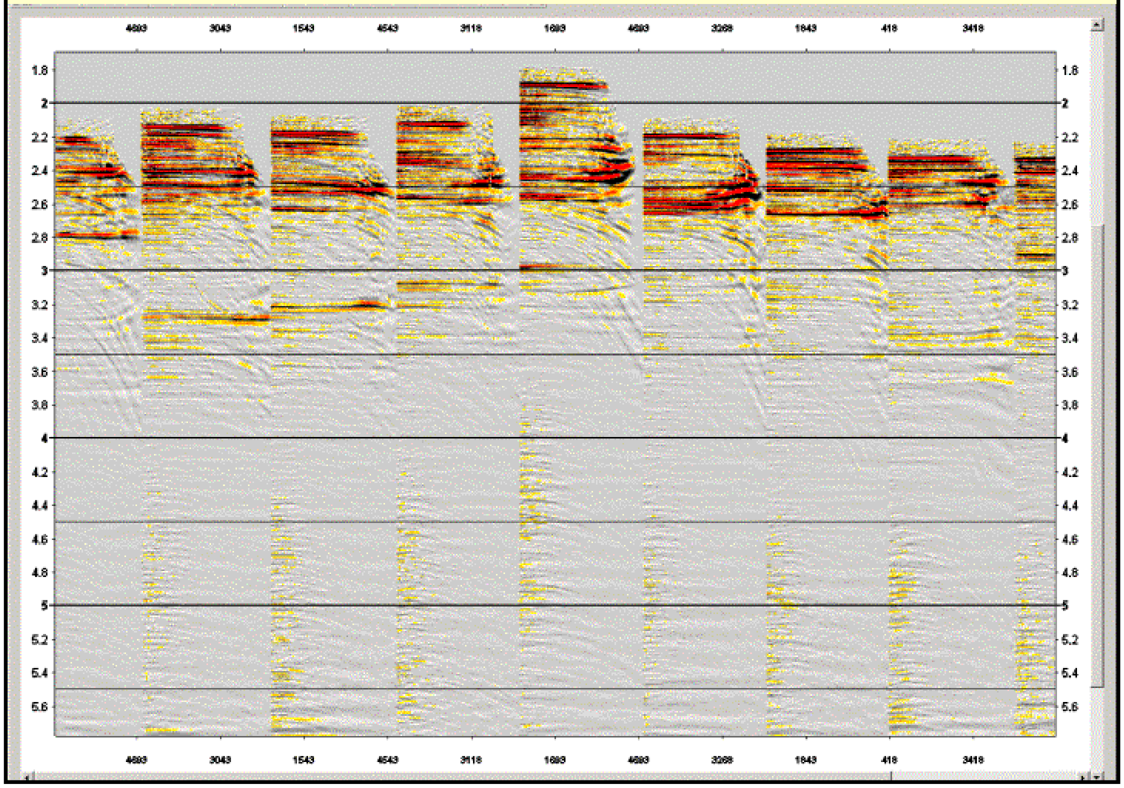
InLine 8112- JC5 Gain



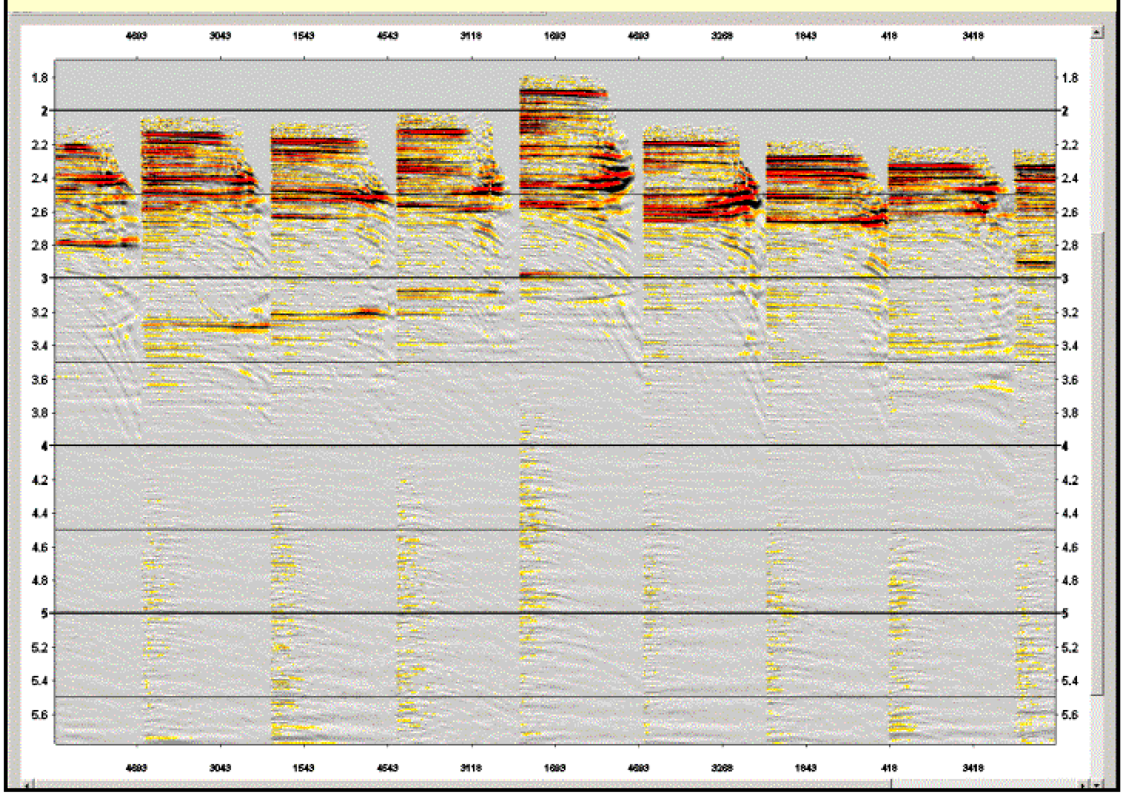
InLine 7370- VDGC Gain (Deep water case)



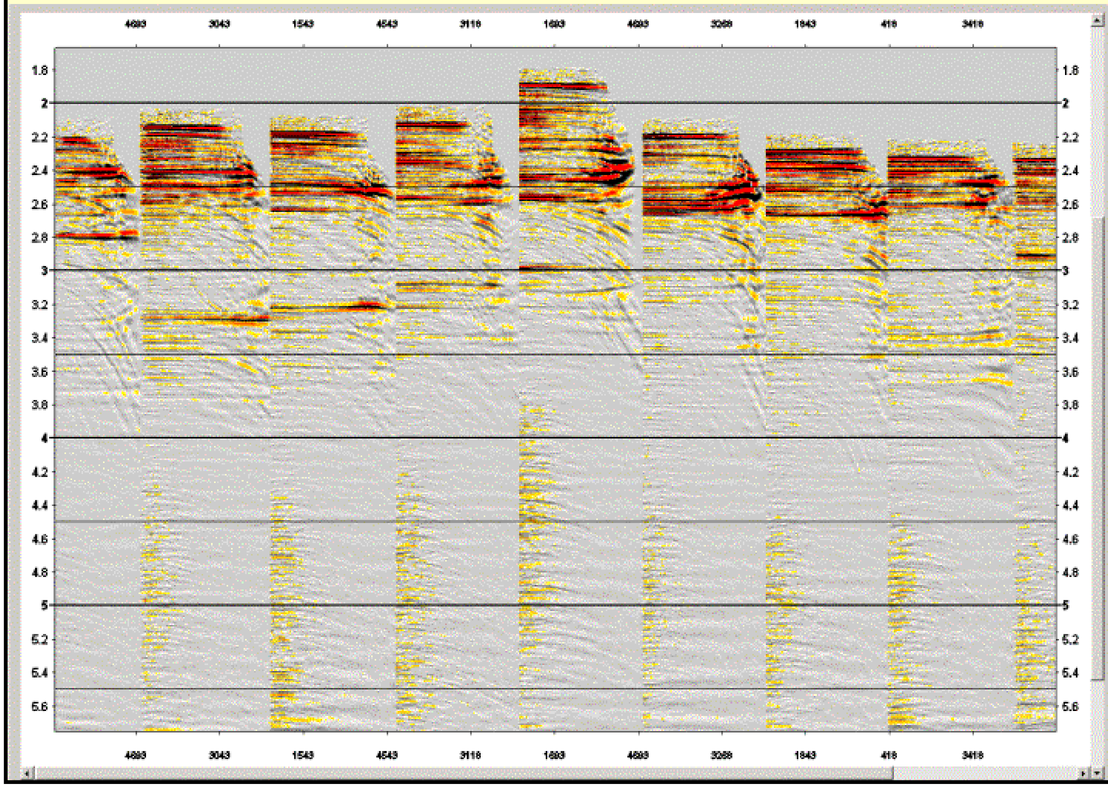
InLine 7370- JC1 Gain



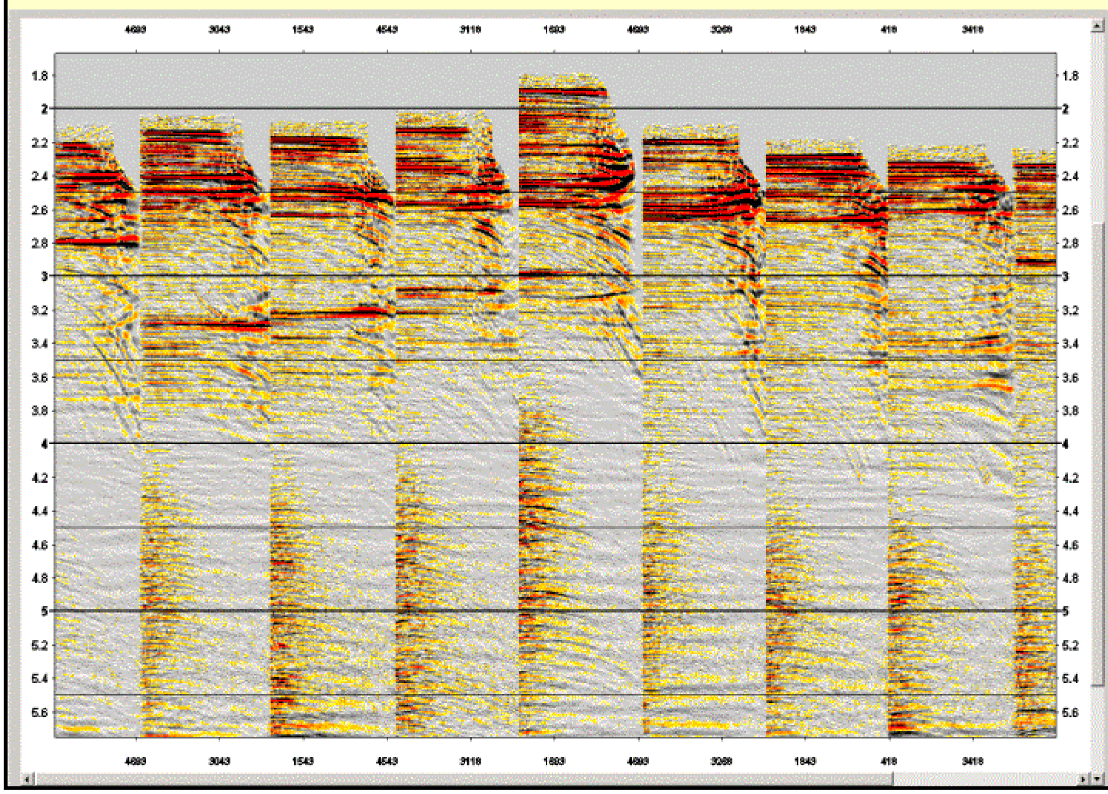
InLine 7370- JC2 Gain



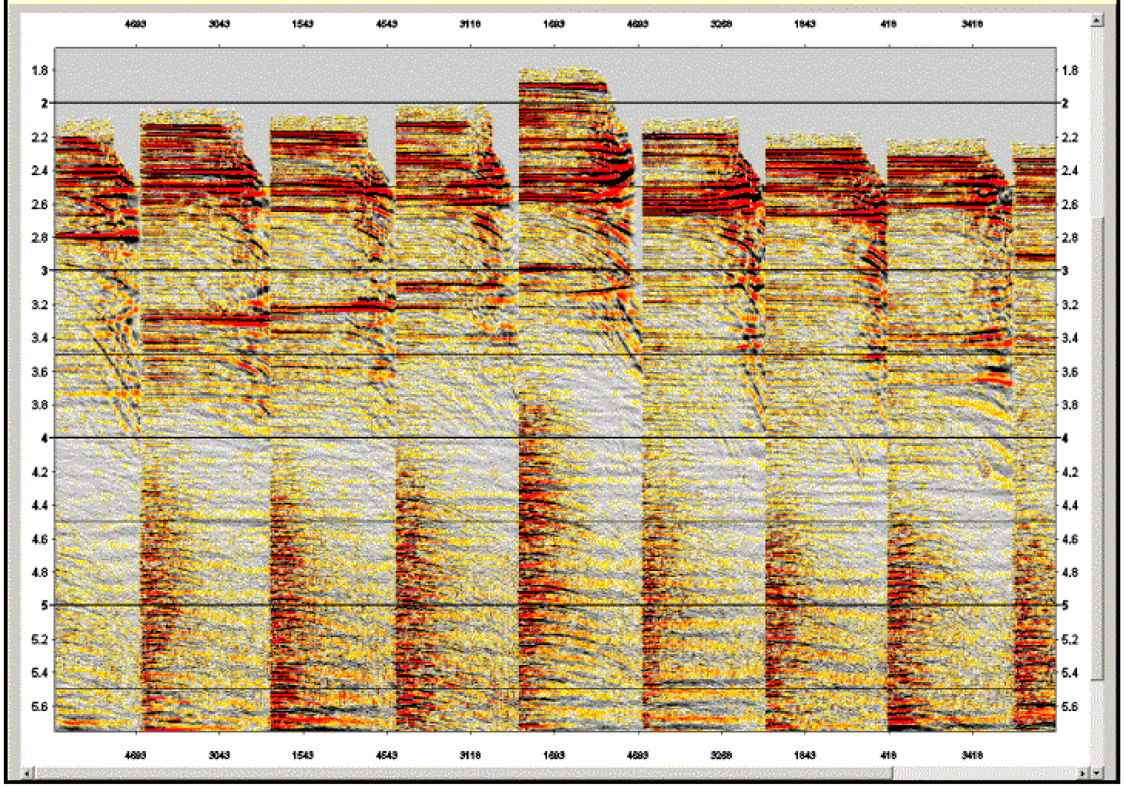
InLine 7370- JC3 Gain



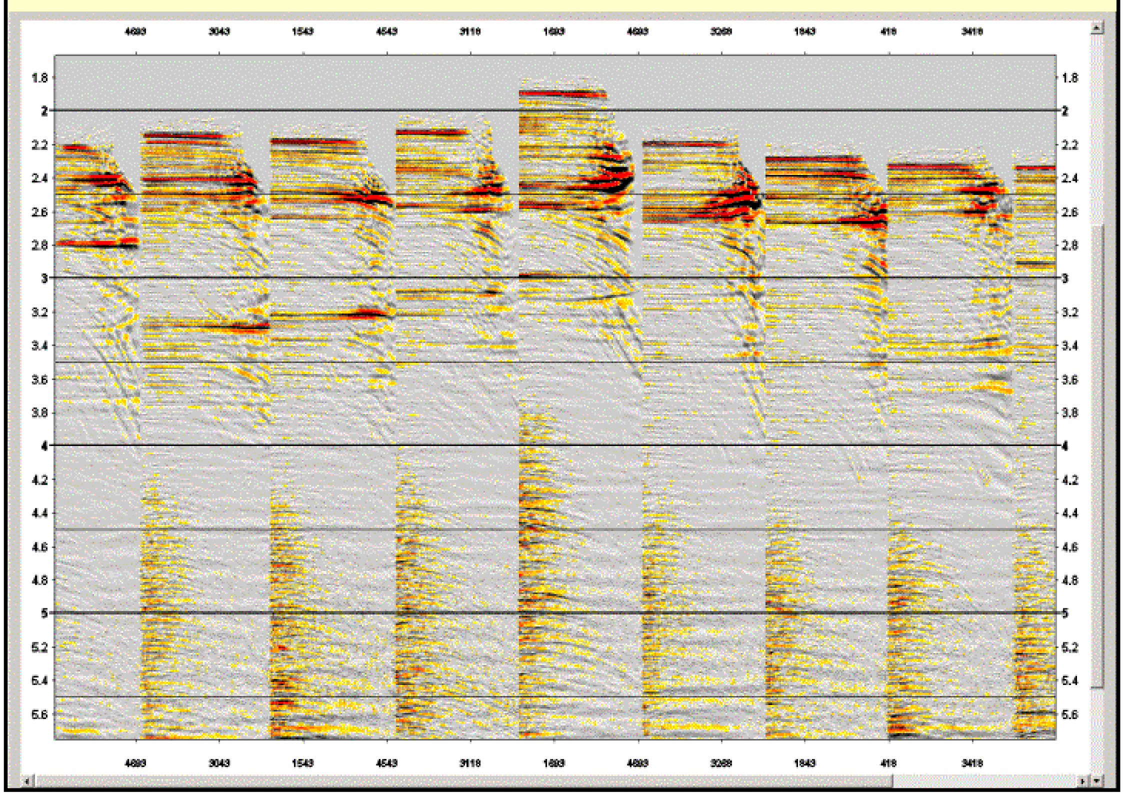
InLine 7370- JC4 Gain



InLine 7370- JC5 Gain



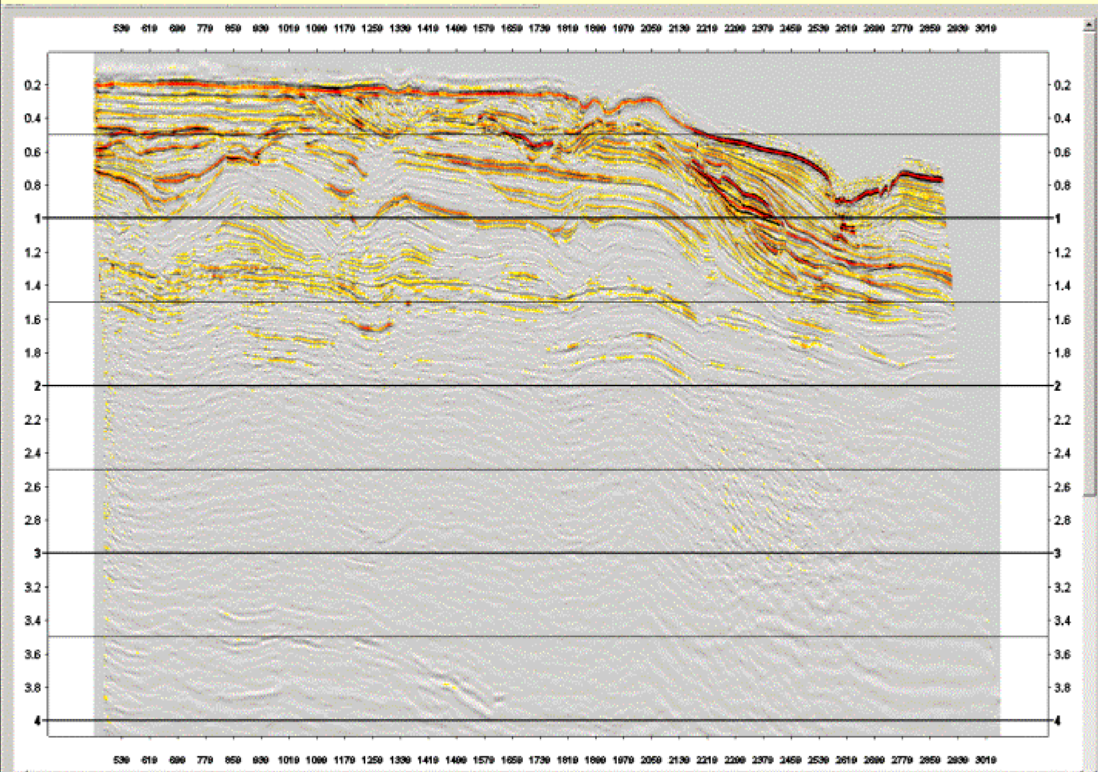
InLine 7370- JC5 Gain – scaled back 8dB



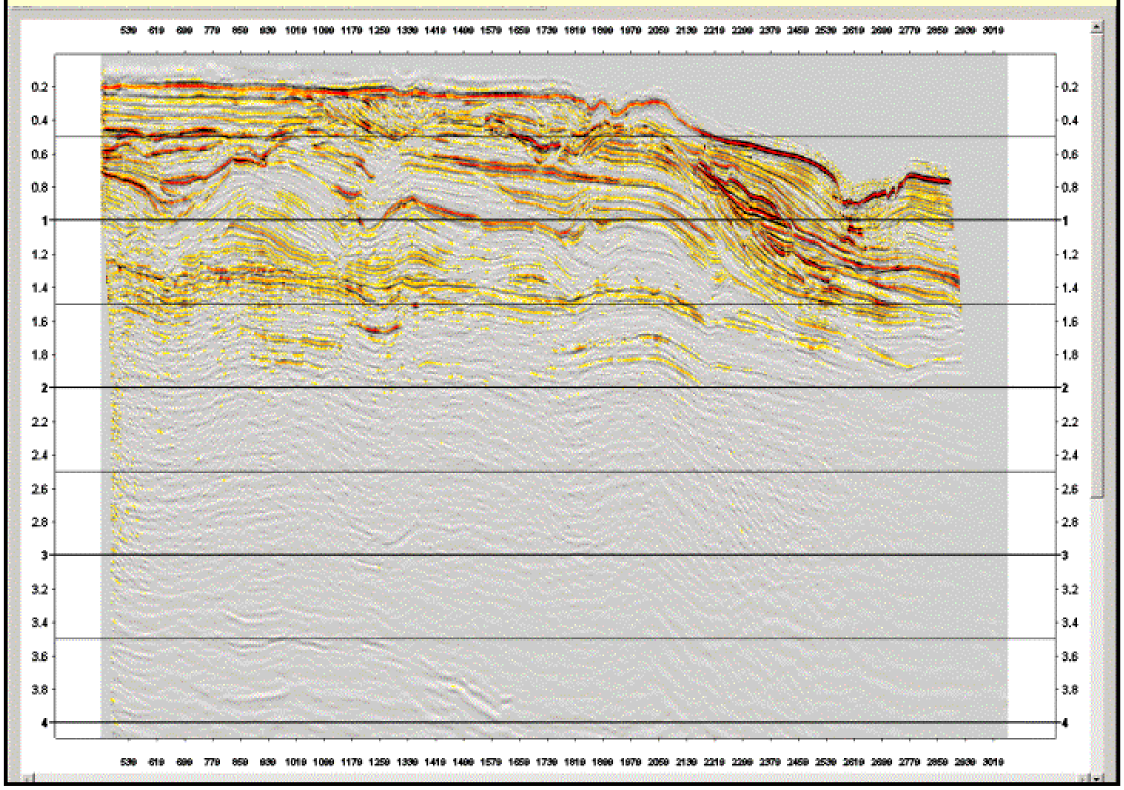
Gain Tests

Stack Displays
(all tests are Fixed Amplitude)

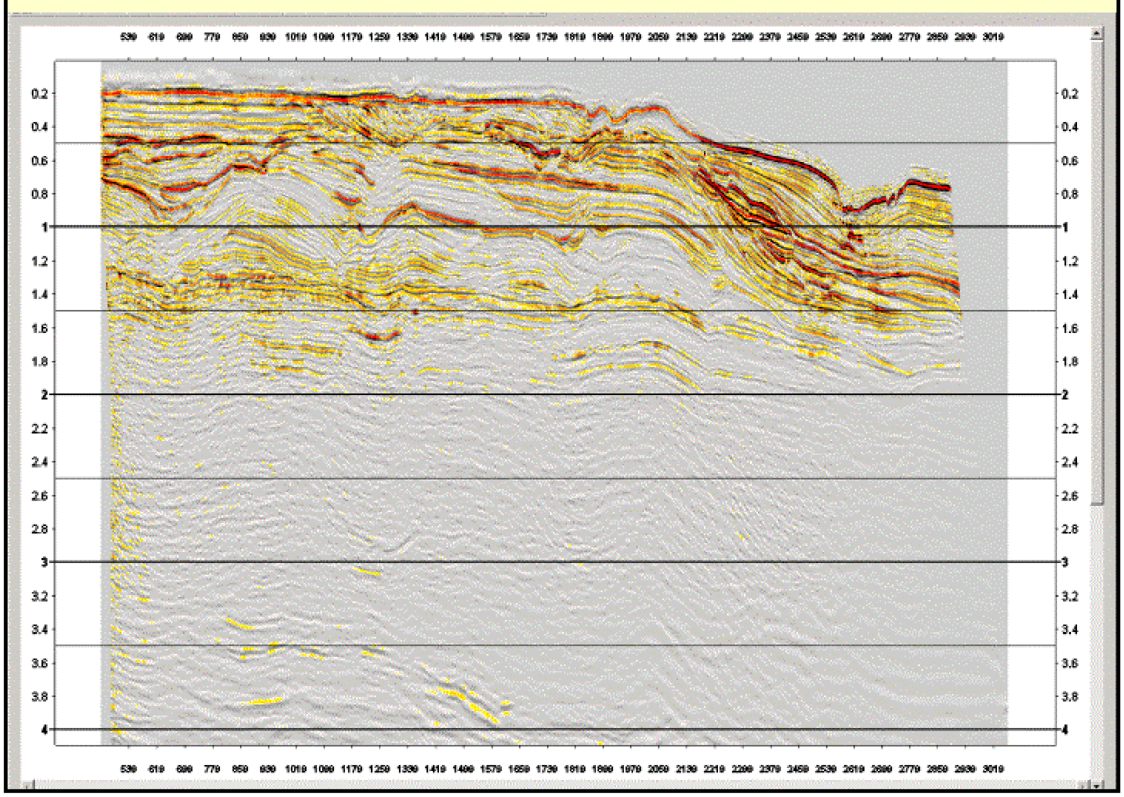
InLine 8712- VDGC Gain (shallow water case)



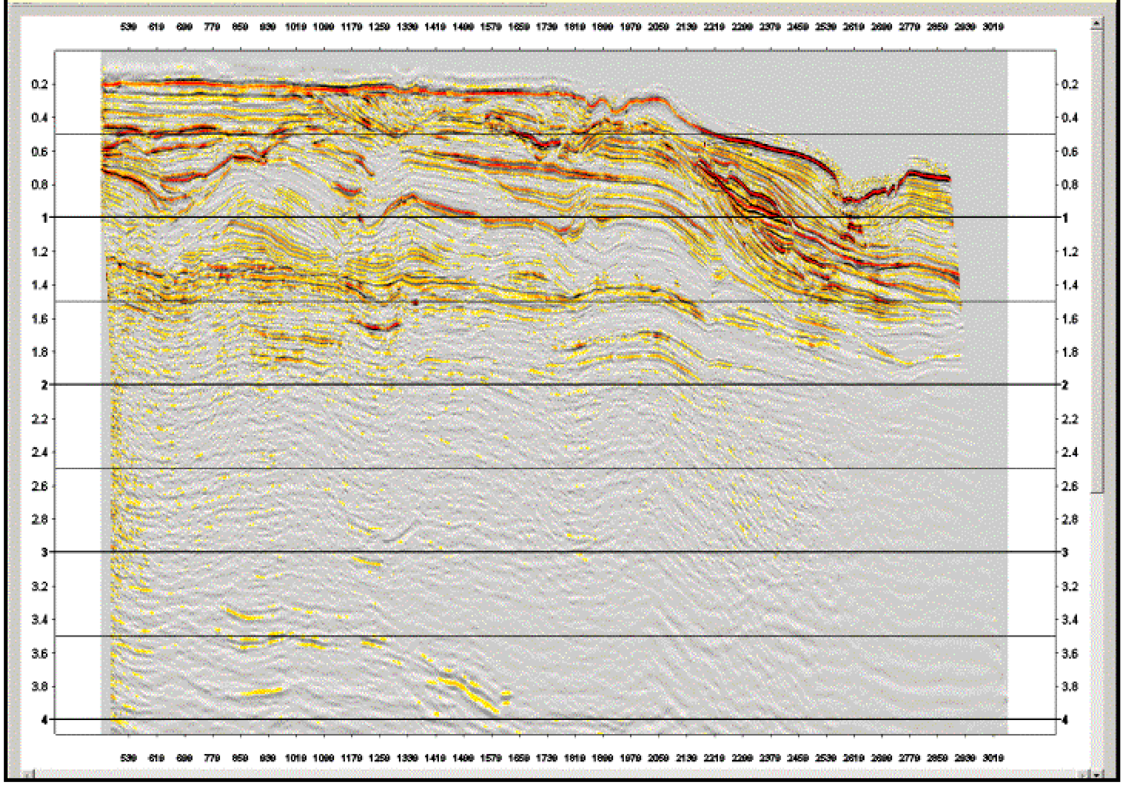
InLine 8712- JC1 Gain



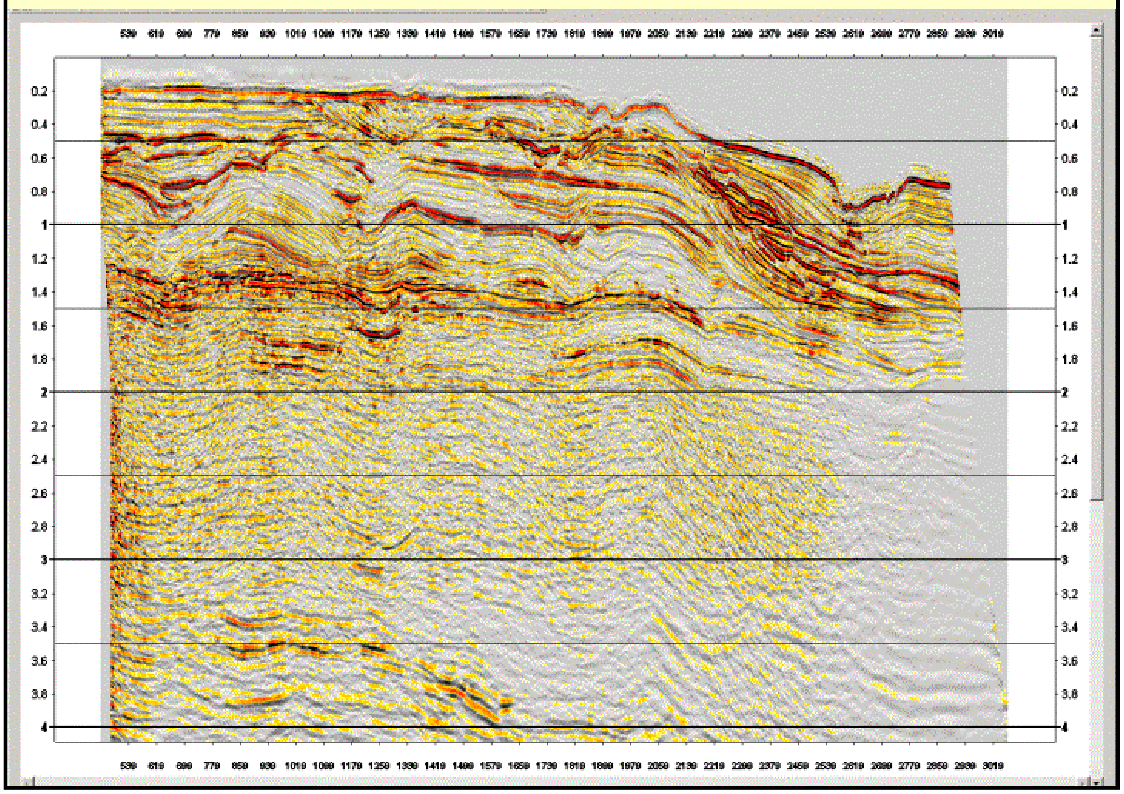
InLine 8712- JC2 Gain



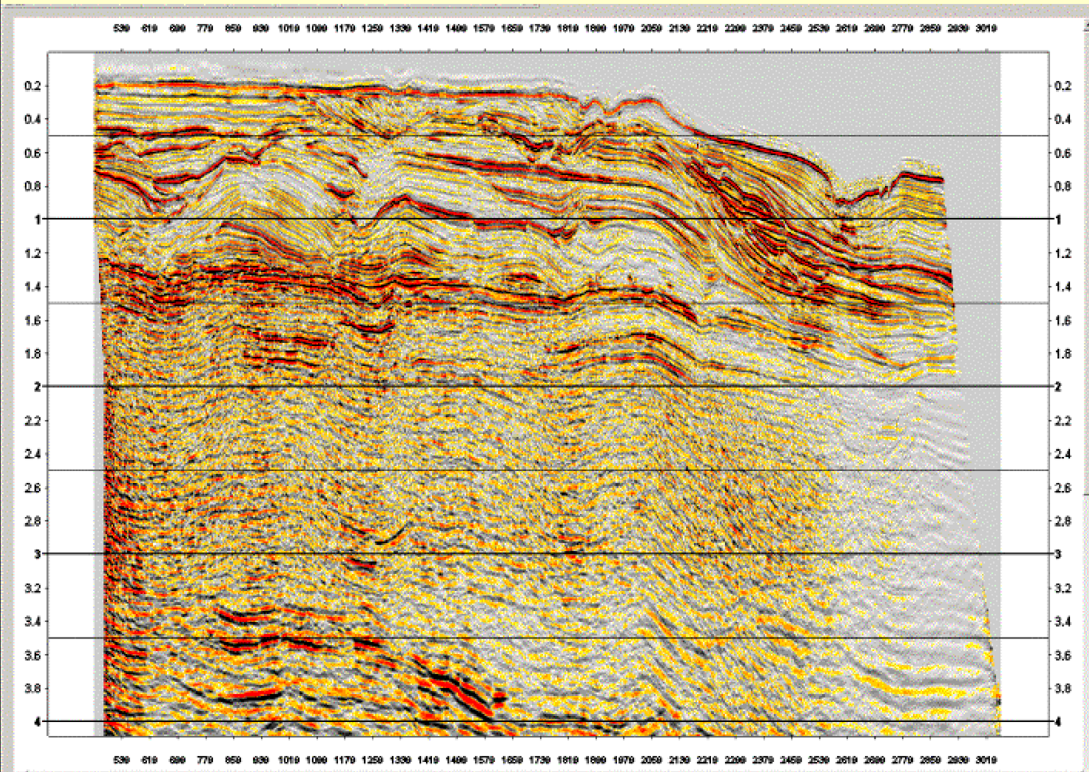
InLine 8712- JC3 Gain



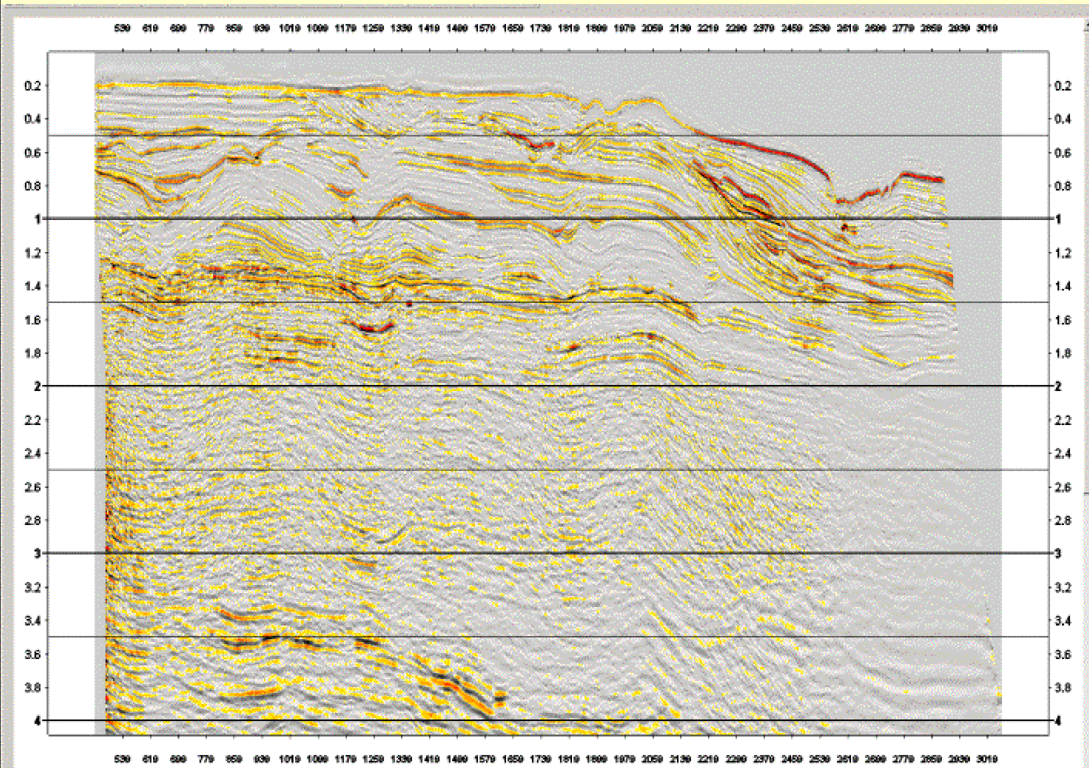
InLine 8712- JC4 Gain



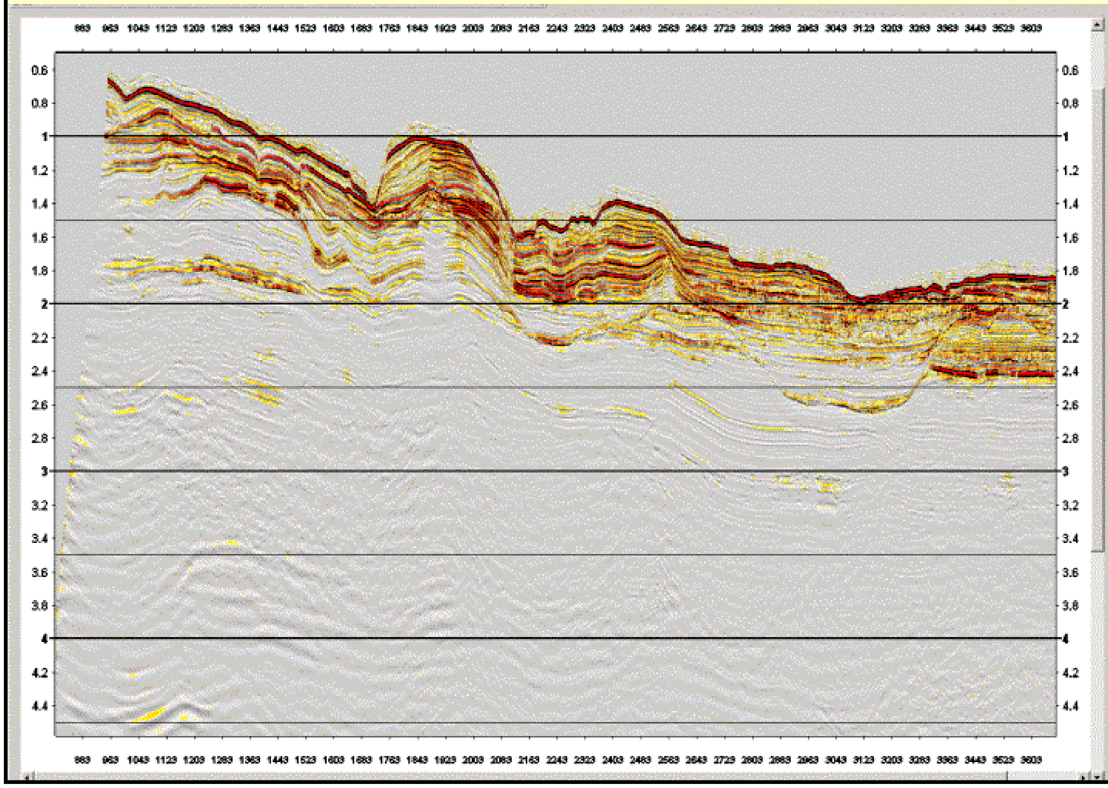
InLine 8712- JC5 Gain



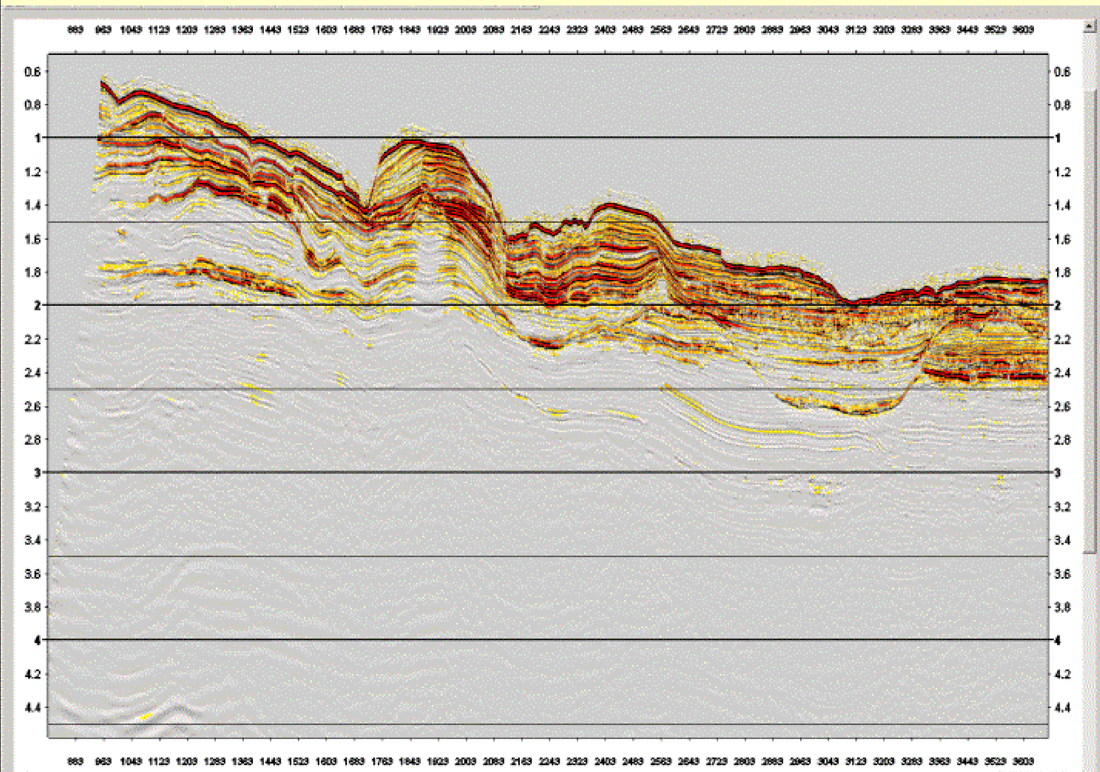
InLine 8712- JC5 Gain – Redisplayed 8dB Lighter



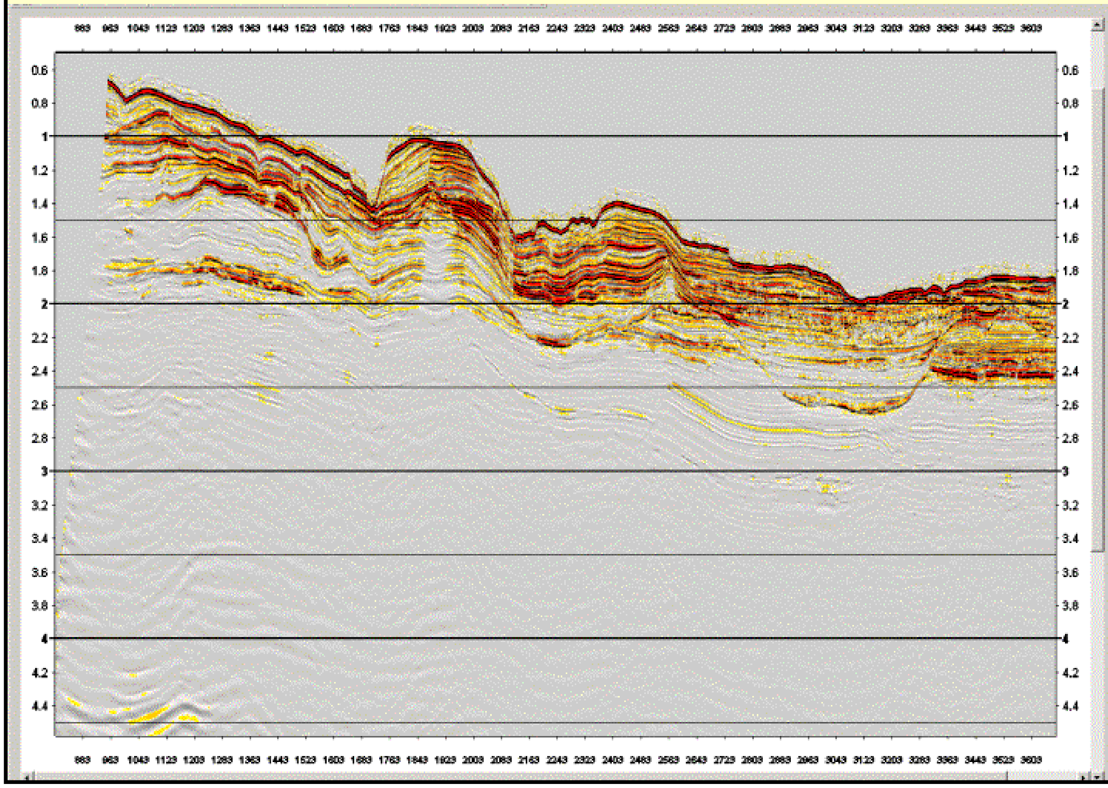
InLine 8112- VDGC Gain (Medium-Deep water case)



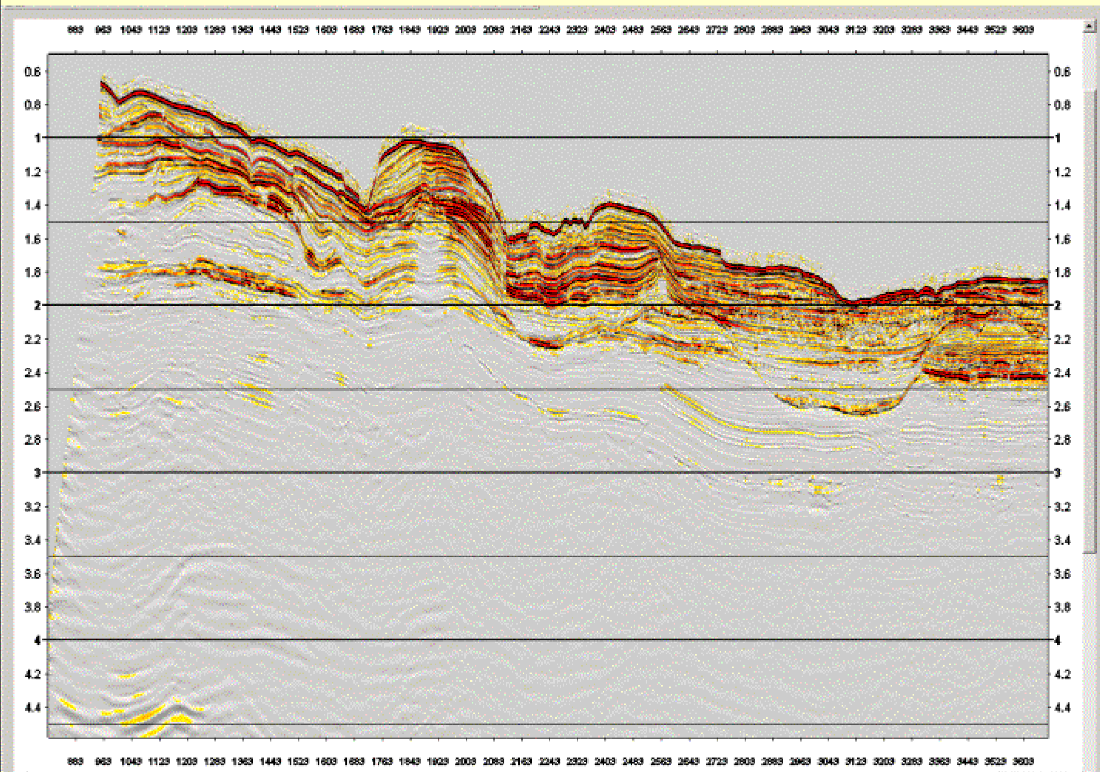
InLine 8112- JC1 Gain



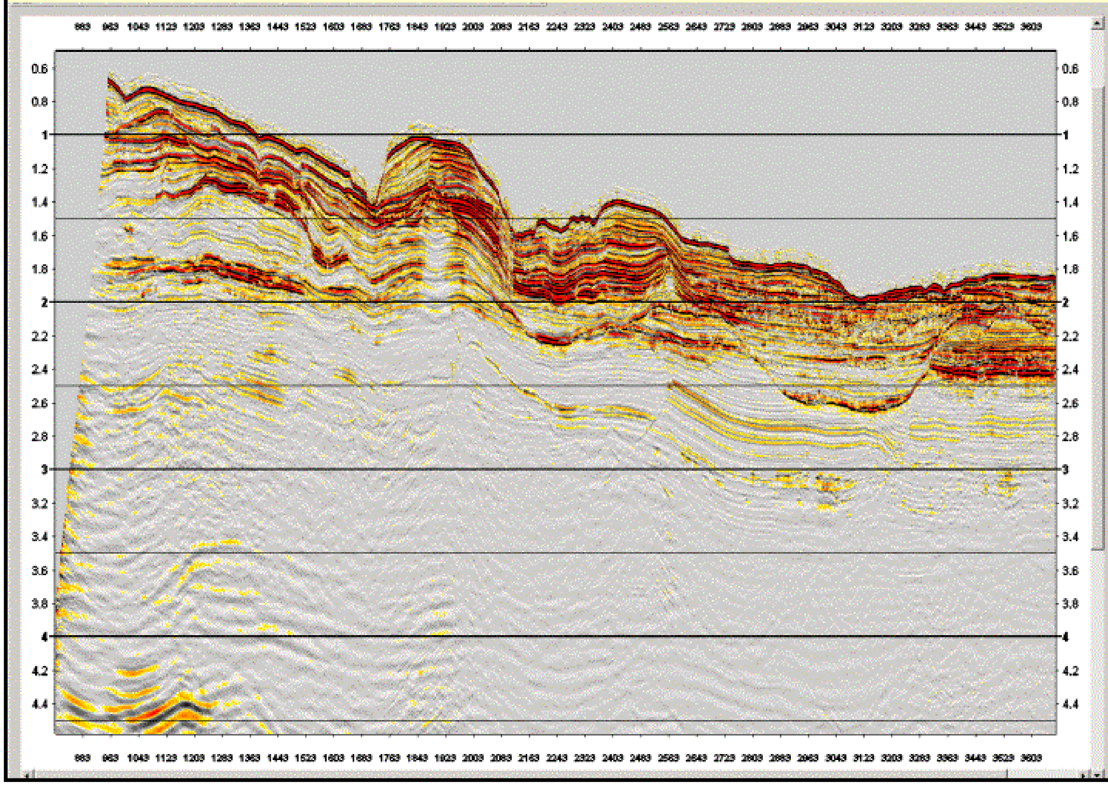
InLine 8112- JC2 Gain



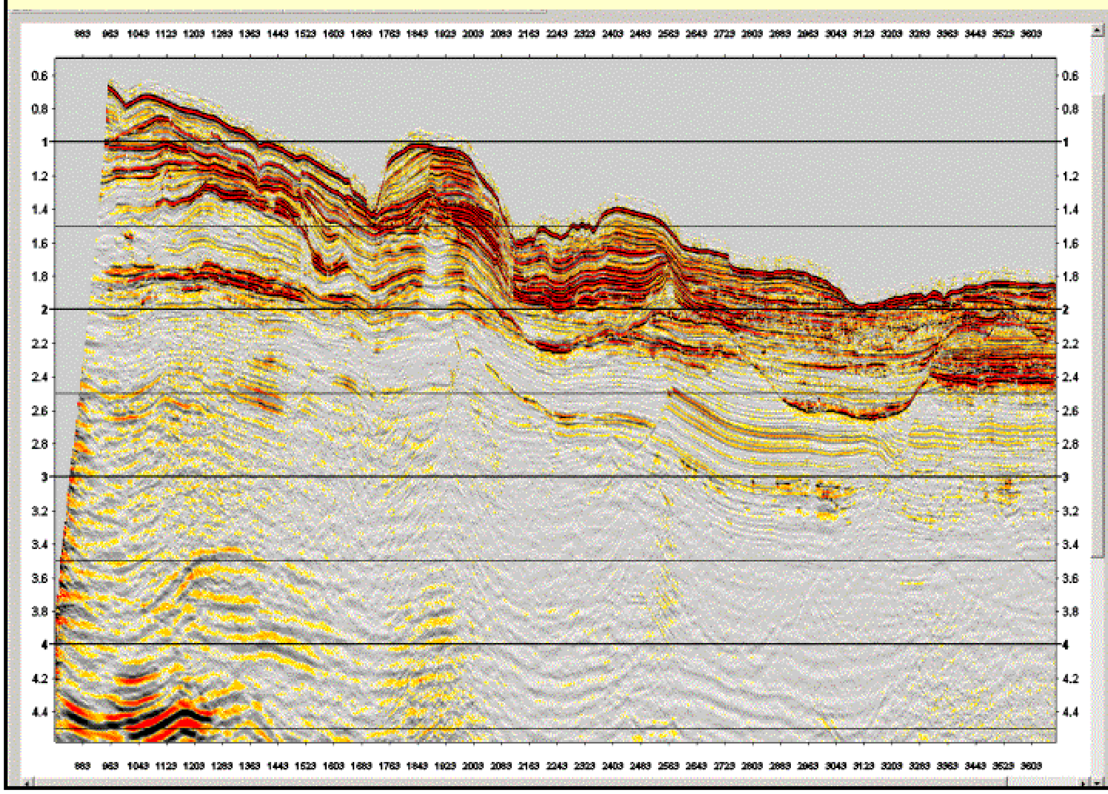
InLine 8112- JC3 Gain



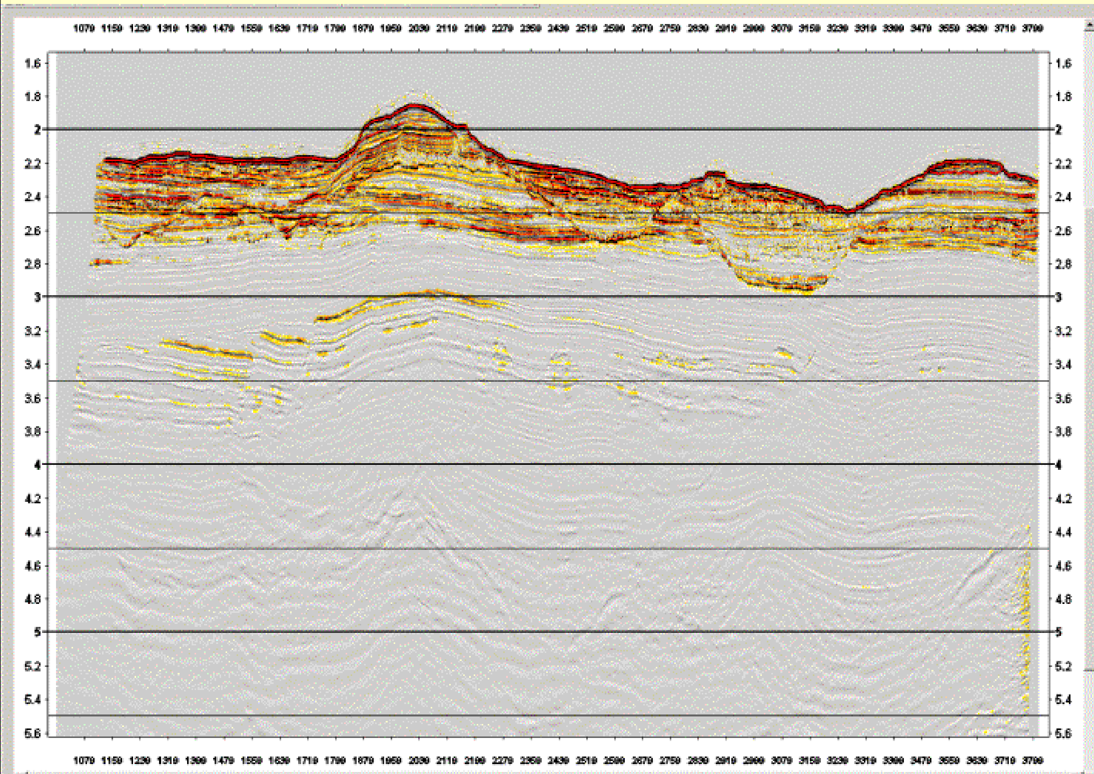
InLine 8112- JC4 Gain



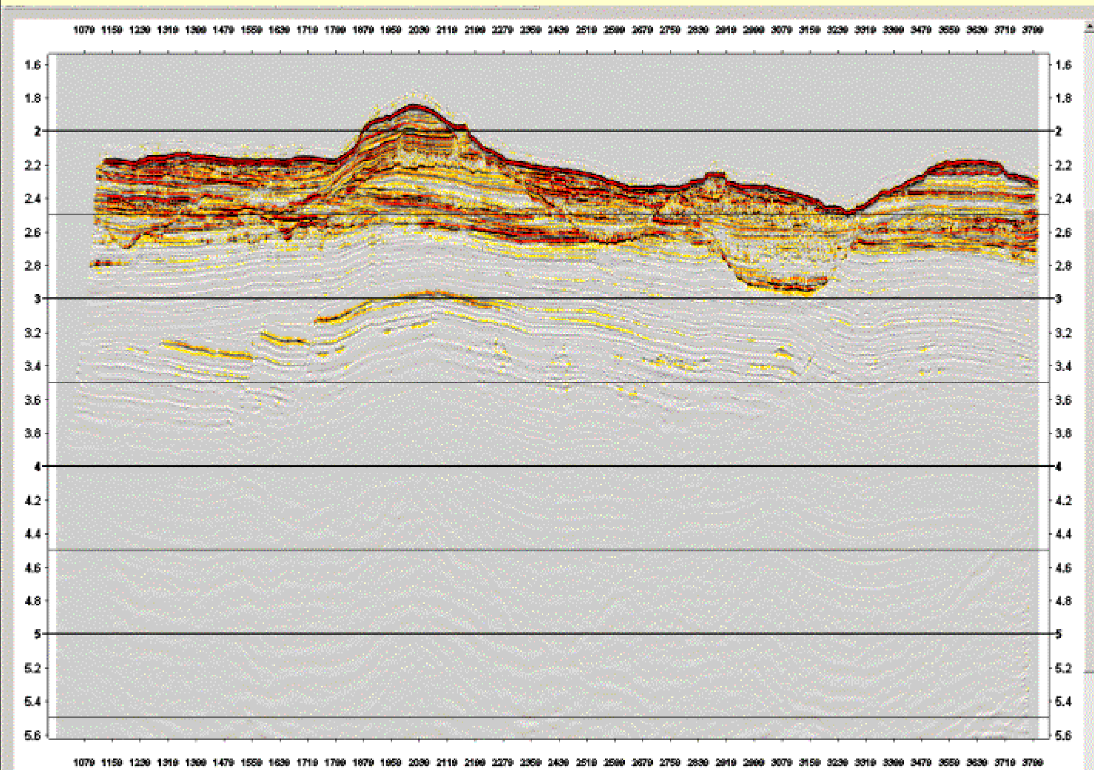
InLine 8112- JC5 Gain



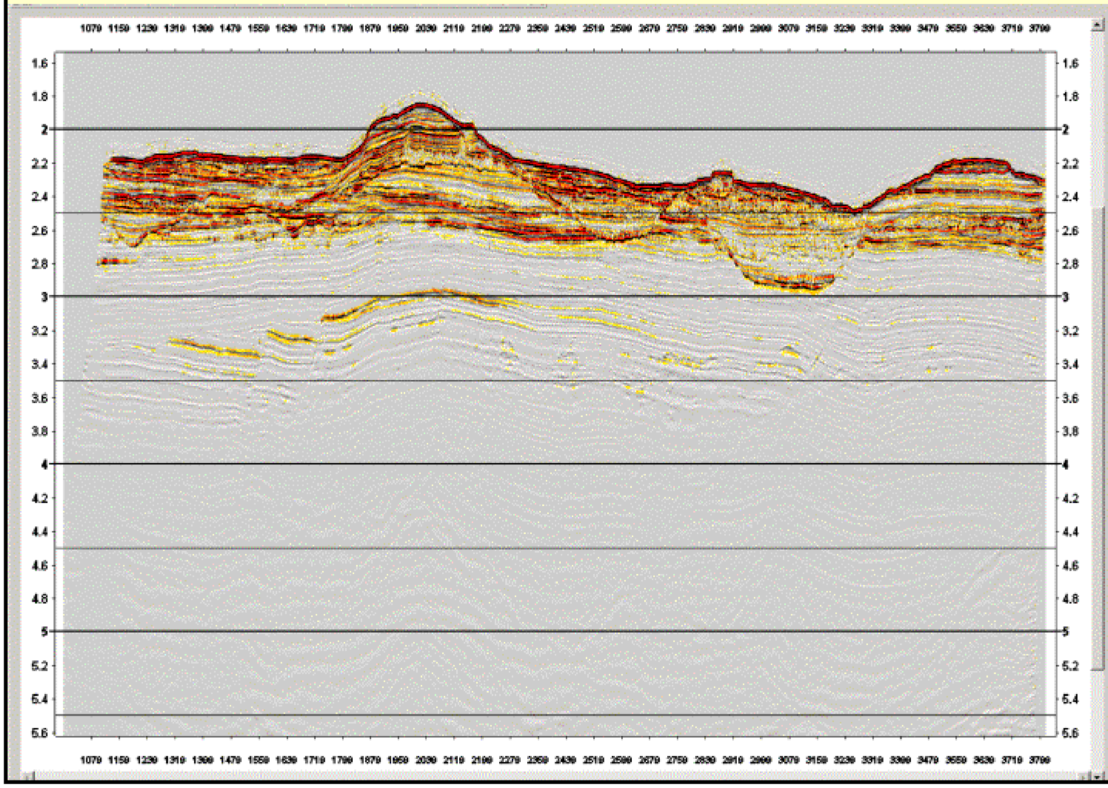
InLine 7370- VDGC Gain (Deep water case)



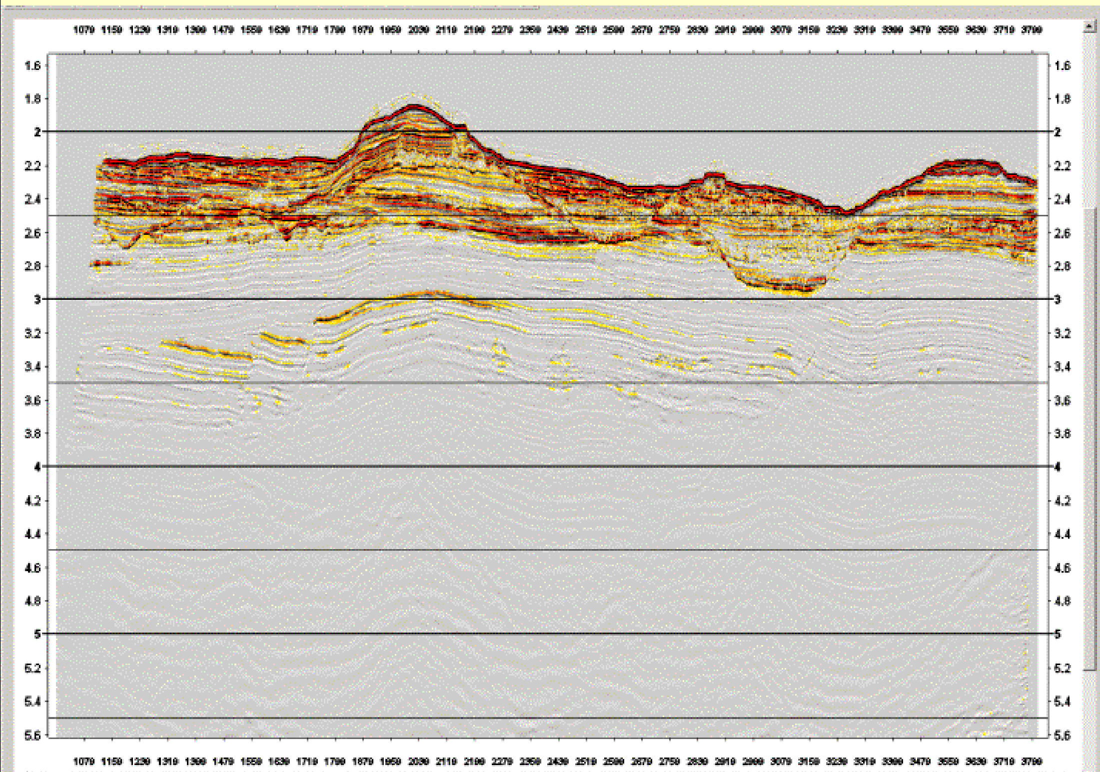
InLine 7370- JC1 Gain



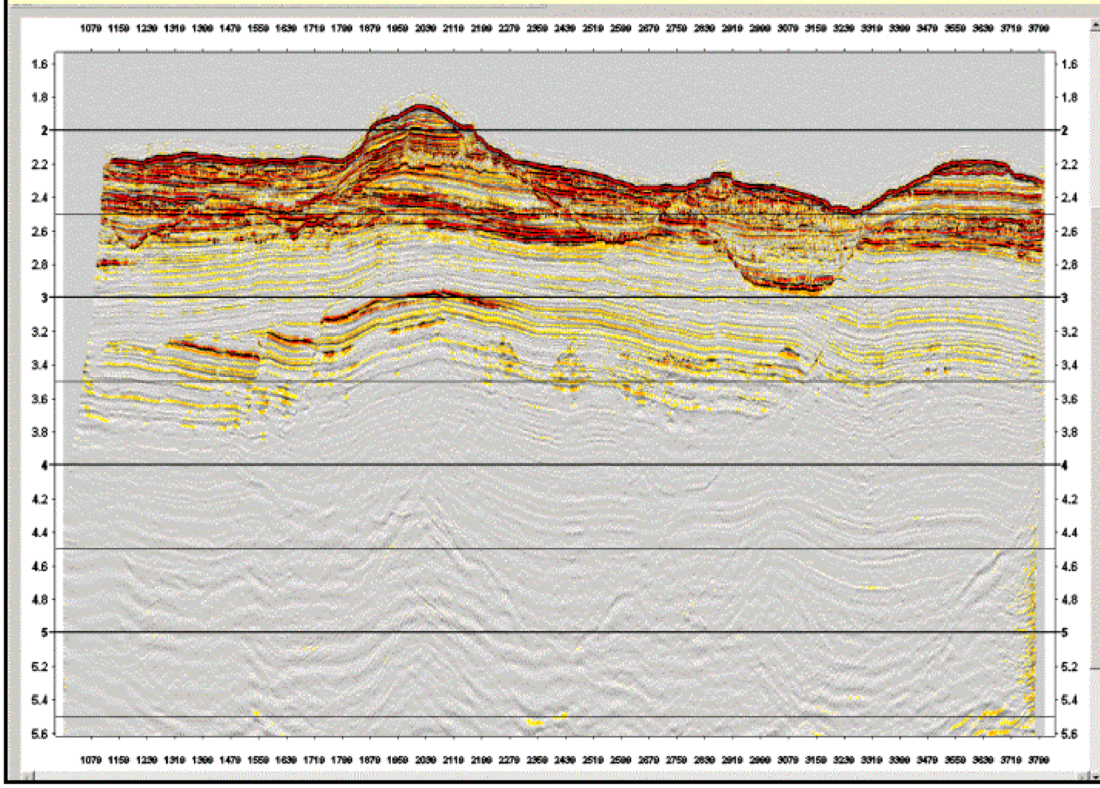
InLine 7370- JC2 Gain



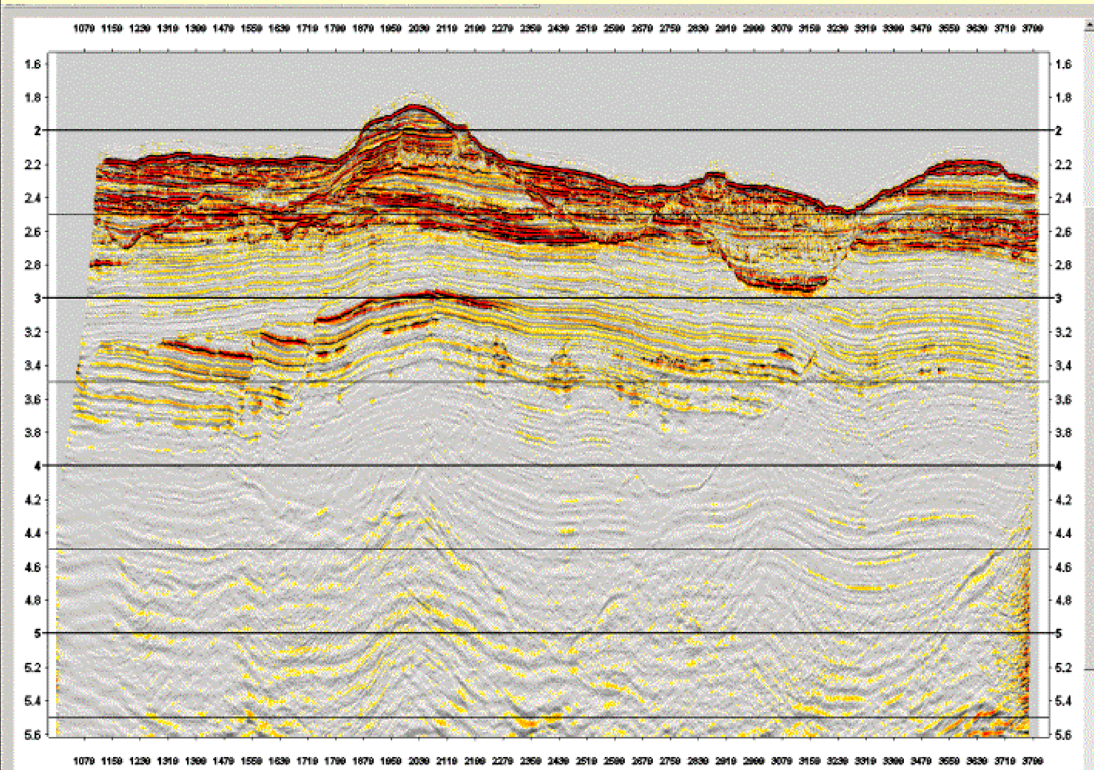
InLine 7370- JC3 Gain



InLine 7370- JC4 Gain



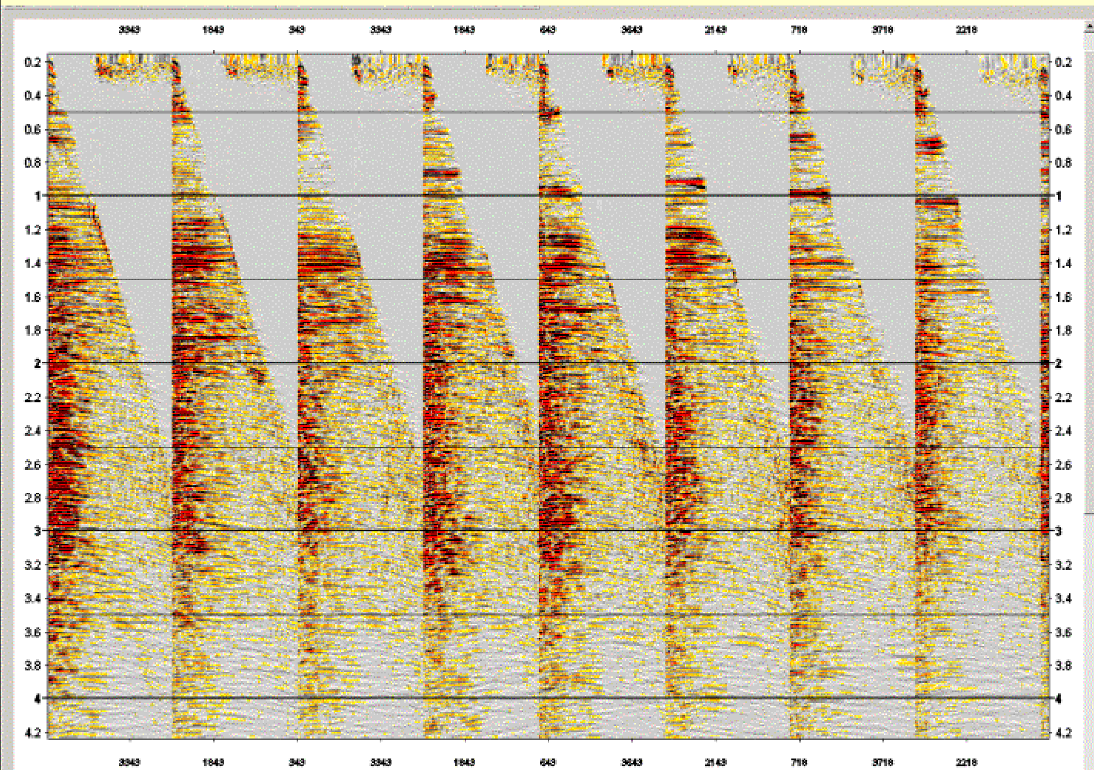
InLine 7370- JC5 Gain



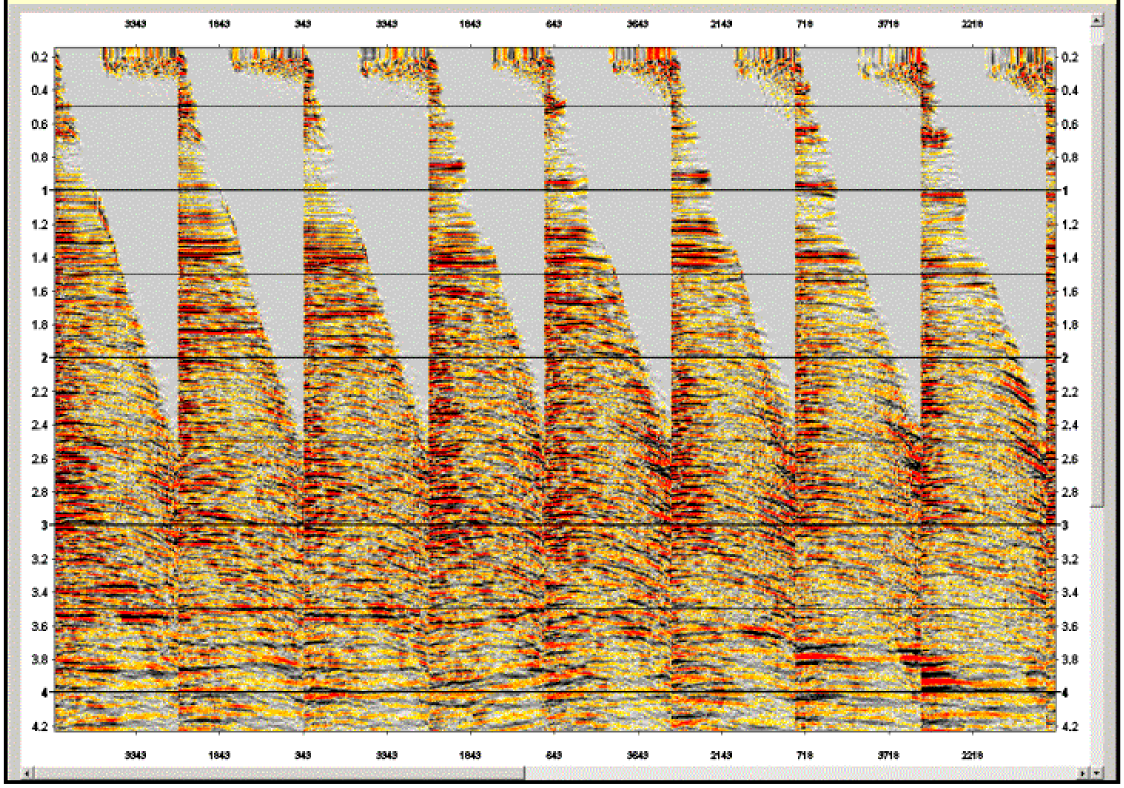
Gain Tests Review

- JC4 Gain Appears to give the best compromise of gain with time on gathers and stacks overall. It is about right in shallow and medium water depths, but a little weak in deep water.
- Recovering gain requires ampliutude scaling more than 25dB
- It appears that the changing lithologies and associated “Q” means that no single gain function can approximate “true” amplitude recovery. We can scale the data post-stack with a water depth related function.

InLine 8712- Q=135 Gain (30dB Max gain)

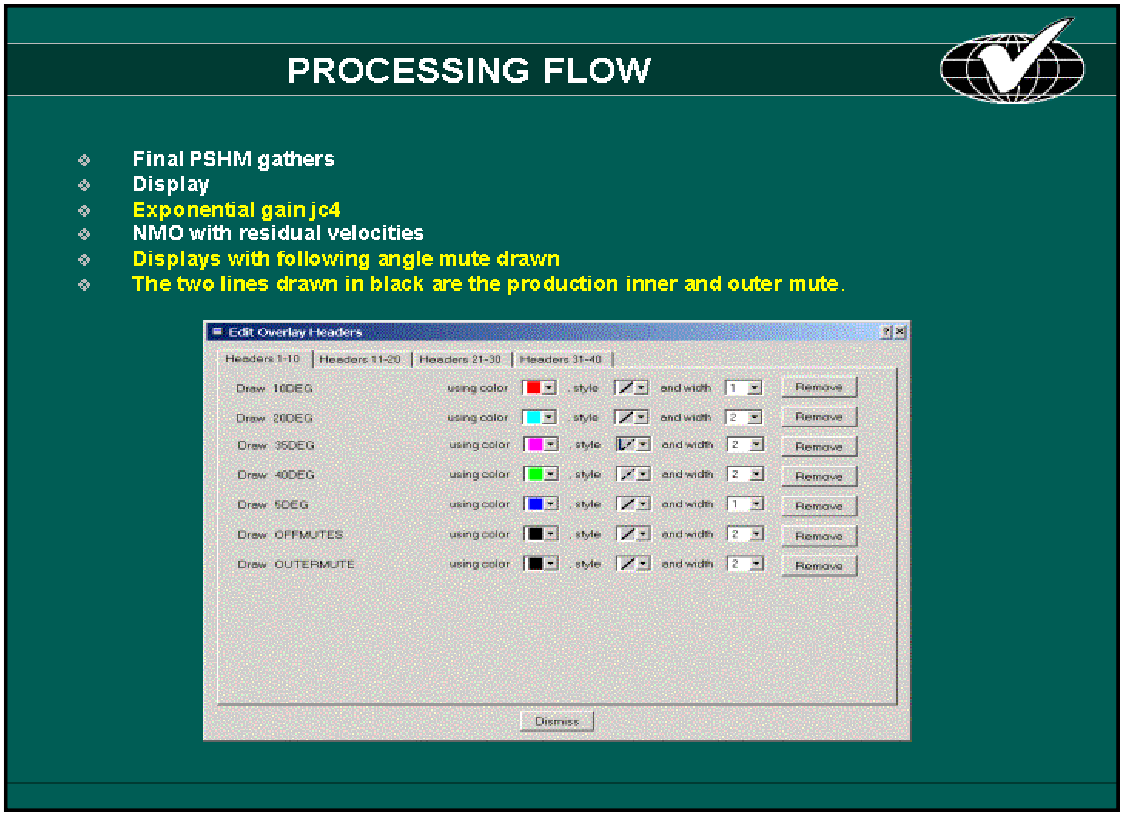


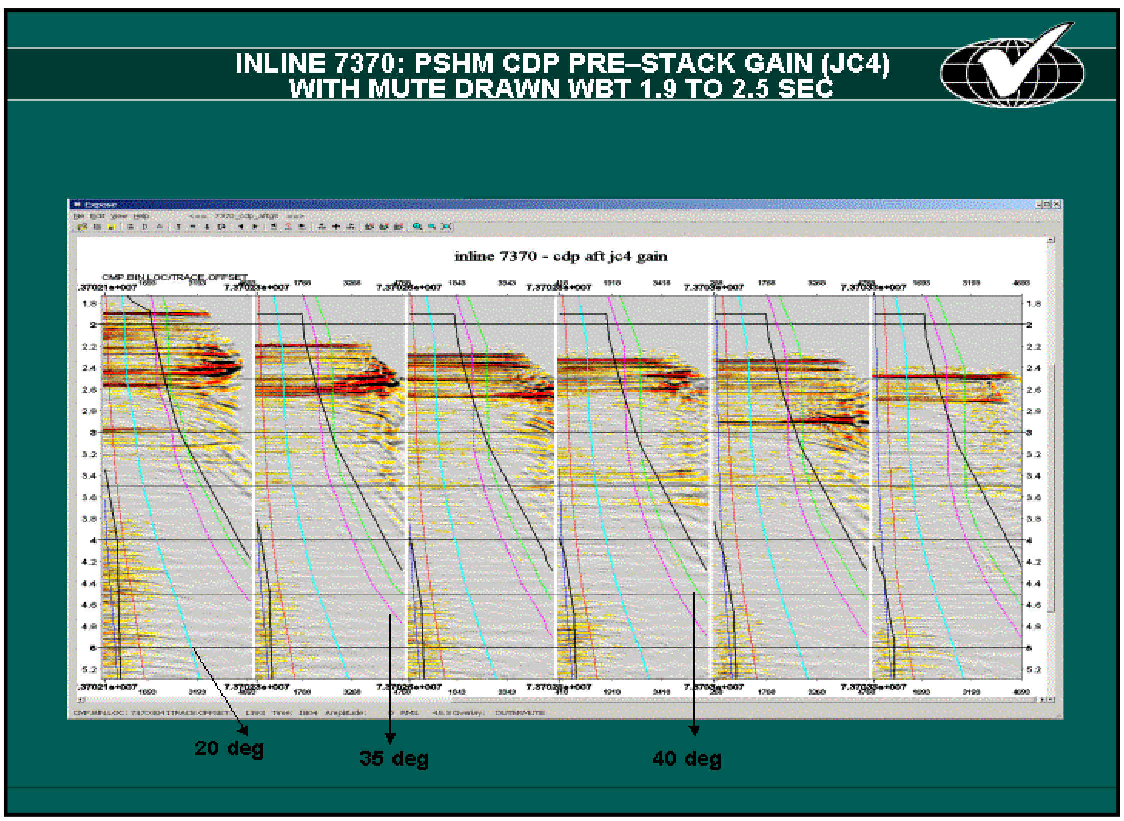
InLine 8712- JC4 Gain

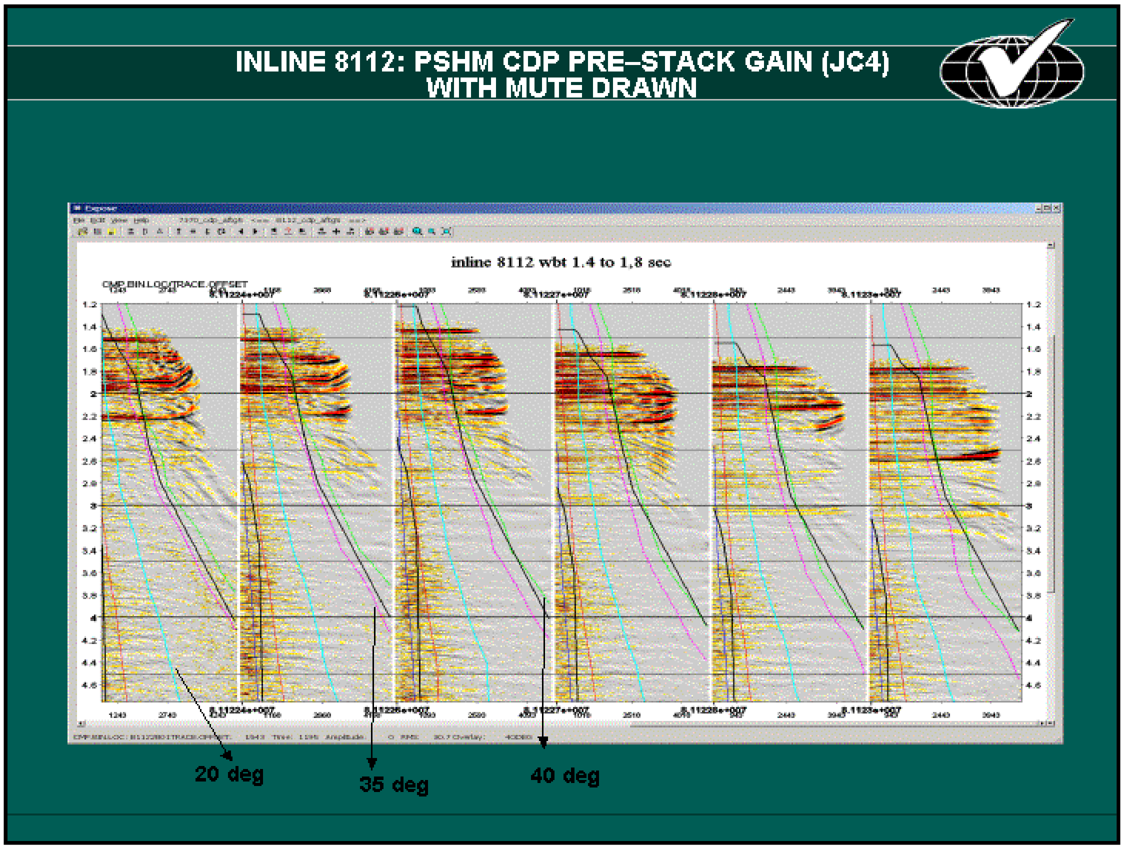


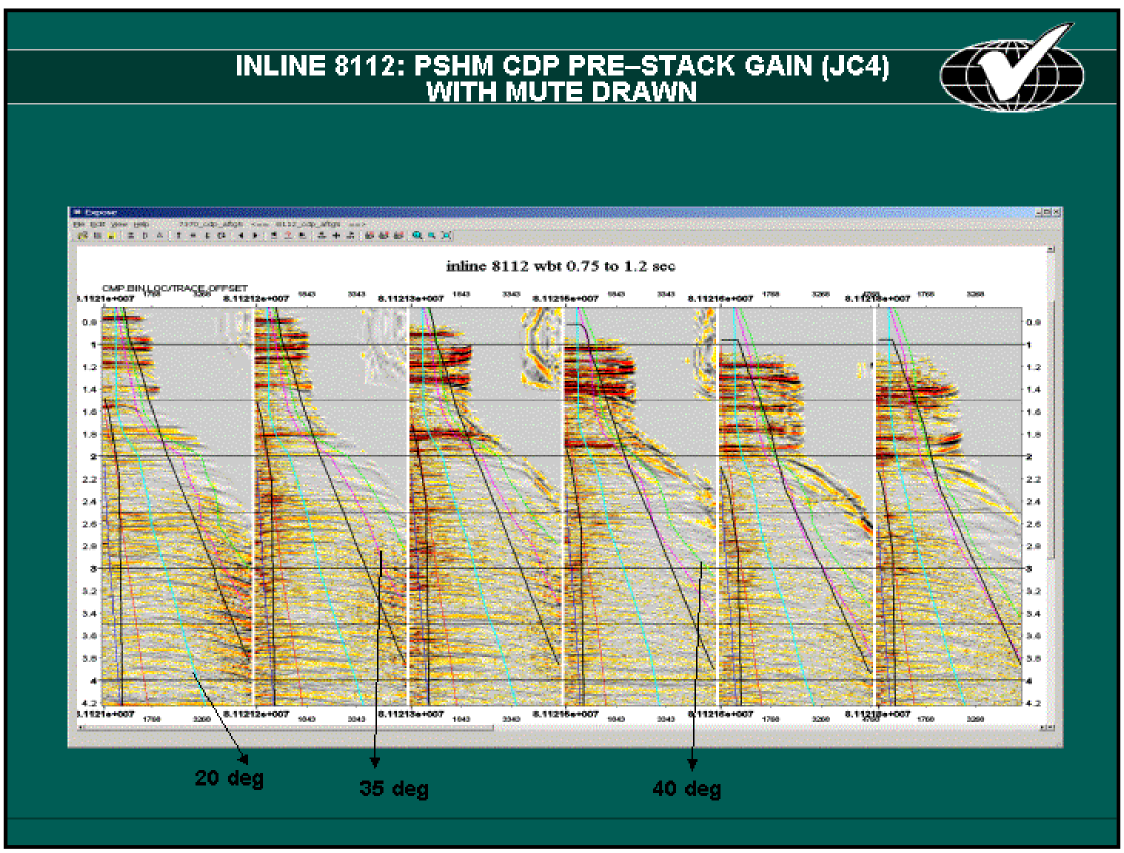
6.3 FINAL MUTE TESTS

Inline 8712, 8112 and 7370: Review of Angle Mute drawn on CDPs with JC4 gain

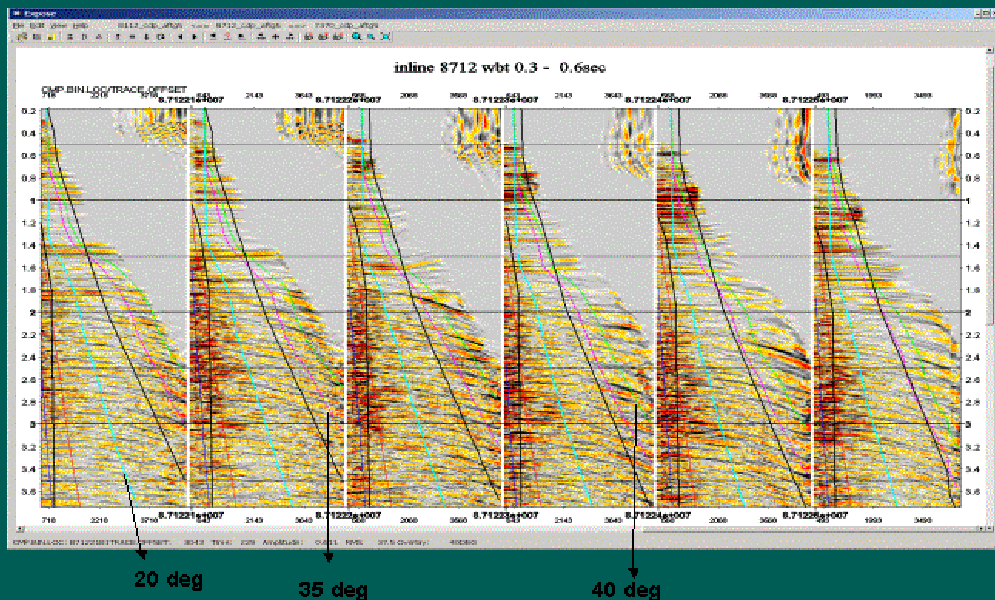




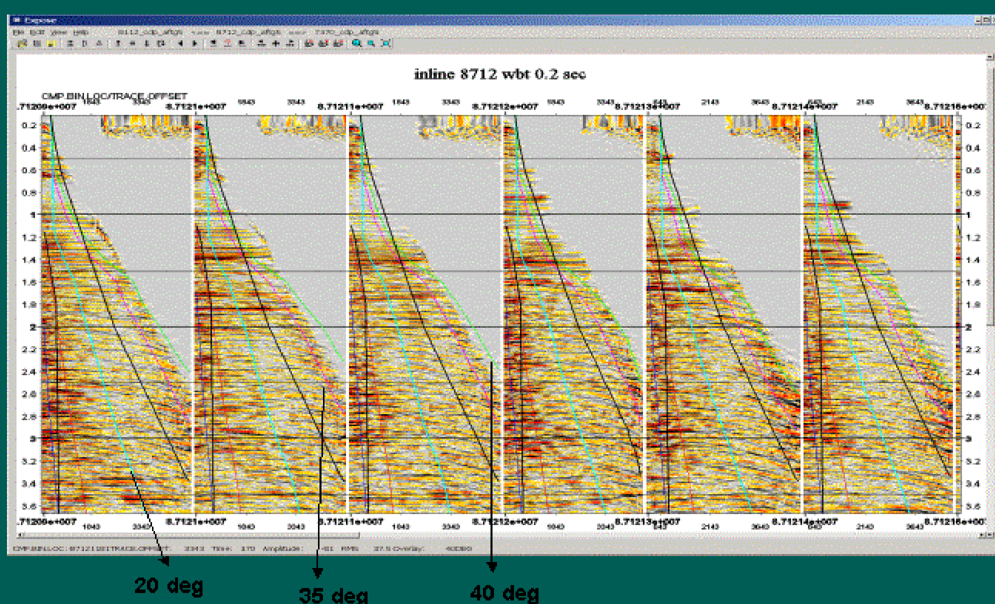

INLINE 8112: PSHM CDP PRE–STACK GAIN (JC4)
WITH MUTE DRAWN
inline 8112 wbt 1.4 to 1.8 sec
CMP.BIN.LOC/TRACE.OFFSET
20 deg
35 deg
40 deg


INLINE 8112: PSHM CDP PRE–STACK GAIN (JC4)
WITH MUTE DRAWN
inline 8112 wbt 0.75 to 1.2 sec
CMP.BIN.LOC/TRACE.OFFSET
20 deg
35 deg
40 deg

INLINE 8712: PSHM CDP PRE–STACK GAIN (JC4) WITH MUTE DRAWN



INLINE 8712: PSHM CDP PRE–STACK GAIN (JC4) WITH MUTE DRAWN

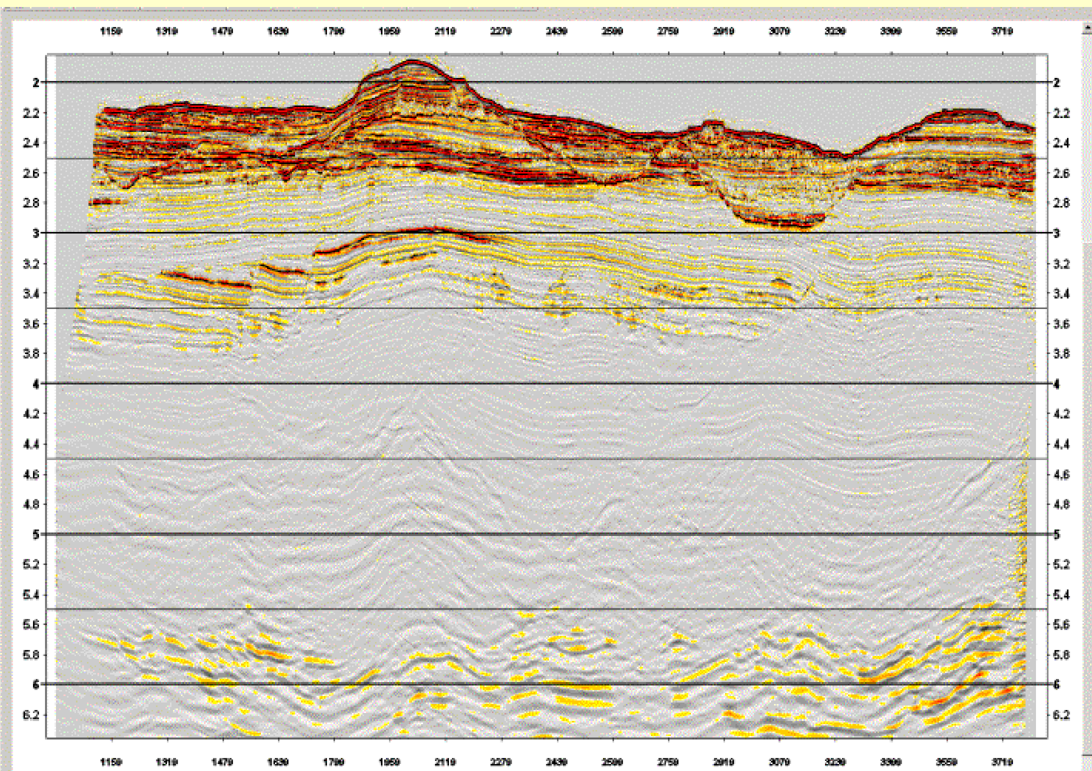


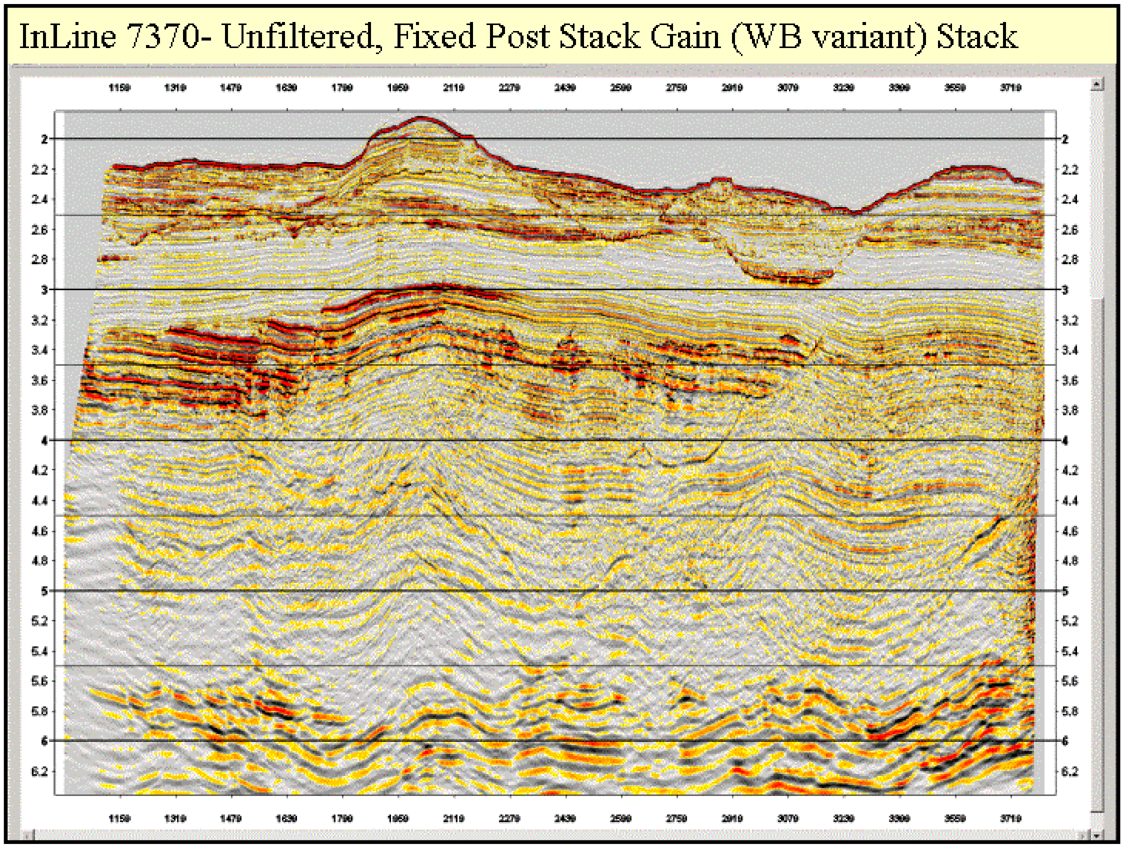
6.4 POST STACK GAIN TESTS

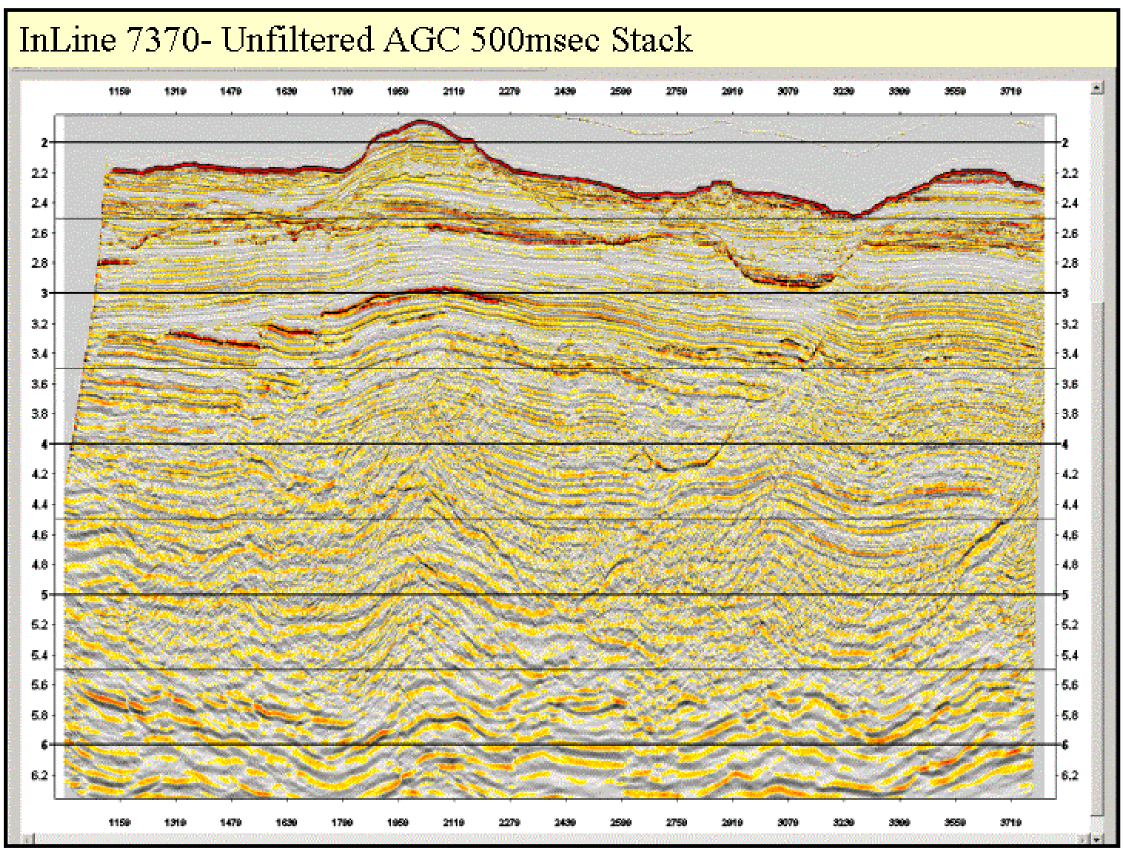
Post Stack Gain Tests

- A series of Post Stack Scaling Options were tested to demonstrate the affects of different scaling options.
- All data is based on the data as scaled pre-stack with scaling "JC4" the best approximation of "true" gain without applying Q based compensation.
- Pre-Stack AGC was also tested, as this showed some Signal to Noise Ratio improvements on the 2D, as well as a reasonable overall scaling.

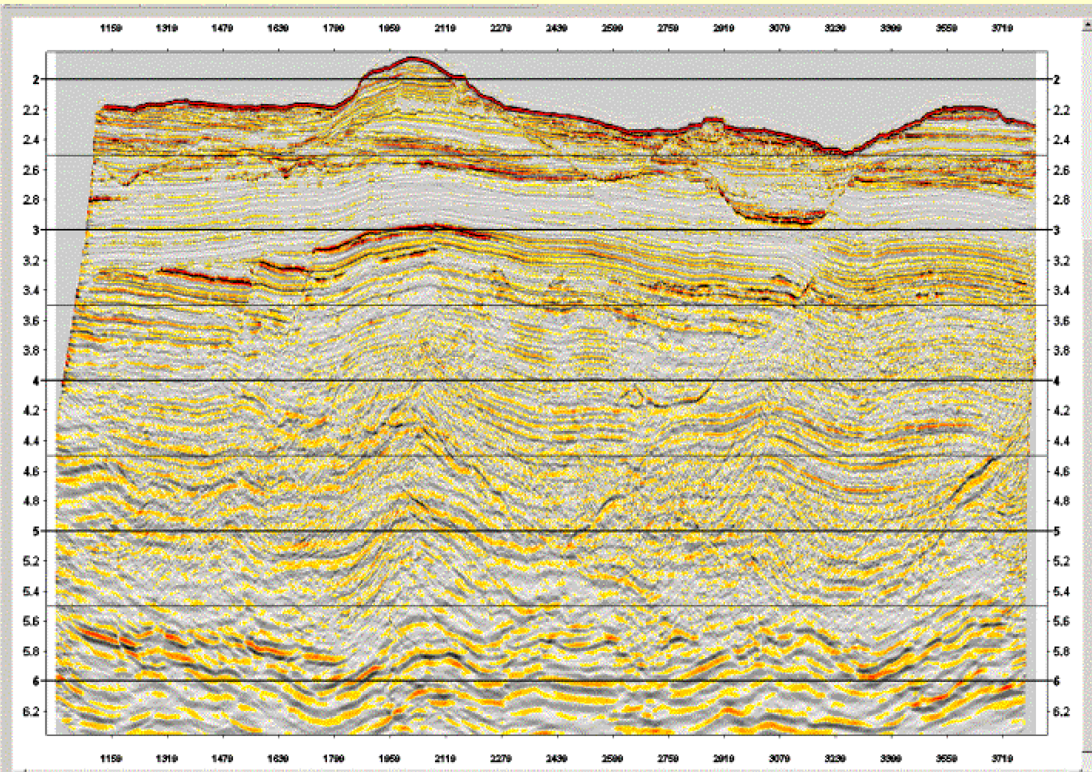
InLine 7370- Unfiltered Unscaled Stack



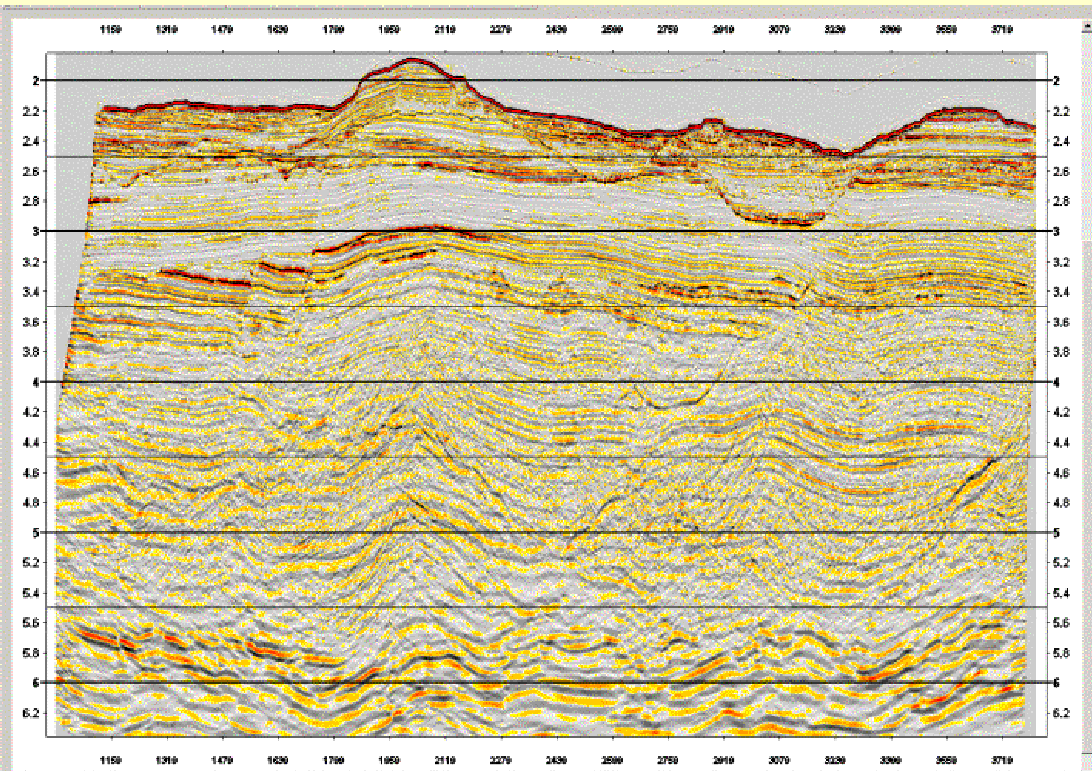

InLine 7370- Unfiltered, Fixed Post Stack Gain (WB variant) Stack


InLine 7370- Unfiltered AGC 500msec Stack

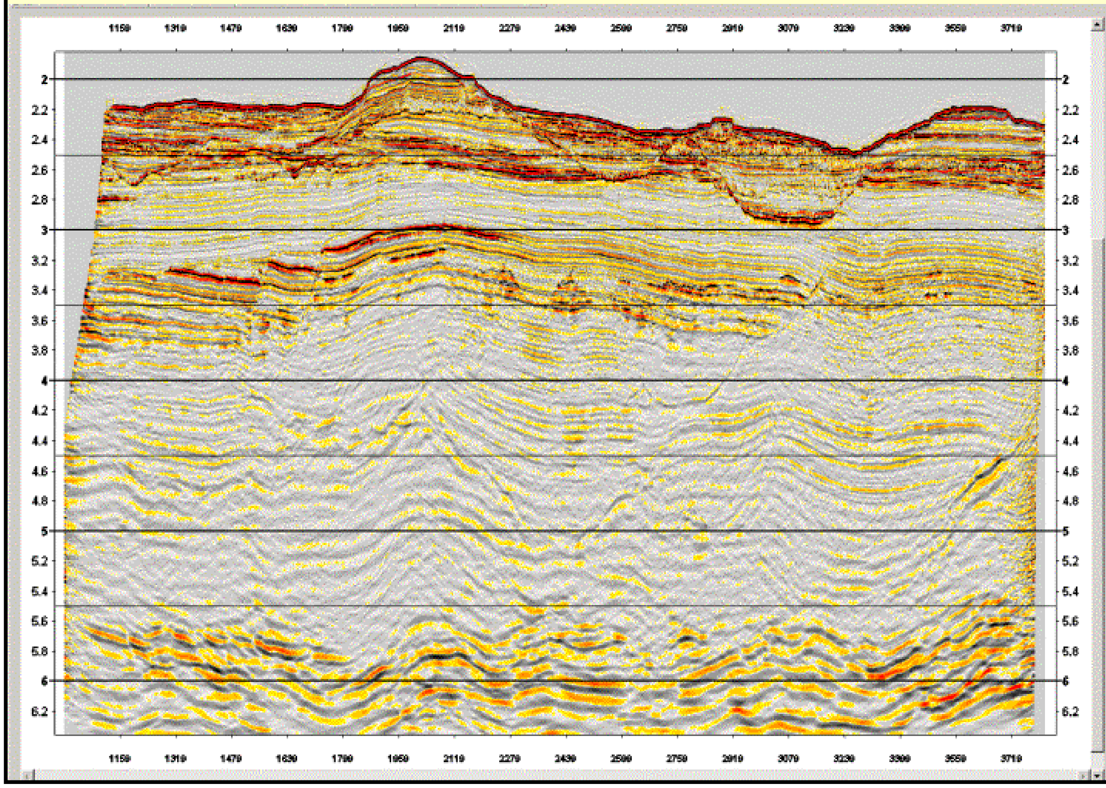
InLine 7370- Unfiltered AGC 800msec Stack



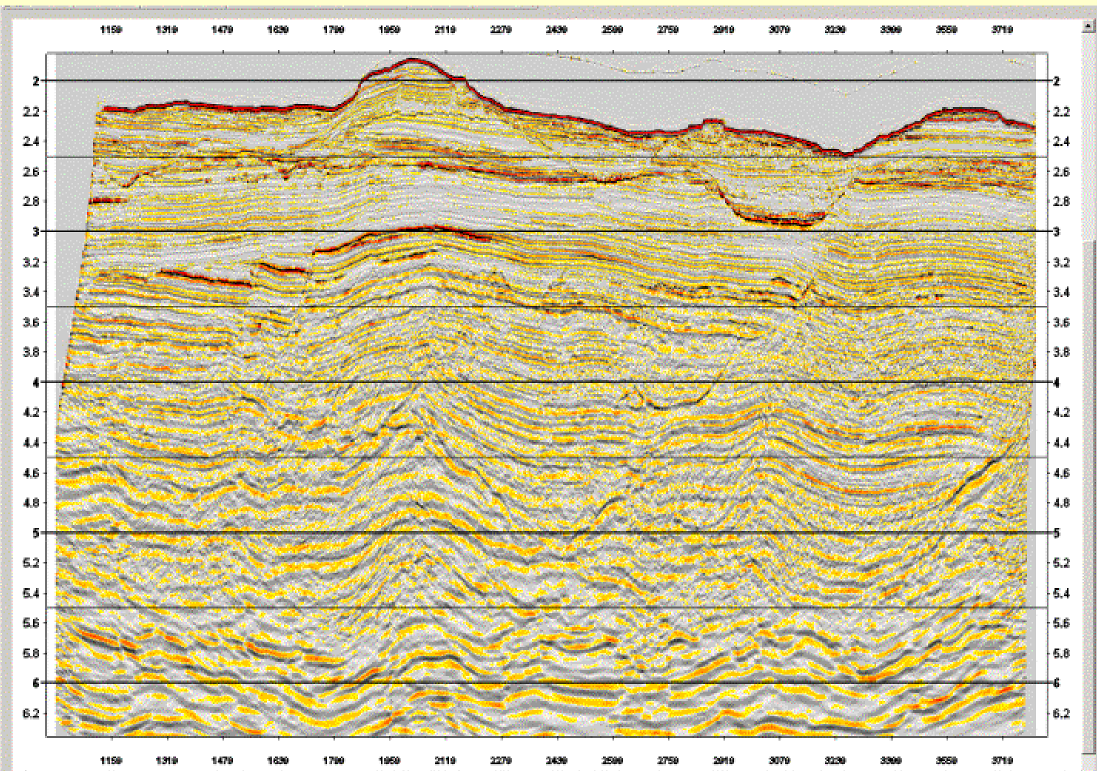
InLine 7370- Unfiltered Robust AGC 800msec Stack



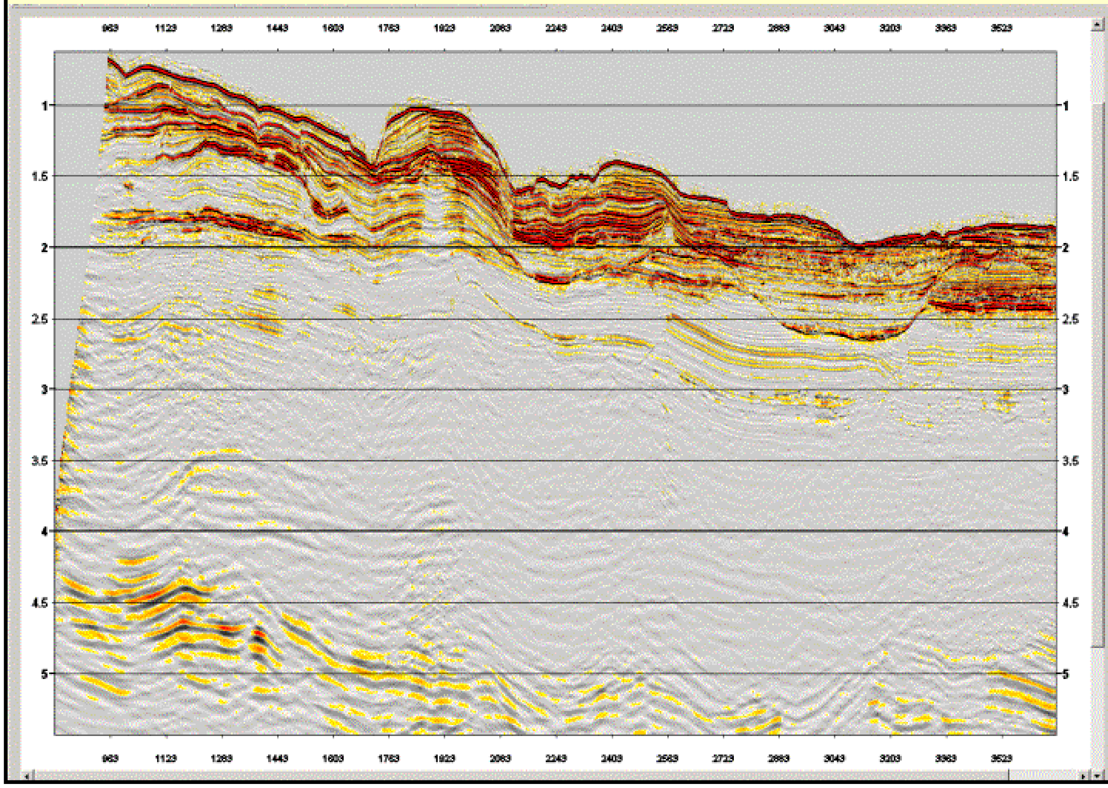
InLine 7370- Unfiltered AGC 1000msec Pre- Stack



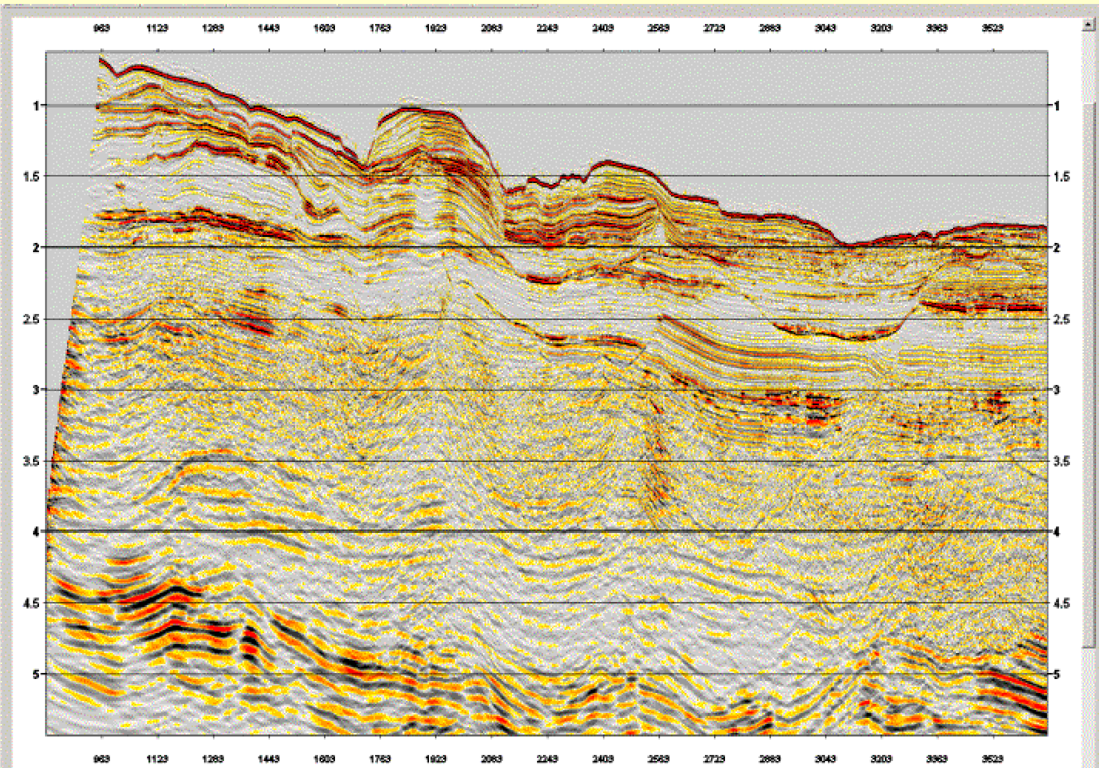
InLine 7370- Unfiltered AGC 1000msec Pre- & AGC 500msec Post- Stack



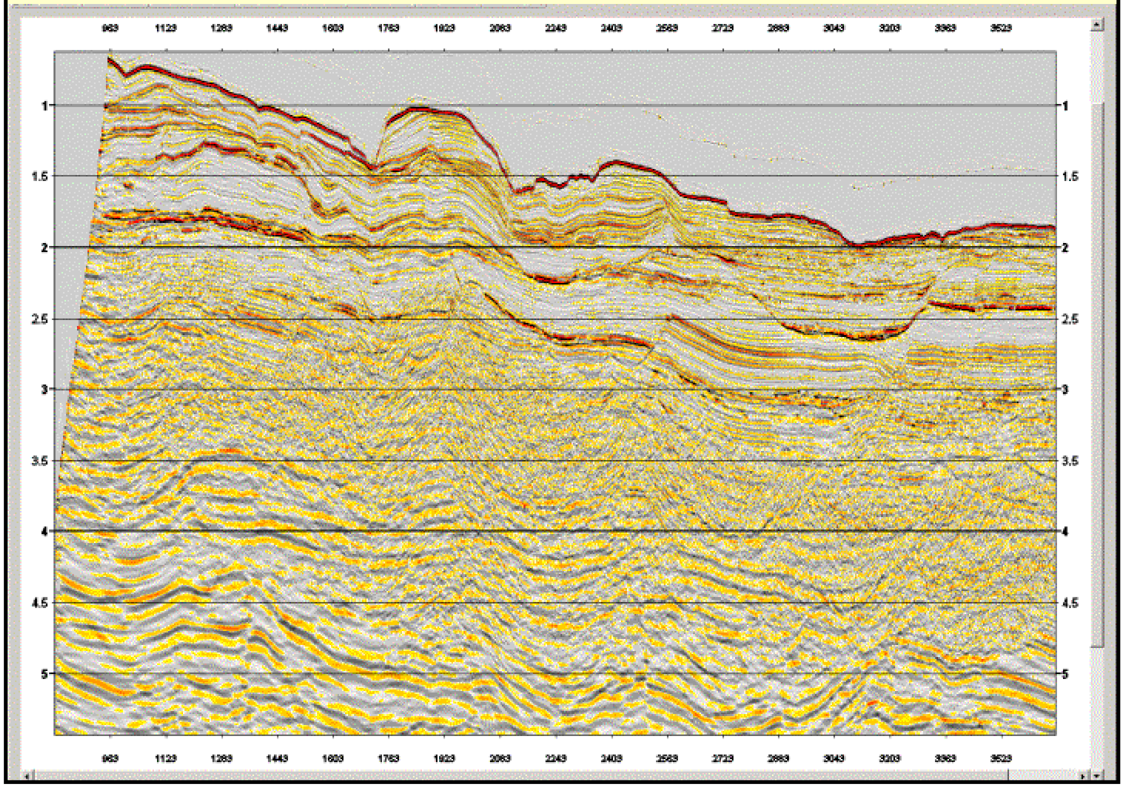
InLine 8112- Unfiltered Unscaled Stack



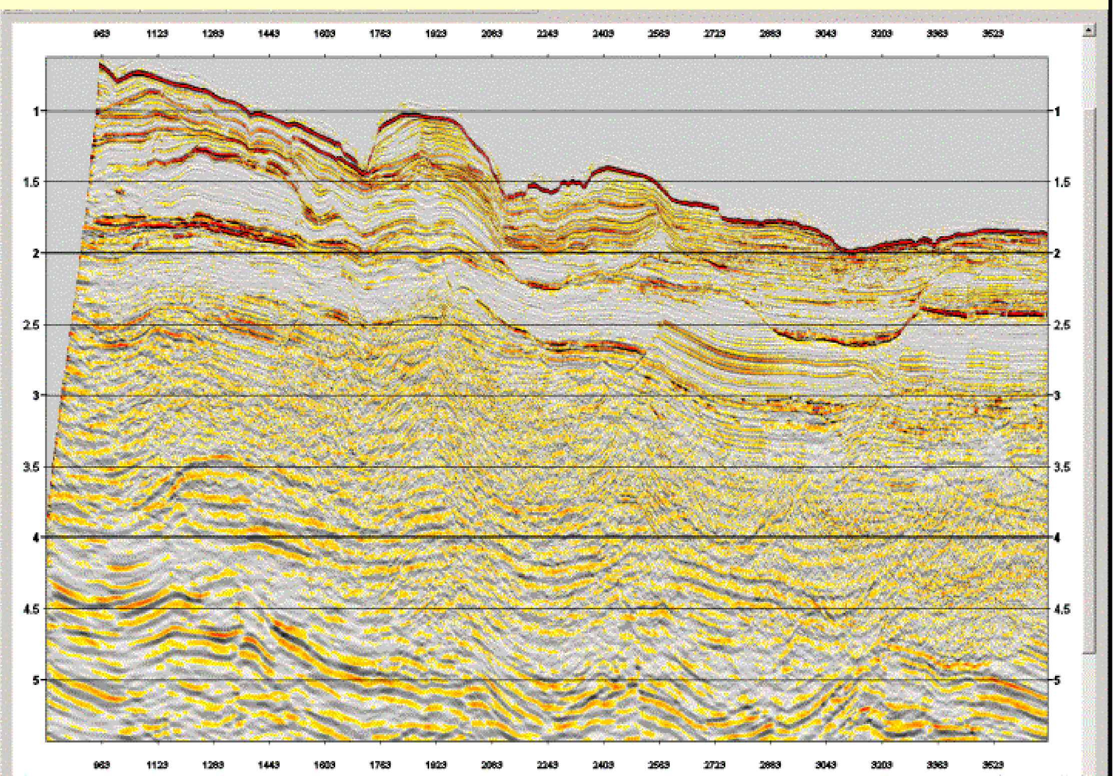
InLine 8112- Unfiltered, Fixed Post Stack Gain (WB variant) Stack



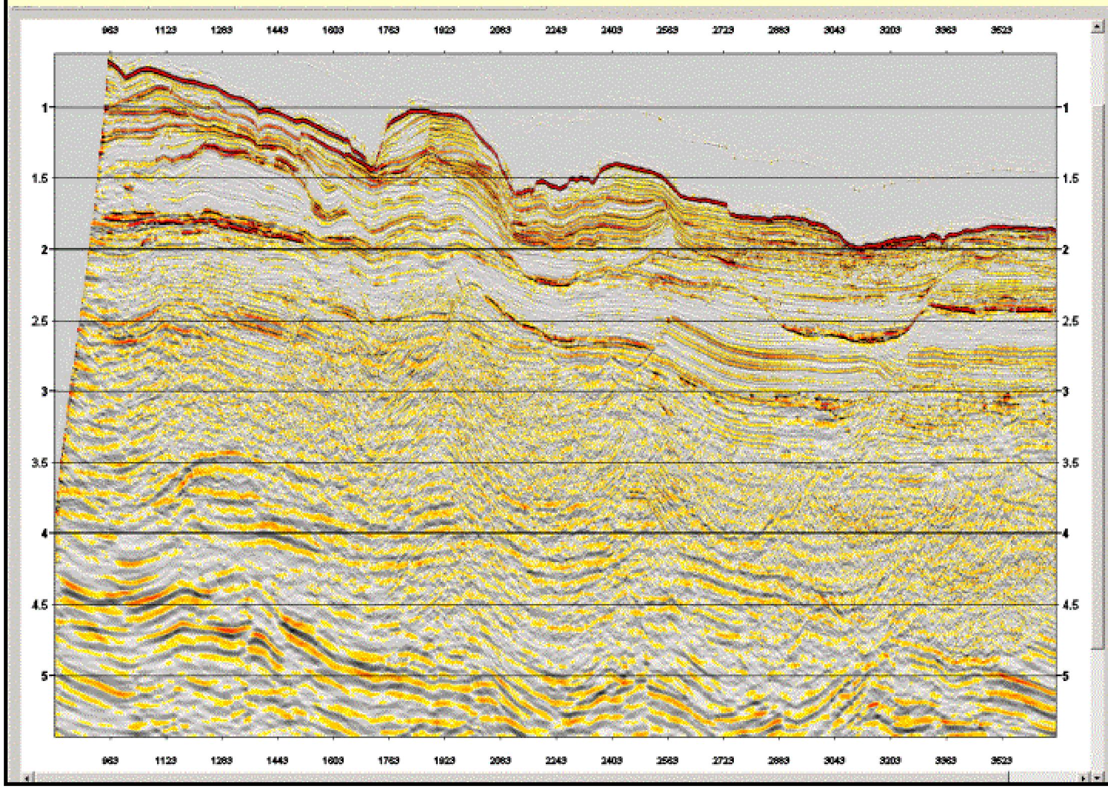
InLine 8112- Unfiltered AGC 500msec Stack



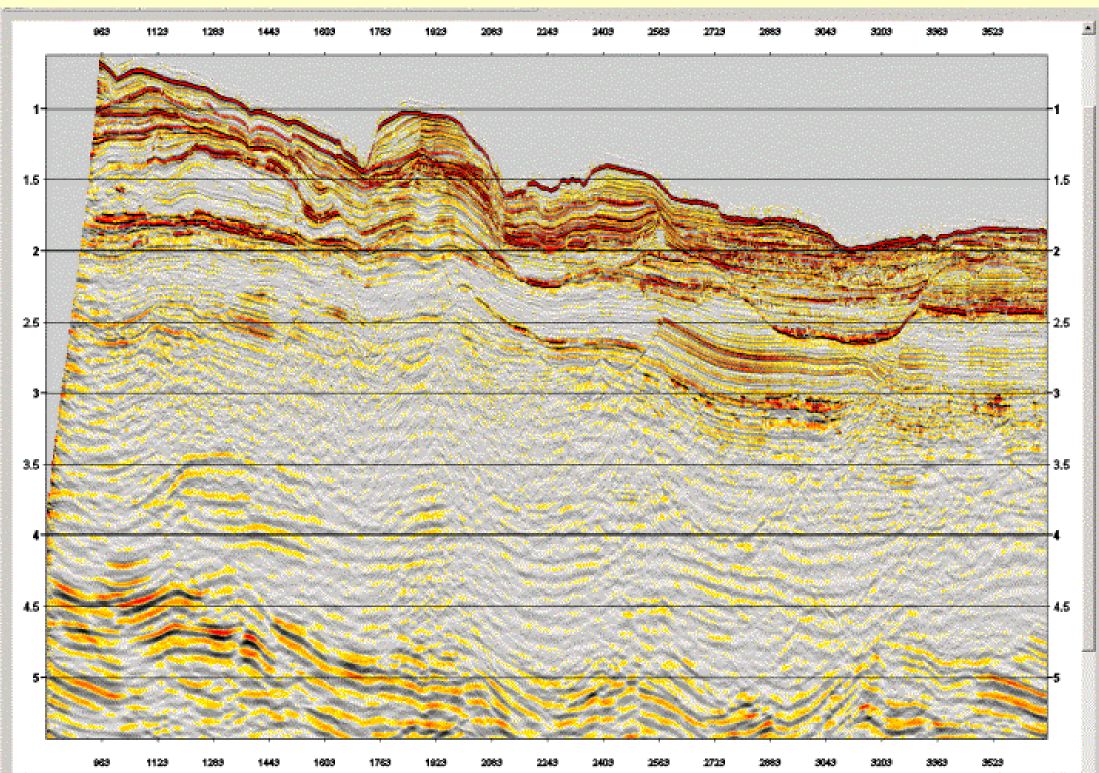
InLine 8112- Unfiltered AGC 800msec Stack



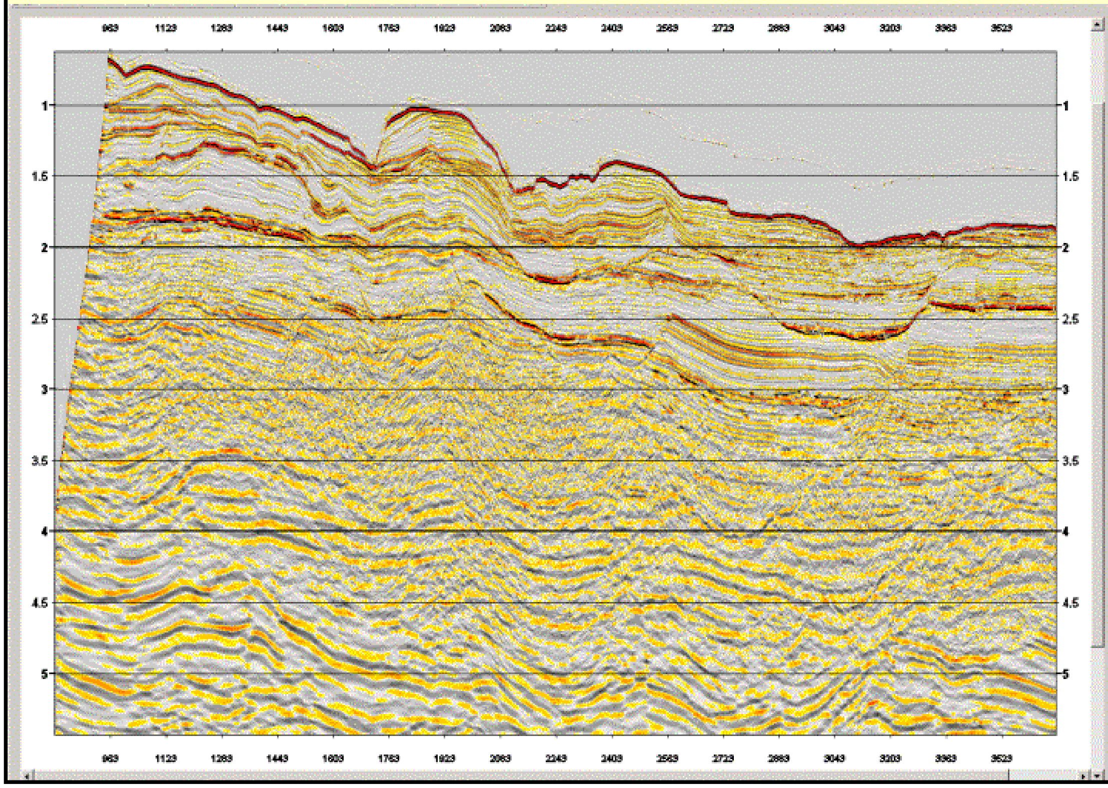
InLine 8112- Unfiltered Robust AGC 800msec Stack



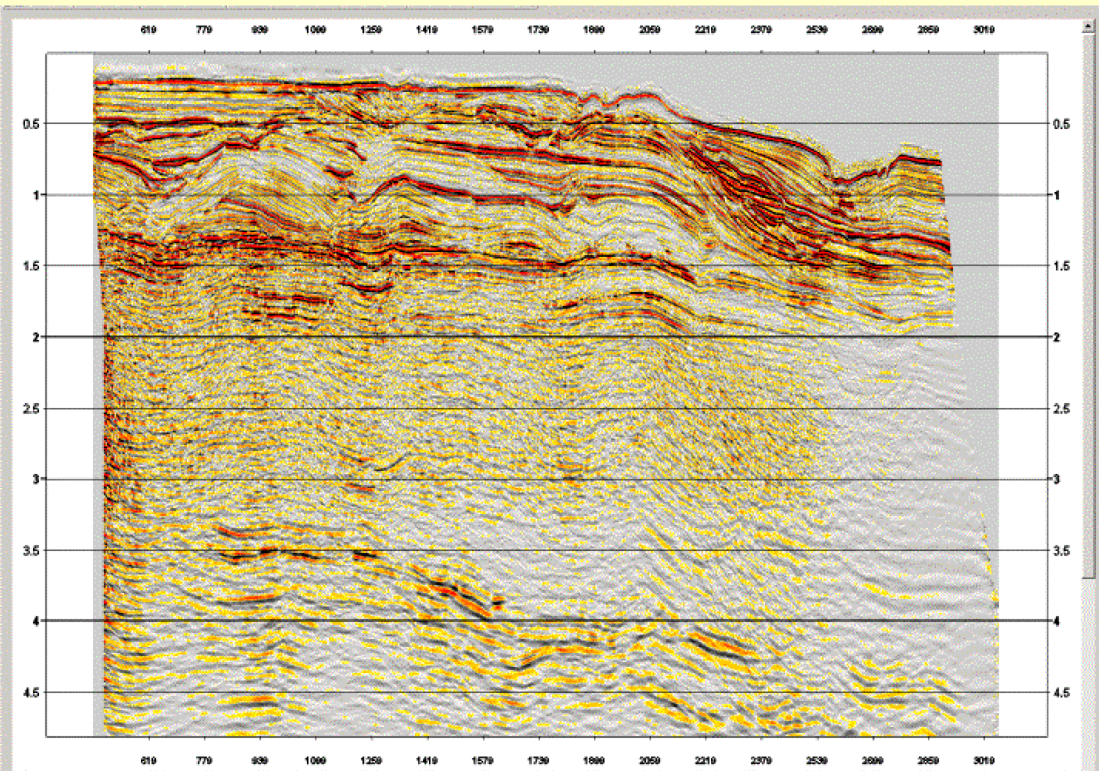
InLine 8112- Unfiltered AGC 1000msec Pre- Stack



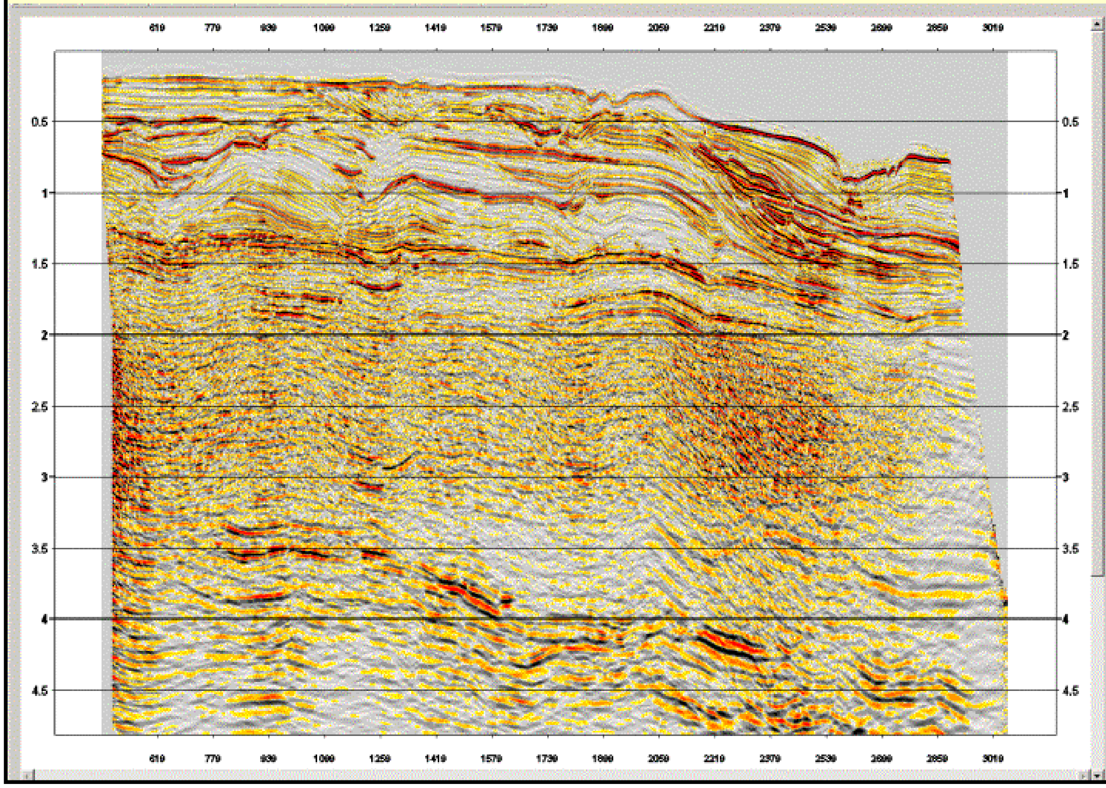
InLine 8112- Unfiltered AGC 1000msec Pre- & AGC 500msec Post- Stack



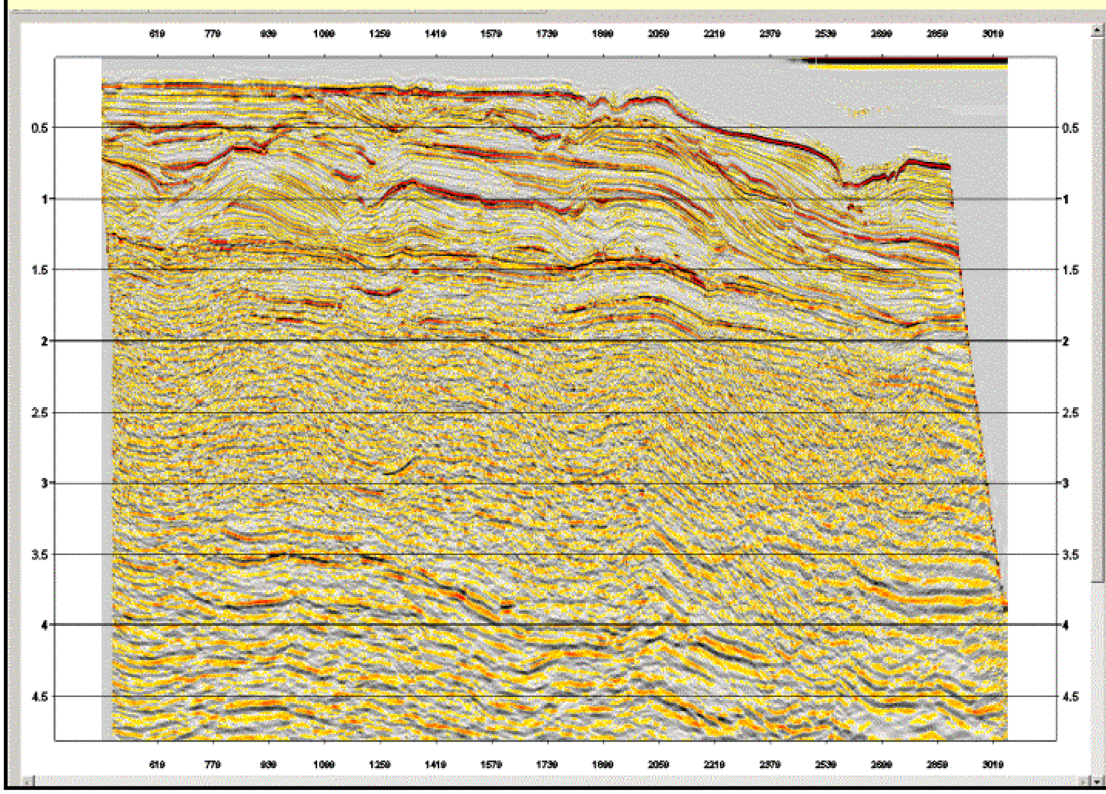
InLine 8712- Unfiltered Unscaled Stack



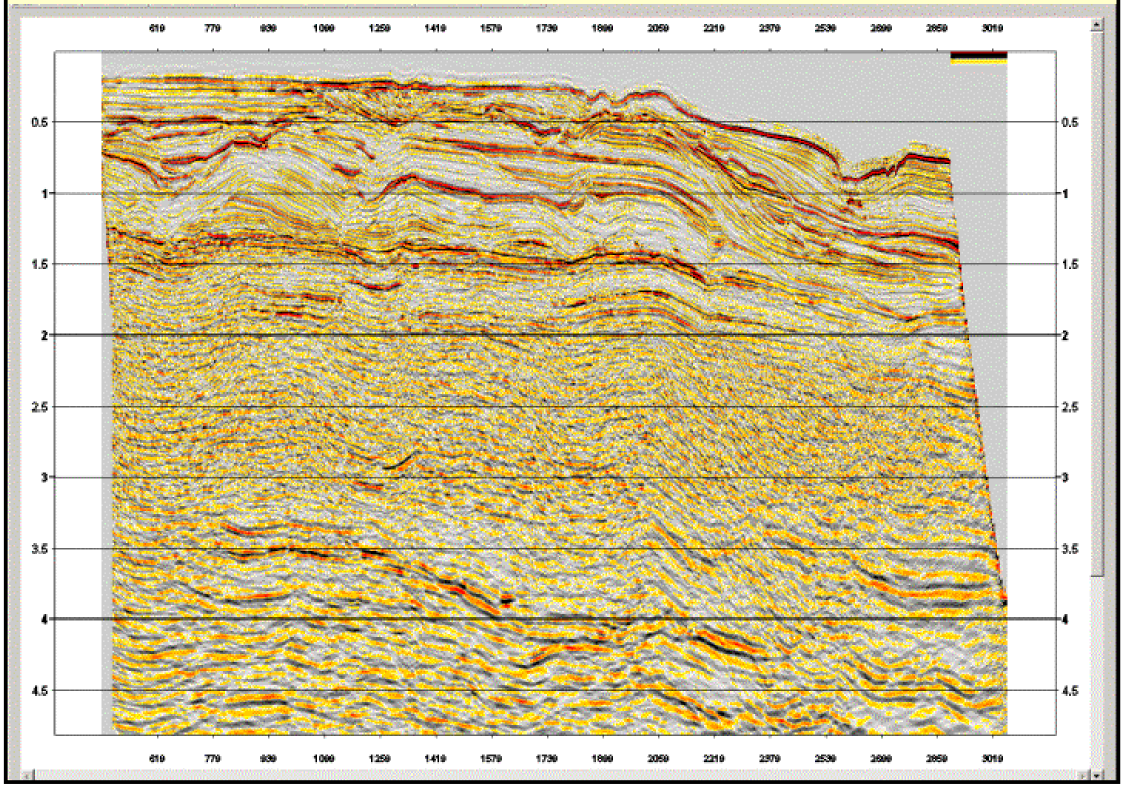
InLine 8712- Unfiltered, Fixed Post Stack Gain (WB variant) Stack



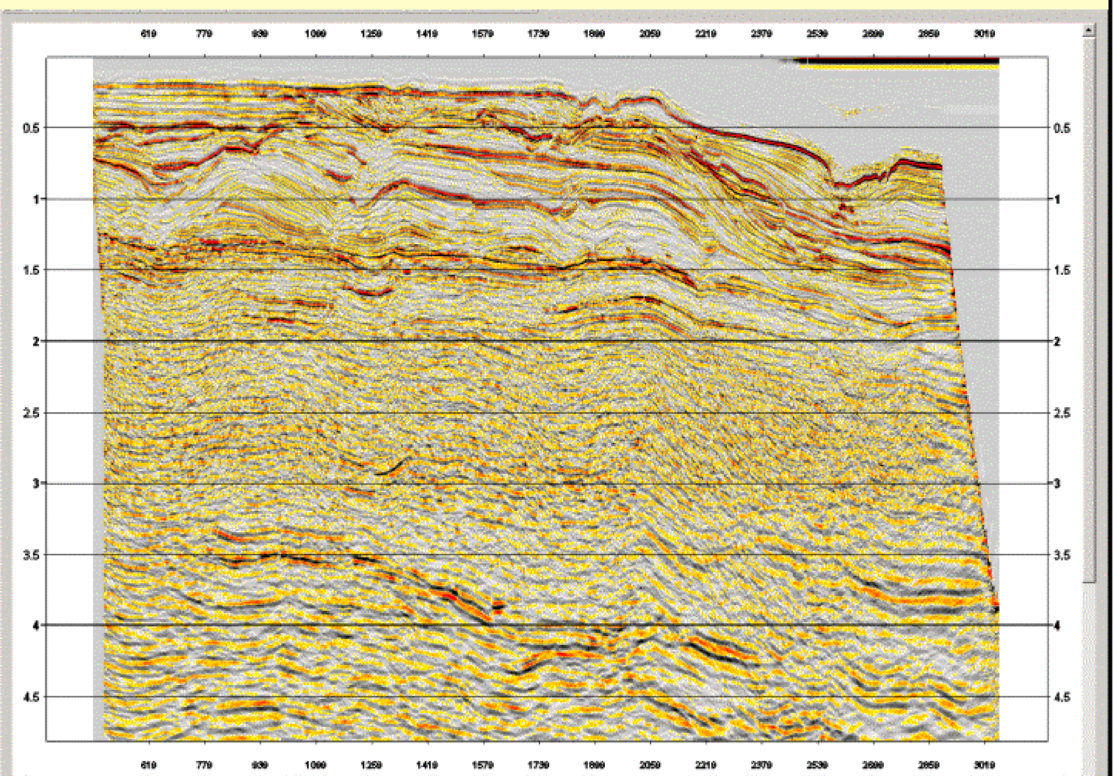
InLine 8712- Unfiltered AGC 500msec Stack



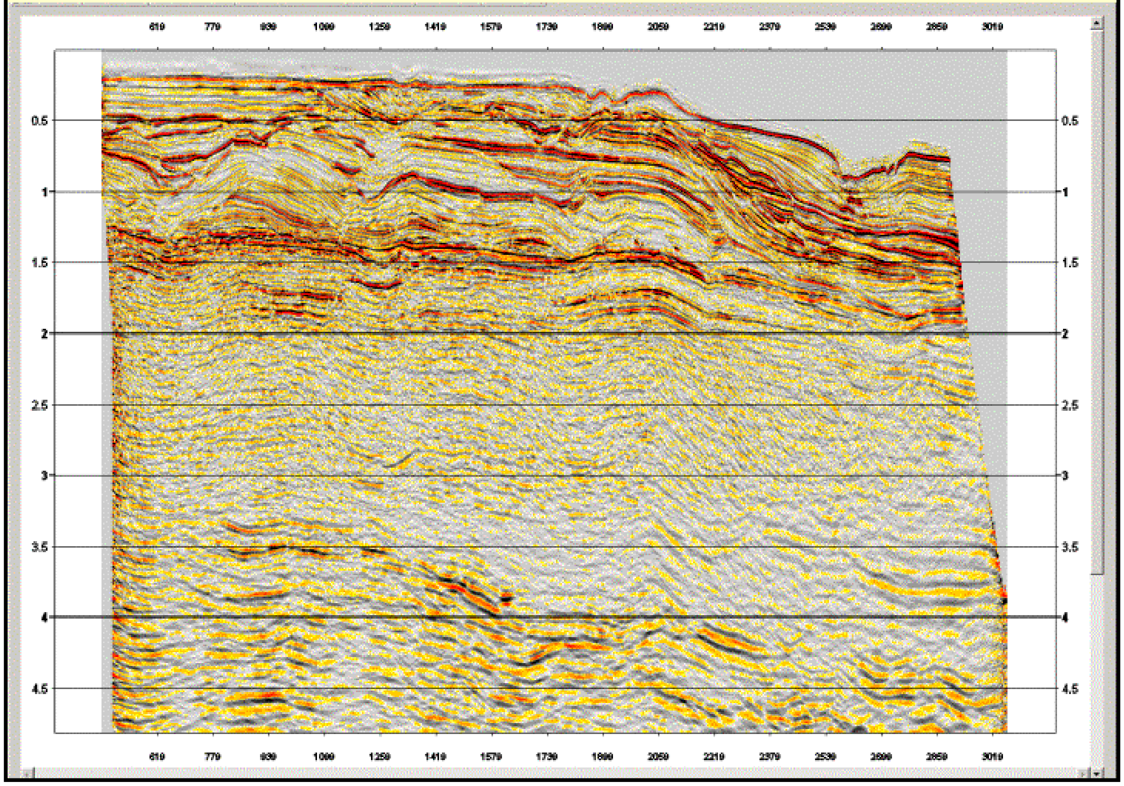
InLine 8712- Unfiltered AGC 800msec Stack



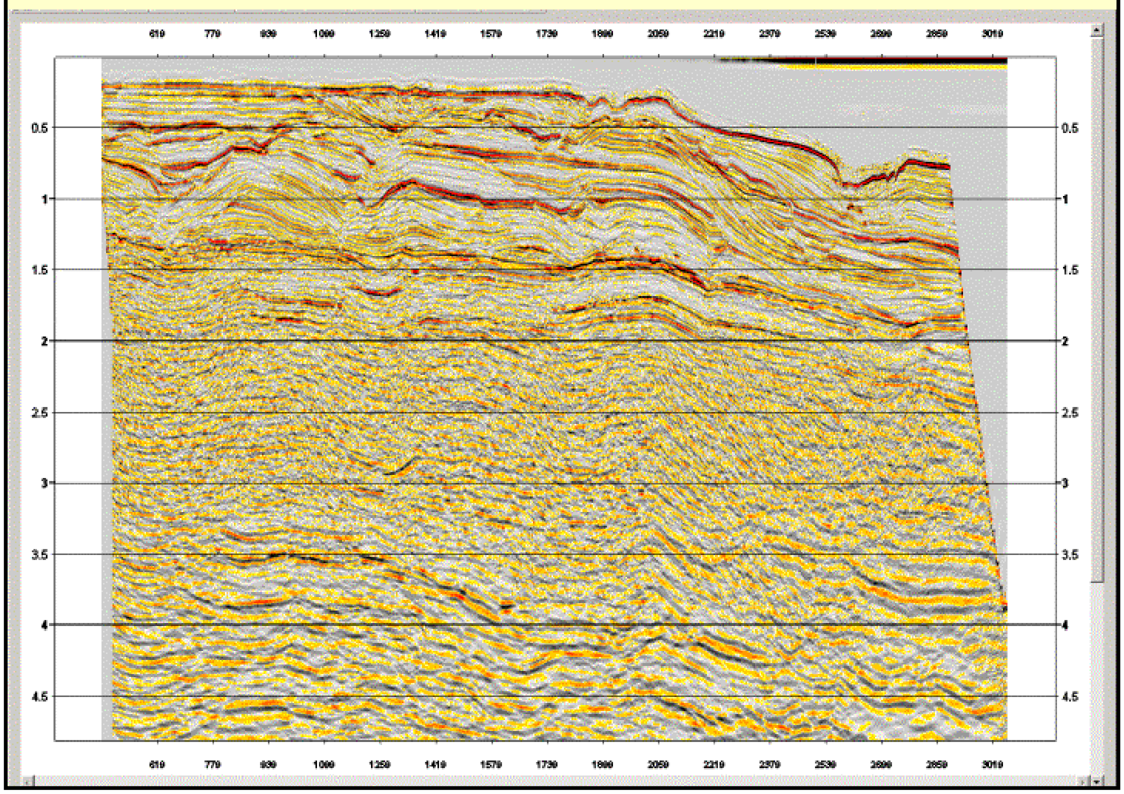
InLine 8712- Unfiltered Robust AGC 800msec Stack



InLine 8712- Unfiltered AGC 1000msec Pre- Stack



InLine 8712- Unfiltered AGC 1000msec Pre- & AGC 500msec Post- Stack



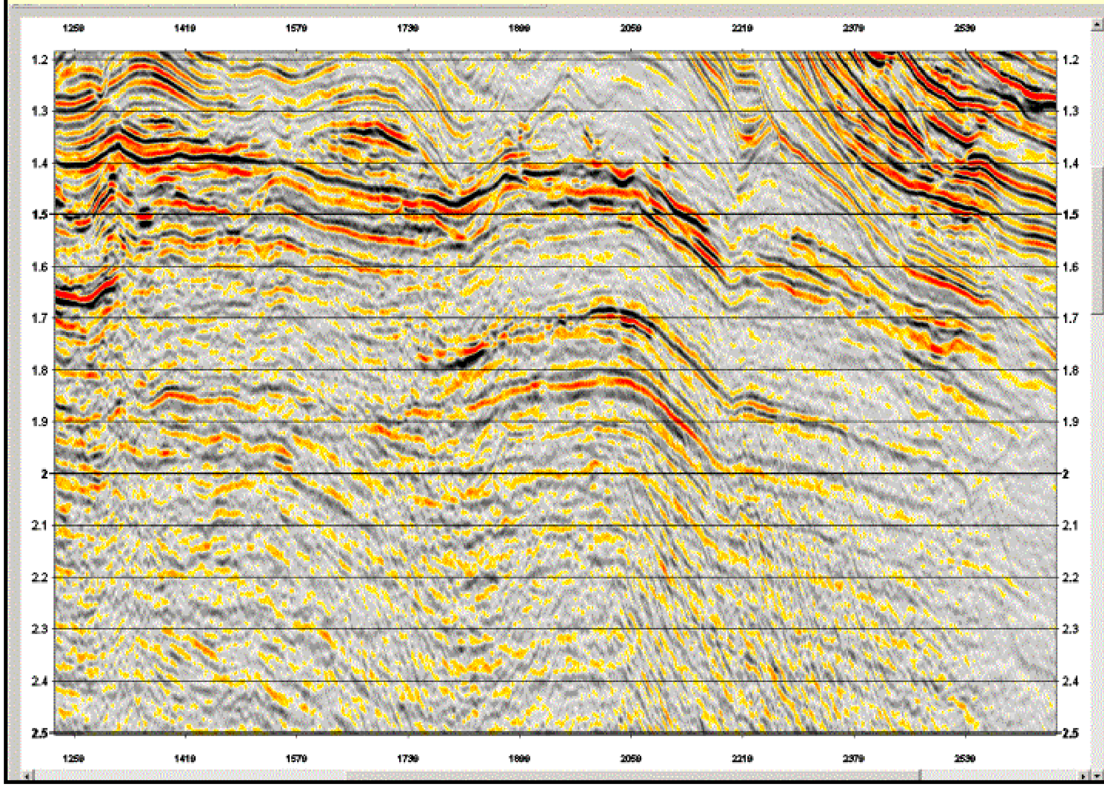
Post Stack Gain Test Review

- The principle difference is between the "deterministic" or "true relative amplitude" scaled sections and the data derived scaled sections (AGC'd).
- The pre-stack scaled data sets show less noise (see later blow up sections)
- The post stack scaled sections allow for bland event mapping.
- The mapping of extracted amplitudes on AGC'd data is not recommended for any quantitative AVO work, but is indicative of relative amplitudes.
- The brightest amplitudes – immediately below K93 & presumed to be associated with Gas - are best seen on the POST STACK GAIN (WB Tied) Stacks.
- The best to interpret may be the pre-stack scaled sections.
- All of the AGC sections (even the robust gain to a lesser extent) show some AGC shadow

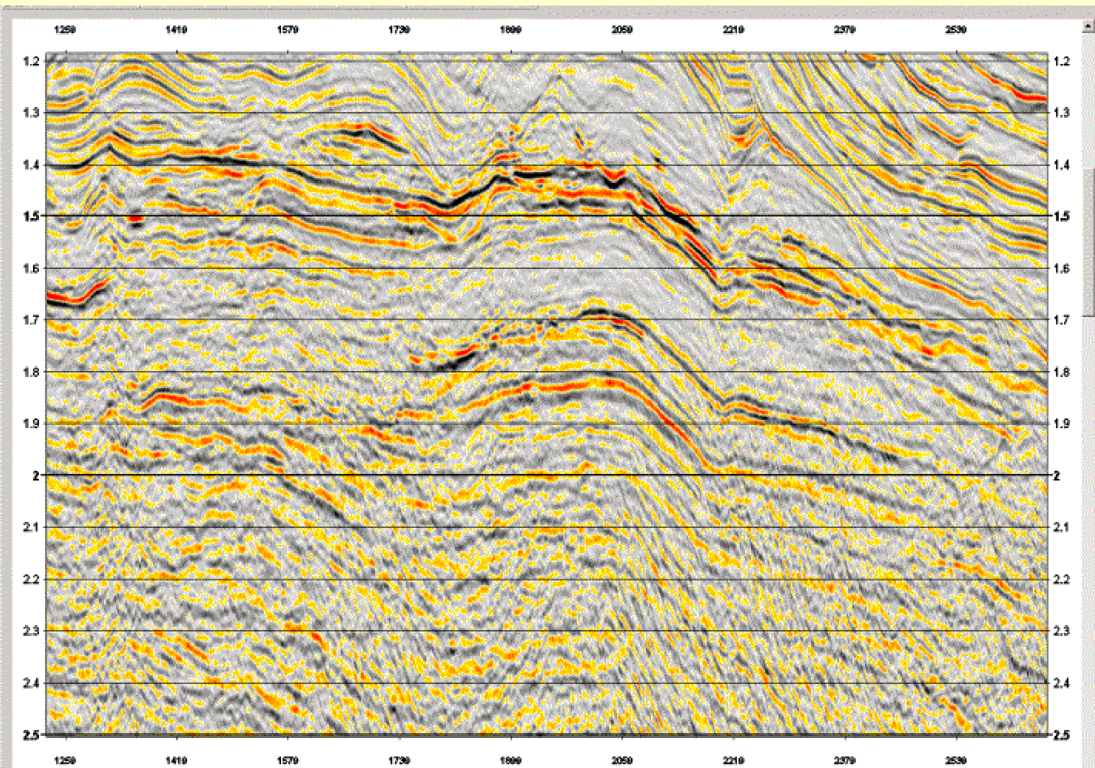
Expanded Sections

- Note that the order of the tests in the following section has changed to more readily allow flicking between relevant tests

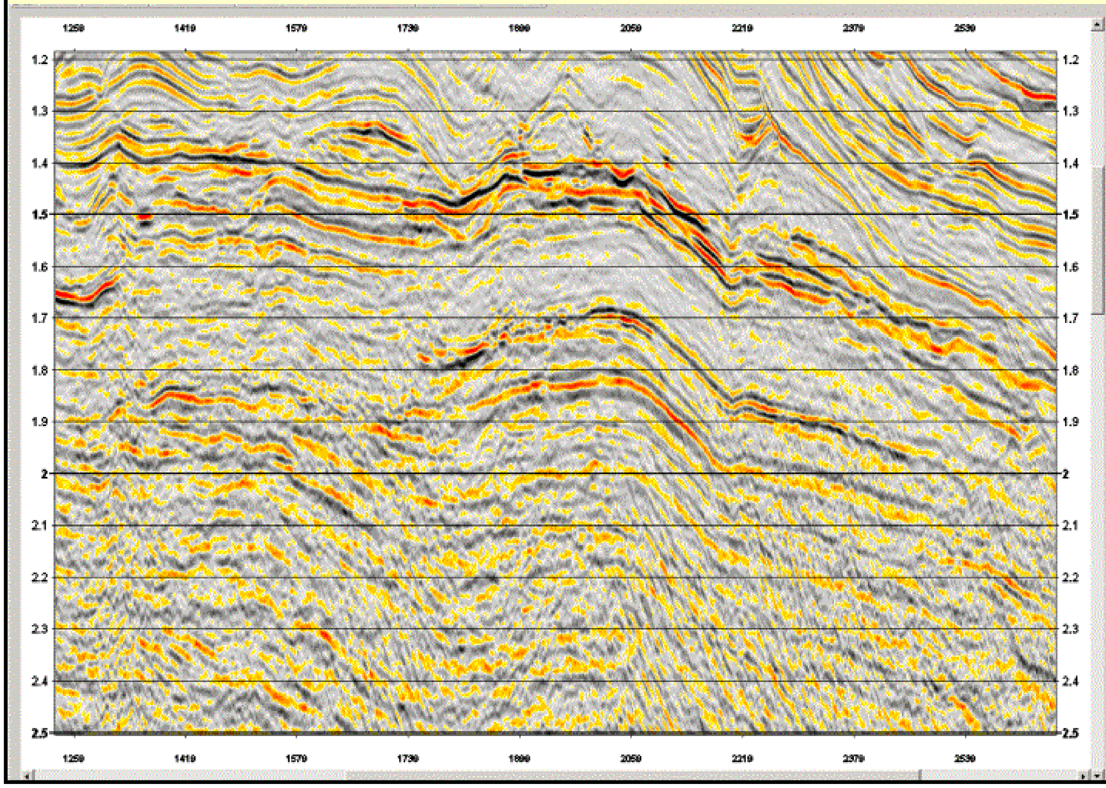
InLine 8712- Unfiltered Unscaled Stack



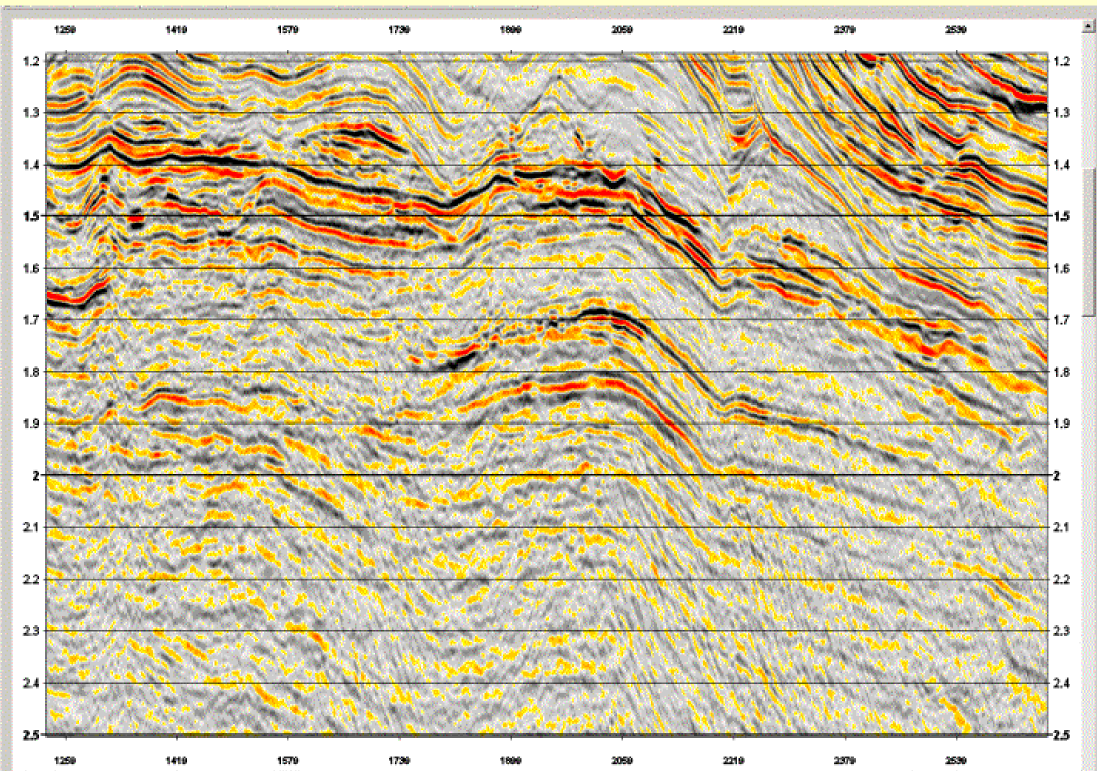
InLine 8712- Unfiltered AGC 500msec Stack



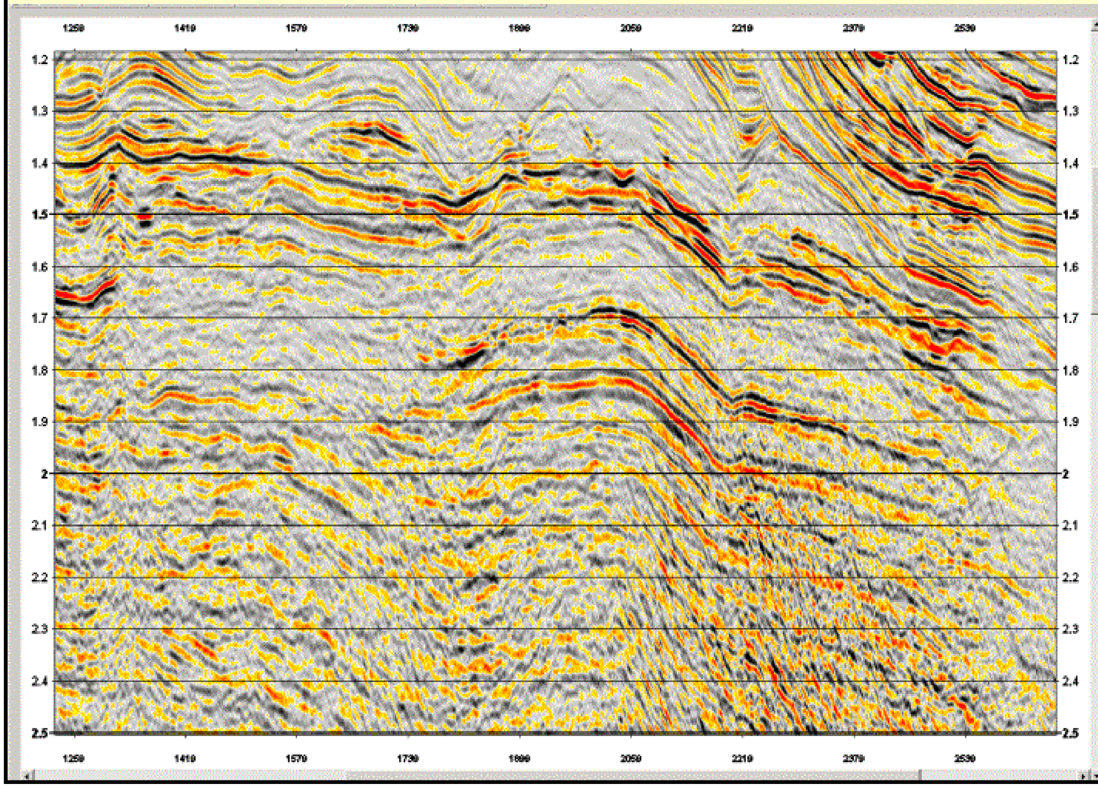
InLine 8712- Unfiltered AGC 1000msec Pre- & AGC 500msec Post- Stack



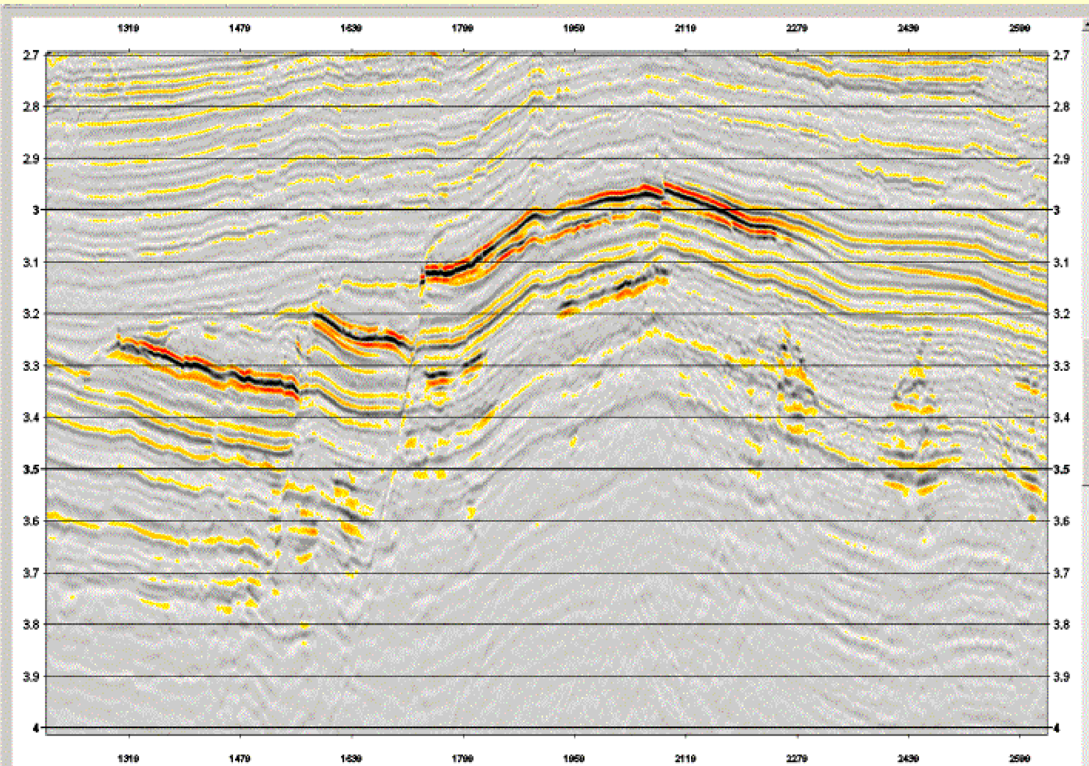
InLine 8712- Unfiltered AGC 1000msec Pre- Stack



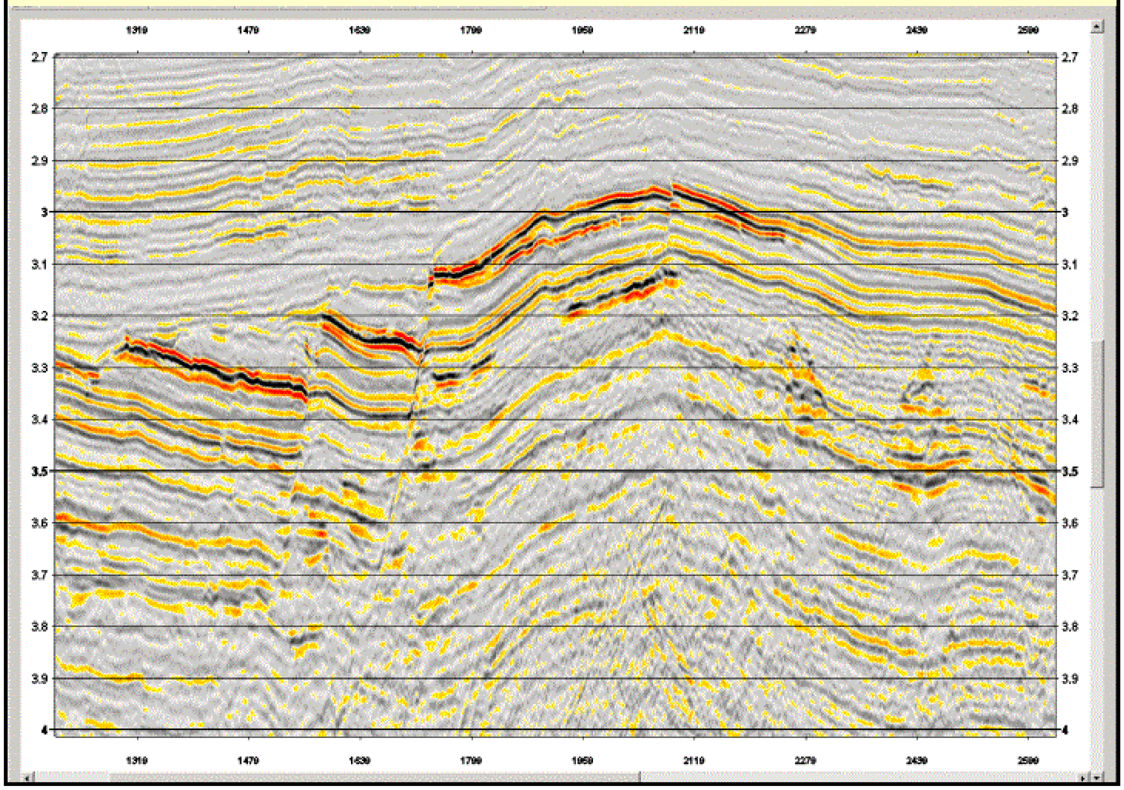
InLine 8712- Unfiltered, Fixed Post Stack Gain (WB variant) Stack



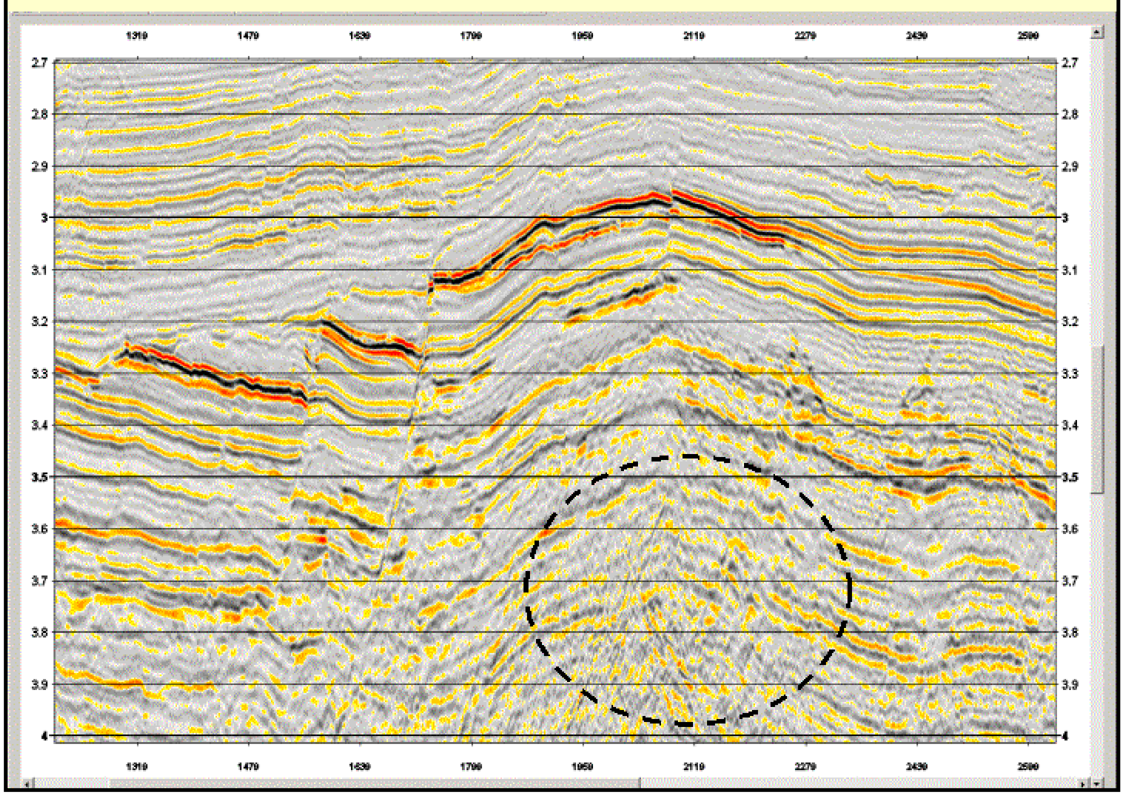
InLine 7370- Unfiltered Unscaled Stack



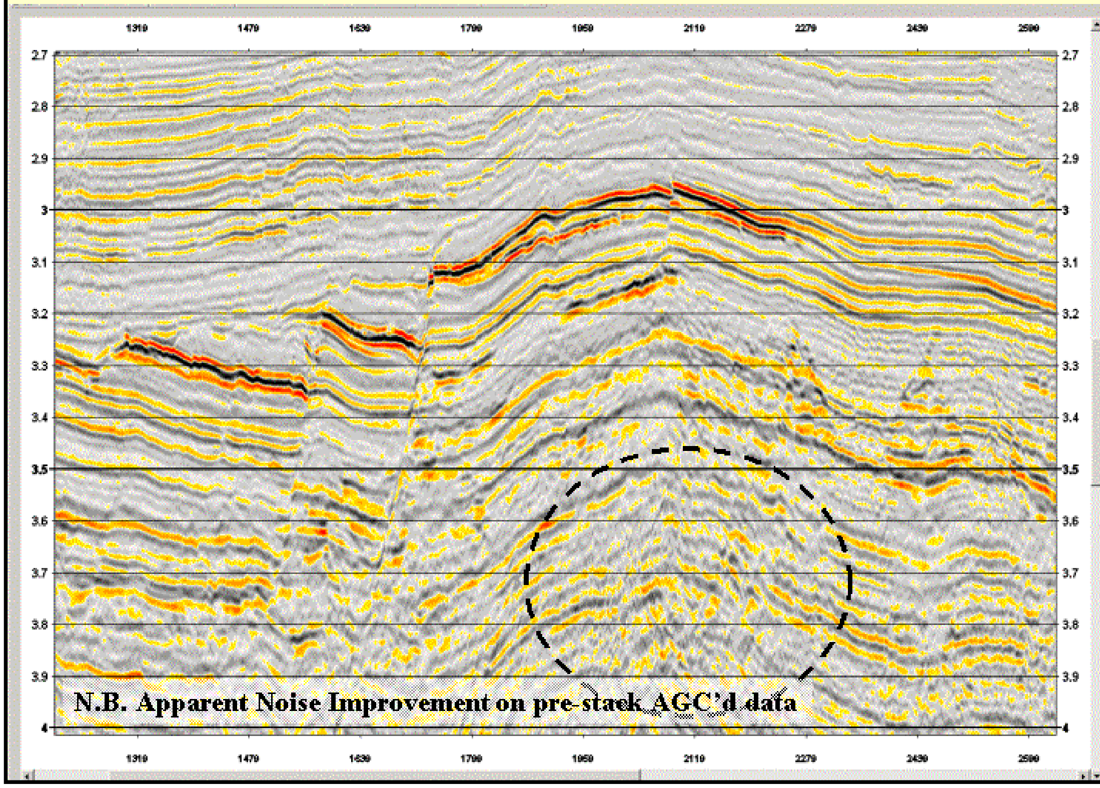
InLine 7370- Unfiltered Robust AGC 800msec Stack



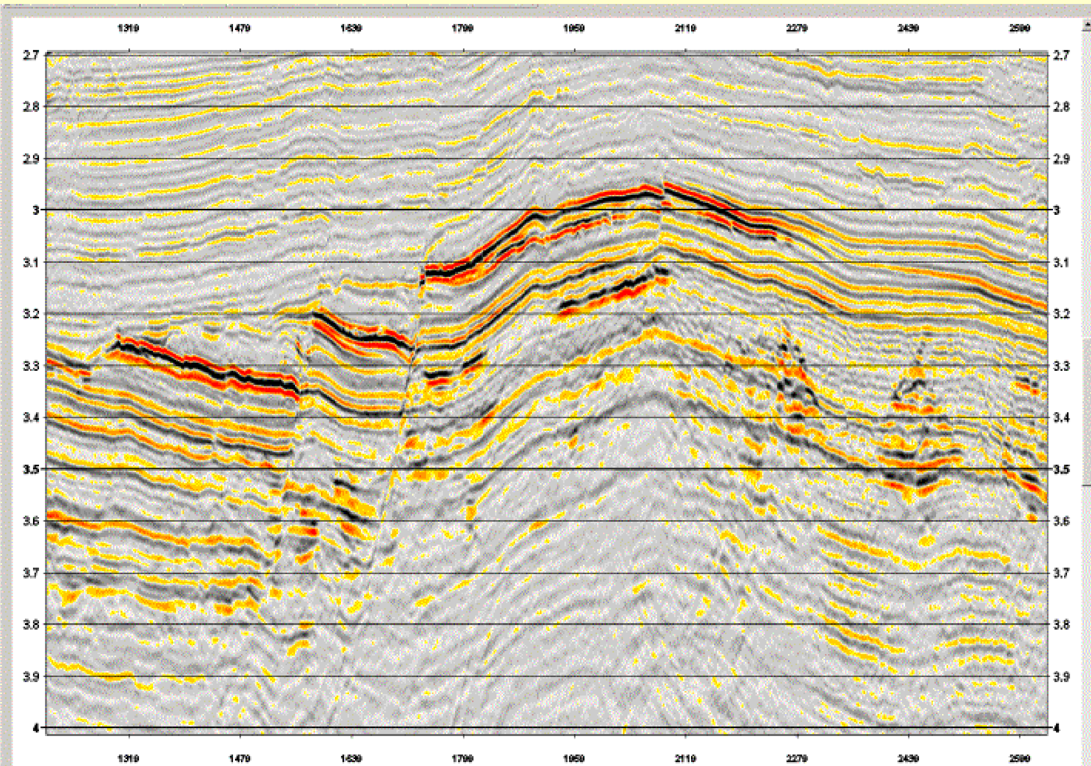
InLine 7370- Unfiltered AGC 500msec Stack



InLine 7370- Unfiltered AGC 1000msec Pre- & AGC 500msec Post- Stack

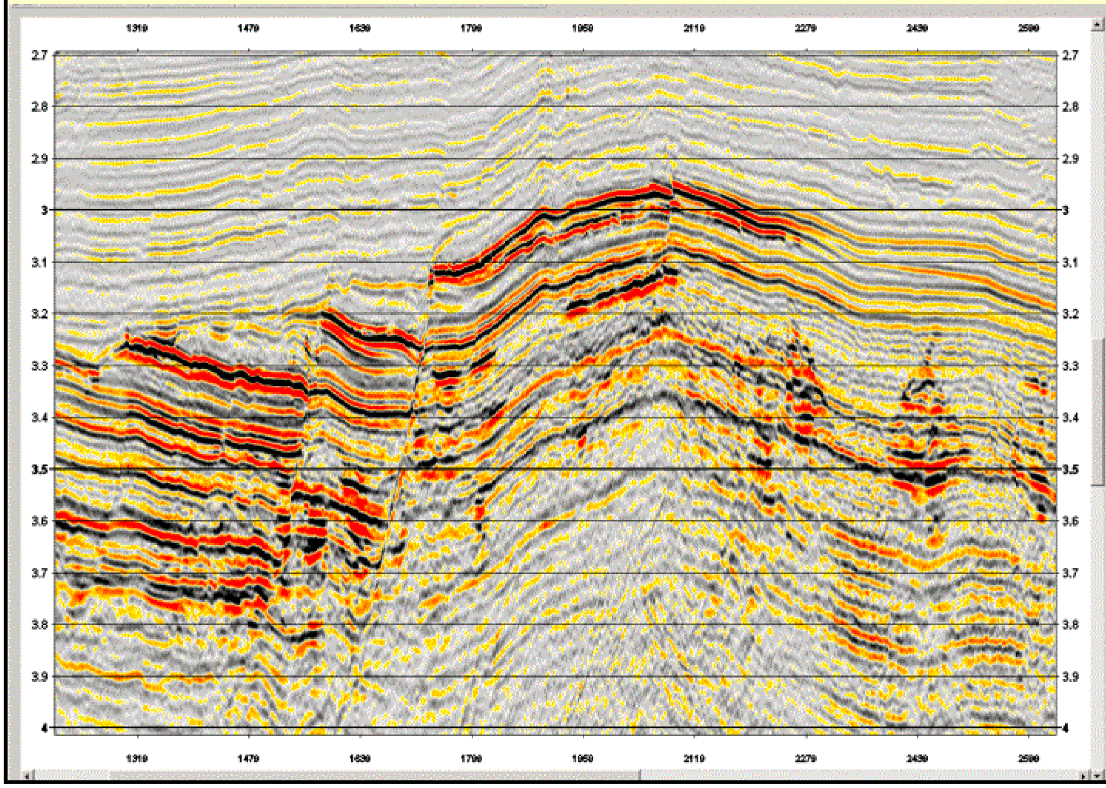


InLine 7370- Unfiltered AGC 1000msec Pre- Stack



VERITAS

InLine 7370- Unfiltered, Fixed Post Stack Gain (WB variant) Stack



PRE-STACK SCALING

The Pre-Stack AGC gives the best data for snapping in terms of amplitude consistency and SNR. The Pre-Stack 1000msec AGC was used for the "Optimum Stack".

It is intended to use the RAW stacked Amplitudes with deterministic pre-Stack gain, for Amplitude work as this is closest to "true" amplitude.

7. COMPREHENSIVE PROCESS AND PARAMETER DESCRIPTION

7.1 PRE PROCESSING SEQUENCE

1. REFORMAT

The field data recorded on 3590 tapes in SEG-D format were reformatted and converted to Veritas DGC's internal format. Data length 6500 msec at 2msec sample rate.

2. SHOT AND TRACE EDITING

Any bad records or portions of records with anomalous amplitudes and excessively noisy traces were edited. This editing was performed on the basis of comments in the observer's logs and QC notes from the field crew.

3. ZERO PHASE LOW CUT FILTER

A zero phase Butterworth low cut filter 3 hz@18dB/ OCT was applied to attenuate low frequency noise observed on shot records prior to FXEDIT and resample

4. INSTRUMENT DEPHASE

A minimum-phasing Filter was derived from the Far-Field signature without the gun and receiver ghosts. This was then applied to the shot records to compensate for any corruption to the minimum phase during acquisition.

5. SPHERICAL DIVERGENCE CORRECTION (TV^2)

This is a correction for amplitude losses due to the spherical spreading of the wavefront as it passes downward through the earth and is reflected back. These losses were compensated by application of a gain function defined as TV^2 where T is the two-way travel time and V is the RMS velocity. For this project, an average function was used together with Ursin's offset dependent formula. This was removed and reapplied with the 1st pass velocity field prior to Radon Demultiple.

6. F-X PROJECTION FILTERING

Code name:FXEDIT. Its basic object is to FX predict signal contained in input gather, then replace the zones of input traces with the predicted signal when ratios of the two are exceeded. The program has another pre-processing loop, which has proven to be important to its effectiveness. In that loop, the frequency components of the input traces are scanned for spiky elements, using a logic similar to the horizontal despike with natural trace amplitudes. This loop seems to predict a much more reliable signal gather.

Usage

The domain in which the algorithms are employed is probably more important than the algorithms themselves. Stray spikes typically can be handled in whatever order the data is presented, usually field shot order. Cable and swell noise often attenuate nicely on traces arranged in their natural acquisition order.

However, it is often the case that data is reorganized in other groups before applying noise attenuation techniques which utilize spatial patterns. For example, seismic interference is more easily removed after organizing traces into gathers of common receiver position. Even traces organized into common offset crosslines can be the preferable domain to eliminate some acquisition related noise pattern.

2 domain of FXEDIT were performed, following are the parameters used for the F-X projection noise estimation and removal.

First pass: Channel domain

Threshold tolerance	:	1.75
Frequency range	:	0 to 11Hz
Start time	:	wbt + 500ms
Gate Length	:	500msec
Number of traces	:	61
Filter points	:	9

Second pass: Shot domain

Threshold tolerance	:2.5	
Frequency range	:	0 to 45Hz
Start time	:	wbt + 500ms
Gate Length	:	1000msec
Number of traces	:	61
Filter points	:	9

7. RESAMPLE

The field data was resample from 2 msec to 4 msec with a zero-phase anti-alias filter of 100 Hz to avoid temporal aliasing.

8. XRLIN

The XRLIN performs noise removal and trace regularization using a constrained, high-resolution, linear Radon transform which gives a better focused representation of the data in the Radon transform. This results in better preservation of the primary amplitudes as a function of offset, more complete removal of linear noise and more resistance to spatial aliasing.

For this survey, pass range ±2100 m/sec (±476ps) with waterbottom time protection of 600msec. + 200msec. taper was selected.

9. EXPONENTIAL GAIN CORRECTION

To compensate for amplitude decay due to inelastic effects, exponential gain of 0dB at wbt+1.5sec; 10dB at wbt+3.0sec was applied to data shallower than water-bottom time 500ms and no gain was applied for water-bottom time deeper than 1.5sec

10. FIRST PASS VELOCITY ANALYSES (1.0 X 1.0 KM GRID)

The first pass velocity analyses were performed at 1.0 x 1.0 km grid using Veritas DGC's interactive PACESETTER software. PACESETTER is an interactive velocity analysis package. The output of this package consists of four components:

i. Display of stack panels corrected with their respective velocity fan functions
ii. CMP gathers, NMO may be applied with the latest RMS velocities picked
iii. Displays of semblance contours
iv. Display of Iso-velocities
v. Disply of velocities map

The velocity gathers were loaded onto the workstation in Veritas DGC's Perth office for Mr. John Cant of Santos Ltd. to QC the velocity picks. Interactive velocity timeslices display were used in conjunction with the interactive DIVAN.

The following processing were applied to the velocity lines prior to running velocity analyses :

11.1 Alternate CDP decimation
11.2 Picked 2X2 km velocity
11.3 Mild High Resolution Radon Multiple Attenuation (XRMULT)

Transform range	: -800 to 3500 msec
Subtraction ranges	: 300 to 3500 msec
Subtraction start time	: 2XWB Time - 100 msec
Reference offset	: 4900 m
No. of P traces	: 384

NMO with coarse 2km picked velocity field

11. PREDICTIVE DECONVOLUTION IN TAU-P DOMAIN

Transform to Tau-P Domain with data length extended to 9.0sec
Low dips cut-off : -500 microseconds per meter
High dips cut-off : 750 microseconds per meter

Gap length	: 32 msec
Total Filter length	: 300 msec
White noise	: 0.1%
Application	: 0.- 6500 msec

Ray parameter limit far decon	Design gate (msec)
-500	300 - 4500
0	200 - 4000
350	100 - 3000
750	50 – 2000

Transform to X-T Domain
Tau-p deconvolution was only applied to data with water-bottom time less than 300msec, ramping to water-bottom time 400ms and no decon thereafter

12. K-FILTER AND CHANNEL DECIMATION

K-filter (spatial low pass filtering) using 0.6 of K-Nyquist was applied with full NMO correction using the first pass velocities. Alternate channels were pass through for subsequent processing. Effective group interval increased from 12.5 m to 25 m and from 368 to 184 channels.

13. 3D SEISMIC/ NAVIGATION MERGE

The 3D navigation data comprising the receiver and source x-y co-ordinate information and spread definitions were recorded in P190 UKOOA format. Maps of the receiver and shot locations were produced before the co-ordinate information were merged with seismic data. The 3D navigation data is matched with the seismic (based primarily on navigation time and channel) and all the required information written to the trace header. Bin dimensions :12.5 m (inline) X 25 m (crossline).

14. HIGH RESOLUTION RADON DEMULTIPLE – XRMULT

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 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 velocity functions derived from the first pass velocities were used to compute the 4^{th} order normal move-out (NMO) corrections to be applied to the traces in the CDP gathers.

Transform range	: -800 to 3500 msec
Subtraction ranges	: 300 to 3500 msec
No. of P traces	: 384
Subtraction start time	: 600 ms + 200 ms taper for wbt 200 ms
	: 700 ms + 200 ms taper for wbt 300 ms
	: 900 ms + 200 ms taper for wbt 500 ms
	: 1800 ms + 200 ms taper for wbt 1000 ms
	: 2700 ms + 200 ms taper for wbt 1500 ms
	: 3700 ms + 200 ms taper for wbt 2000 ms
	: 4500 ms + 200 ms taper for wbt 2500 ms
Processing window width	: 68 traces
Processing window length	: 500 msec

15. CABLE DEPTH CORRECTION

The acquisition event logs stated all lines with 7 meters streamer depth except line sequences 56, 57, 67, 69 to 77 had cable depth of 8m to 9m due to strong swell noise. These lines were corrected to reference to mean cable depth of 7m.

16. TIDAL STATIC CORRECTION

Tidal static corrections were applied to the data to compensate for tidal variation. Tidal information from the period of data acquisition were provided by Santos. One static value was computed every 15 minutes , per sail line using the following formula :

2*(tidal height in meters at the time of recording)*(-1)/1.5

17. 3D OFFSET BINNING – 62 FOLD

Prior to 3D Offset Binning into 12.5 X 12.5 m grid to achieve 62 fold bin gathers, the seismic and navigation data were re-merged with bin 12.5m crossline spacing from data acquired with 25m cross line acquisition.

18. FLOOD – FOLD LEVELLING FOR OPTIMUM OFFSET DISTRIBUTION

The CDP fold coverage maps showed the coverage to be low and the offset distribution was not regular. Some bins had duplicate offsets while others were missing that offset altogether. FLOOD was performed to achieve better offset distribution within CDP bins (FLOOD is an acronym for Fold Levelling for Optimum Offset Distribution). FLOOD uses dip-dependent interpolation to supply missing traces, instead of copying.

FLOOD is something of an on the fly operation, and a formal database is not accumulated. Total number of traces input, output and rejected because of duplicate offsets are reported. Retained traces can be scrutinised, but the capture of thorough statistics for rejected traces is not implemented. Interpolated traces are flagged, so can be analysed by other means after job completion. Fold maps are the norms for ensuring appropriate results.

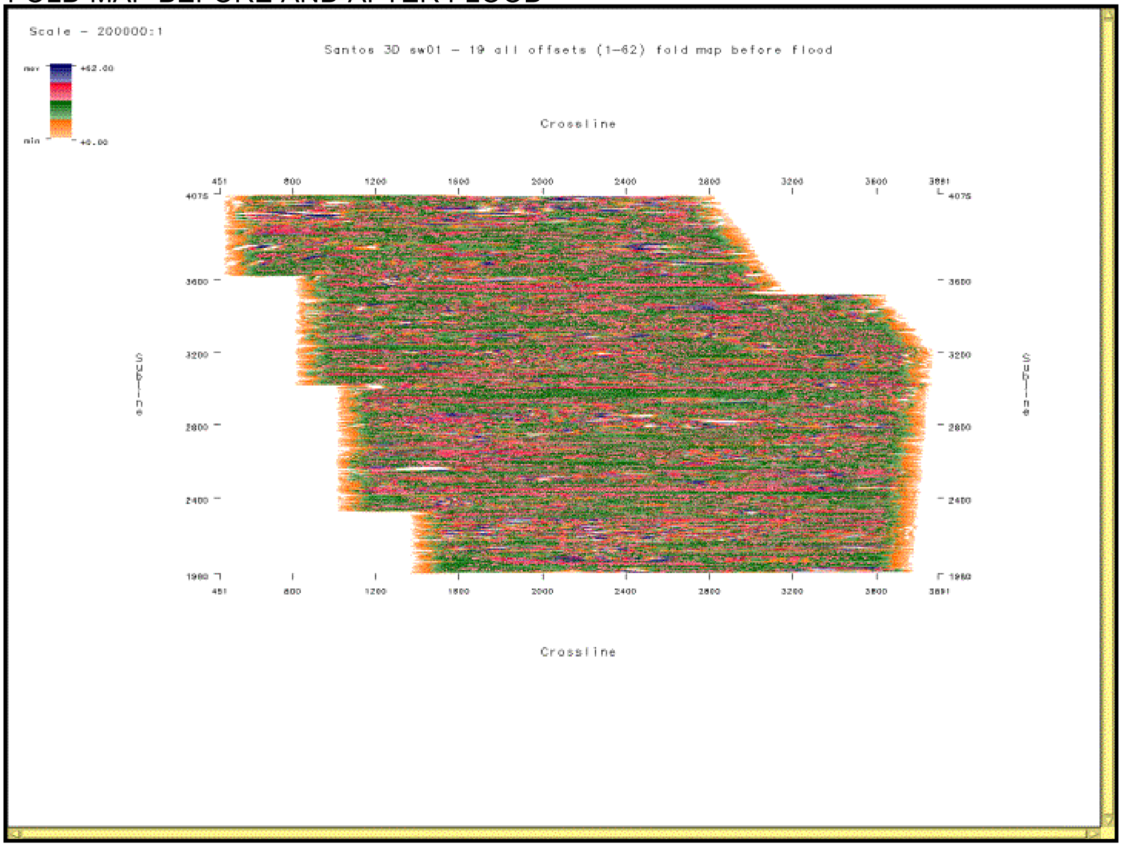
The process was performed over 62 common offset planes, comprising offsets 193 m to 4768 m at increments of 75 m. Trace interpolation was performed in the F-X domain in crossline direction to interpolate missing data. Gaps of a maximum width of seven traces were interpolated. Gaps greater than seven traces are not interpolated.

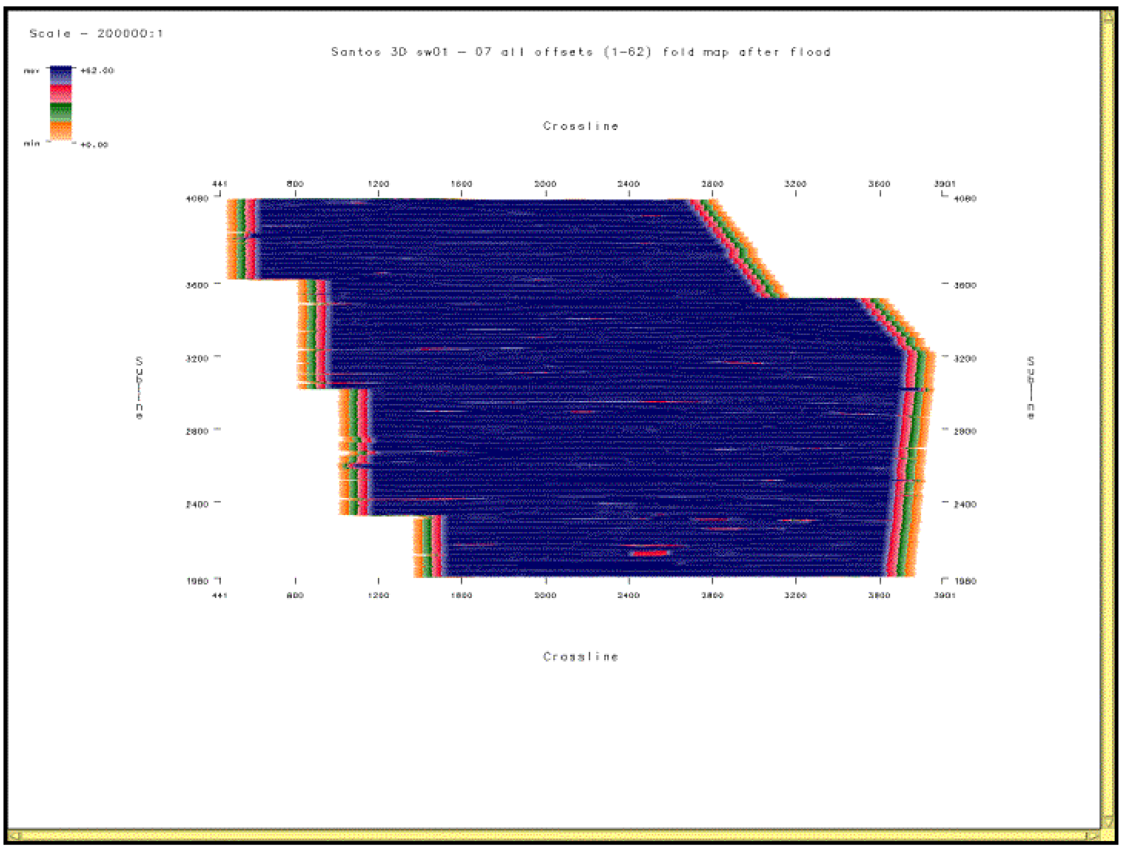
Fold Coverage Plots Before and After FLOOD generated:

1.	Offset range	:	193	–	1243	(First 15 offsets)
2.	Offset range	:	1318	–	2368	(Second 15 offsets)
3.	Offset range	:	2443	–	3493	(Third 15 offsets)
4.	Offset range	:	3568	–	4768	(Fourth 17 offsets)
5.	Offset range	:	193	–	4768	(All 62 offsets)

Bad cable spikes on some sail lines in the South Eastern part of the survey (not noted in observer's log) were noticed on the fast track volume, these were edited and re-FLOOD for final volume.

FOLD MAP BEFORE AND AFTER FLOOD





7.2 FAST-TRACK PROCESSING DMO / STACK /POST MIGRATION VOLUME

CONTINUE FROM SECTION 7.1 ITEM 16 – TIDAL STATIC CORRECTION DATASETS

1. 2D DMO ON VELOCITY LINES FOR VELOCITY ANALYSES (V2)

The second pass velocity analyses were performed at 1.0 km grid using Veritas DGC's interactive PACESETTER software.

PACESSETER is an interactive velocity analysis package. The output of this package consists of four components:

- i) Displays of stack panels corrected with their respective velocity fan functions
- ii) CMP gathers, NMO may be applied with the latest RMS velocities picked
- iii) Displays of semblance contours
- iv) Display of Iso –velocities
- v) Display of velocities map

The 2D DMO velocity gathers were loaded onto the workstation in Veritas DGC's Perth office for Mr. John Cant of Santos Ltd. to QC the velocity picks

2. 3D OFFSET BINNING – 62 FOLD

3D Offset Binning into 25m X 25 m grid to achieve 62-fold bin gathers.

3. FLOOD – FOLD LEVELLING FOR OPTIMUM OFFSET DISTRIBUTION

The CDP fold coverage maps showed the coverage to be low and the offset distribution was not regular. Some bins had duplicate offsets while others were missing that offset altogether. FLOOD was performed to achieve better offset distribution within CDP bins (FLOOD is an acronym for Fold Levelling for Optimum Offset Distribution). FLOOD uses dip-dependent interpolation to supply missing traces, instead of copying.

FLOOD is something of an on the fly operation, and a formal database is not accumulated. Total number of traces input, output and rejected because of duplicate offsets are reported. Retained traces can be scrutinised, but the capture of thorough statistics for rejected traces is not implemented. Interpolated traces are flagged, so can be analysed by other means after job completion. Fold maps are the norms for ensuring appropriate results.

The process was performed over 62 common offset planes, comprising offsets 193 m to 4768 m at increments of 75 m. Trace interpolation was performed in the F-X domain in crossline direction to interpolate missing data. Gaps of a maximum width of seven traces were interpolated. Gaps greater than seven traces, are not interpolated.

Fold Coverage Plots Before and After FLOOD generated :

1. Offset range	:	193	–	1243	(First 15 offsets)
2. Offset range	:	1318	–	2368	(Second 15 offsets)
3. Offset range	:	2443	–	3493	(Third 15 offsets)
4. Offset range	:	3568	–	4768	(Fourth 17 offsets)
5. Offset range	:	193	–	4768	(All 62 offsets)

4. NORMAL MOVEOUT CORRECTION

The velocity functions derived from the second pass velocities were used to compute the 2nd order normal move-out (NMO) corrections.

2nd order NMO correction was performed assuming that the energy travelled in a straight ray-path and utilised the following equation :

$$T_x^2 = T_0^2 + x^2/v^2$$

where:
T_x = Total recorded travel time in seconds
x = Offset
T_0 = Time of reflector at zero offset in seconds
V = RMS velocity

Velocity-time knee points were honoured on adjacent control points prior to interpolation of the temporal velocity field. Then the space variant velocity function was derived by linear interpolation between control points.

5. 3D DMO (DECODE)

A simplification of the DECODE algorithm is first to apply the DMO operator and subsequently interpolate the individual smile traces to all adjacent bins prior to summing. This is faster than the full DECODE algorithm. This method is normally used on marine data, but this does not have the same theoretical basis as Vermeer□fs work on cross spreads. It can reduce numerical noise but does not accurately compensate for shadow zones caused by lack of illumination.

This approach could be called a "Broad" or "Fat" DMO and is currently available with Kirchhoff DMO only, but can be extended to use the FK algorithm.

6. OUTER, INNER AND ANGLE TRACE MUTE

A front-end (outer trace) mute (or ramp) was applied to the shallow and far offset data to remove any undesirable, excessive stretching after NMO application. As the start time of the mute is from zero time it will also remove non-compressional background noise recorded above the first breaks. An inner trace mute was used to remove any residual multiple energy still present on the near offset traces.
For full stack, inner mute to outer mute were applied. Near stack: inner mute to near outer mute were applied and for far stack, near outer mute to far outer mute were applied.

OUTER MUTE

WBT (msec)	Offset (m)	Time (msec)
200	0	0
	631	0
	650	200
	930	600
	1380	1000
	1830	1400
	2542	2000
	4800	3400
550	0	0
	895	0
	910	560
	1120	900
	1495	1200
	2250	2000
	4800	3800
940	0	740
	1012	740
	1025	940
	1400	1250
	1700	1580
	2837	2400
	4800	3900
1300	0	1100
	825	1100
	900	1300
	1287	1500
	1725	1800
	2187	2500
	4800	4000
1700	0	1500
	962	1500
	1262	1700
	1800	1850
	2560	2900
	4800	4100
2100	0	1900
	1788	1900
	1826	2100
	2236	2600
	2761	3100
	4800	4300

INNER MUTE

WBT (msec)	Offset (m)	Time (msec)
200-500	150	800
	225	1000
	480	1200
	800	1800
	999	6500
3000	150	4800
	225	5000
	480	5200
	800	5800
	999	6500

FAR STACK OUTER MUTE

WBT (msec)	Offset (m)	Time (msec)
200	0	0
	757	0
	780	200
	1116	600
	1656	1000
	2196	1400
	3050	2000
	5760	3400
550	0	0
	1074	0
	1092	560
	1344	900
	1794	1200
	2700	2000
	5760	3800
940	0	740
	1214	740
	1230	940
	1680	1250
	2040	1580
	3404	2400
	5760	3900
1300	0	1100
	990	1100
	900	1300
	1287	1500
	1725	1800
	2187	2500
	4800	4000
1700	0	1500
	1154	1500
	1514	1700
	2160	1850
	3072	2900
	5760	4100
2100	0	1900
	2146	1900
	2191	2100
	2683	2600
	3313	3100
	5760	4300

NEAR STACK OUTER MUTE

WBT (msec)	Offset (m)	Time (msec)
200	0	0
	460	0
	462	200
	625	600
	872	1000
	1367	1400
	1862	2000
	2743	3000
	2818	3400
	2968	6500
550	0	0
	625	0
	652	560
	707	900
	872	1200
	1697	2000
	2780	3150
	2818	3800
	2893	6500
940	0	740
	707	740
	735	940
	955	1250
	1120	1580
	2110	2400
	2818	3300
	3043	3900
	3118	6500
1300	0	1100
	706	1100
	790	1300
	872	1500
	1120	1800
	1697	2500
	2668	3300
	2968	4000
	3043	6500

NEAR STACK OUTER MUTE

WBT (msec)	Offset (m)	Time (msec)
1700	0	1500
	790	1500
	812	1700
	1037	1850
	1532	2900
	2668	3600
	2968	4100
	3043	6500
2100	0	1900
	1202	1900
	1224	2100
	1450	2600
	1780	3100
	2443	4000
	2968	4300
	3043	6500
2500	0	2300
	1285	2300
	1307	2500
	1615	3100
	2368	3800
	2743	4700
	2893	5500
	2968	6500

7. STACK (1/FOLD NORMALISATION)

Stack is the summation of traces within each CDP producing a single stacked trace for each input gather record. The stack was normalised and mute zone compensated to account for the smaller number of live traces in the mute zone and for uneven fold of coverage. This amplitude compensation was done using 1/ fold normalisation function.

8. POST STACK KIRCHHOFF MIGRATION

Post stack Kirchhoff migration method was used with a maximum dip of 80degree and 3km aperture

9. POST STACK ZERO PHASING FILTER

Using a stable waterbottom reflection of the near trace stack where the waterbottom is relatively deep and uncomplicated, an estimate of the recorded wavelet can be made by flattening a large portion of the waterbottom and summing it together - this wavelet estimate is truncated appropriately and a zero-time is manually picked - then the wavelet (of unknown phase) is converted to zero-phase and filter for the seismic data results.

10. TIME VARIANT FILTER

The purpose of this process is to remove any unwanted noise that lies outside the frequency range in which an acceptable signal to noise ratio exists. The stacked data were filtered with a series of zero phase bandpass filters. The following time variant filters were used :

water-bottom time 200msec:

Time (msec)	Filter (Hz/dB per Octave)
0	16/20 - 90/72
200	16/20 - 90/72
700	8/18 - 88/64
1200	6/18 - 80/60
1700	4/18 - 72/54
2200	3/18 - 65/48
3200	3/18 - 50/45
4200	3/18 - 42/40
6500	3/18 - 38/35

water-bottom time 1000msec

Time (msec)	Filter (Hz/dB per Octave)
0	12/18 - 95/72
1000	12/18 - 95/72
1500	8/18 - 93/72
2000	6/18 - 80/60
2500	4/18 - 72/48
3000	3/18 - 65/48
4000	3/18 - 52/48
5000	3/18 - 38/35
6500	3/18 - 35/35

water-bottom time 2000msec

Time (msec)	Filter (Hz/dB per Octave)		
0	12/18	-	95/72
2000	12/18	-	95/72
2500	8/18	-	93/72
3000	6/18	-	78/60
3500	4/18	-	65/48
4000	3/18	-	56/48
5000	3/18	-	42/40
5500	3/18	-	40/36
6500	3/18	-	35/35

11. EXPONENTIAL GAIN CORRECTION

The aim of this process is to scale the data to increase the amplitude of events in the deeper section so that they can more readily visible. The exponential gain function applied were:

Water-bottom time 200msec
0dB@ wbt; 20dB @ wbt+2 sec; and 20dB @ 6 to 6.5sec.

Water-bottom time 500msec
0dB@ wbt; 23dB @ wbt+2 sec; and 20dB @ 6 to 6.5sec.

Water-bottom time 1000msec
0dB@ wbt; 30dB @ wbt+2 sec; and 20dB @ 6 to 6.5sec.

Water-bottom time 2000msec and deeper
0dB@ wbt; 30dB @ wbt+1.5 sec and 20dB @ 6 to 6.5sec.

12. SOURCE AND CABLE STATIC CORRECTIONS

A total of +8 msec source and streamer static correction was applied to mean sea level (MSL) datum

13. FAST TRACK MIGRATION ARCHIVES

Full DMO migrated stack raw and scaled volumes were SEG-Y archived to DLT and DVD respectively.
See Appendix B1 for details of tapes archived.

7.3 FAST-TRACK PROCESSING INITIAL PRE-STACK HYBRID MIGRATION

CONTINUE FROM SECTION 7.2 ITEM 3 – FLOOD DATASETS

1. SCALEMUL

This process is primarily aimed at attenuating residual multiples in deep water marine surveys. After application of conventional multiple attenuation processes, significant residual muiltiple may remain (especially in areas where the first waterbottom bounce is high amplitude). SCALEMUL estimates the 'background' amplitude just above the location of the first waterbottom multiple and then examines all amplitudes below the multiple time within a series of frequency bands. Operating independently on each of these frequency bands, the algorithm searches for any sample below the first waterbottom multiple time that has an amplitude grater than 'threshold' time the background amplitude and scales these samples to 'level' times the background amplitude.

Scalemul start time are as follows:

Water-bottom time	Start time
0 to 1.0sec	1.8 sec
1.0sec and deeper	2 X water-bottom time – 200ms

Threshold 1.5

Parameters used for this process only were:
NMO removed
Spherical divergence removed
Data corrected to M.S.L.
NMO with water velocity of 1506m/s

2. REMOVE SPHERICAL DIVERGENCE

The spherical divergence was removed prior to migration

3. HYBRID MIGRATION

The workflow for prestack time migration processing is relatively simple compared to that for prestack depth migration, primarily because of the effort required in velocity model building. Prestack time migration assumes that lateral velocity variations are mild and hence only a spatially smooth velocity model is required, whereas prestack depth migration can accomodate all variations and demands the geoscientist prepare the best possible estimate of the subsurface velocity structure. Velocity model building for depth migration usually incorporates horizon based model building, iterative updating and tomography.

Sometimes the imaging problem at hand is essentially a time migration problem (mild lateral velocity variations only) except for the complication of a single complex surface that introduces lateral variations (this single surface is often a rough, undulating waterbottom but can also be a significant deeper horizon that characterises a rapid change in interval velocity). The aim of Hybrid prestack migration is to gain the benefits of prestack depth migration for coping with the complex surface, while maintaining the relative simplicity of prestack time migration for the rest of the velocity model.

The result of Hybrid Prestack Migration is improved imaging and event continuity beneath the complex horizon (normally the waterbottom) without adding significantly to the complexity of the processing flow.

This initial Hybrid Migration was performed with a simple velocity model built from the DMO velocity. 3km aperture was used.

4. THIRD PASS PRE-STACK MIGRATION VELOCITY ANALYSES

The third pass velocity analyses were performed at 1.0 km grid using Veritas DGC's interactive PACESETTER software.

PACESSETER is an interactive velocity analysis package. The output of this package consists of four components :

- vi) Displays of stack panels corrected with their respective velocity fan functions
- vii) CMP gathers, NMO may be applied with the latest RMS velocities picked
- viii) Displays of semblance contours
- ix) Display of Iso –velocities
- x) Display of velocities map

The velocity were picked at 1km grid, QC'ed and better interpolated for the subsequent fast track stacks.

The velocity was also smoothed and converted to depth for the 2nd Fasttrack Hybrid Migration

5. FOOTPRINT REMOVAL

To remove acquisition footprints, the following procedure were applied post-migration:

1. Compute average amplitude maps over consecutive 500m windows from top to bottom of the data.
2. Filter out linear patterns along inlines from each amplitude map.
3. Compute a scalar for each window by computing the ration between the raw and filtered maps.
4. Apply a scalar to the input traces

For this volume the Footprint removal was applied post migration.
Gate used every 500ms below water-bottom horizon
Smoothing filter 800m diameter
Line averaged over 3km

6. NMO CORRECTIONS

The third pass velocities were used to compute the normal moveout (NMO) corrections prior to stack. These velocities were sent to Santos digitally in Western Velocity format. SEG-Y of both the rms and interval velocities were also put on DVD and DLT tape respectively.

7. **OUTER AND INNER MUTE**
The same mute as per section 7.2 item 6 were applied on this dataset

8. **FULL AND ANGLE STACKS**
Stack is the summation of traces within each CDP producing a single stacked trace for each input gather record. The stack was normalised and mute zone compensated to account for the smaller number of live traces in the mute zone and for uneven fold of coverage. This amplitude compensation was done using 1/ fold normalisation function.
The full raw stack volume was SEG-Y archive on DLT tape

9. **POST STACK ZERO PHASING FILTER**
The zero-phasing filter as applied in item 7.2.9 was applied on the full, near and far stack volumes.

10. **TIME VARIANT FILTER**
The time variant filter as in item 7.2.10 was applied on the full, near and far stack volumes

11. **EXPONENTIAL GAIN CORRECTION**
The exponential gain in item 7.2.11 was applied on all 3 stack volumes

12. **SOURCE AND CABLE STATIC CORRECTION**
A total of +8 msec source and streamer static correction was applied to mean sea level (MSL) datum. This was applied to all 3 stack volumes

13. **ARCHIVE INITIAL HYBRID MIGRATION STACK TO SEG-Y DLT TAPES (3 VOLUMES)**
1 copy of each full, near and far initial Hybrid Migrated Stack volumes were archived to DLT tapes in SEG-Y format. A cut copy for VIC/P52 area was sent to Unocal.

7.4 FAST-TRACK PROCESSING 2ND PRE-STACK HYBRID MIGRATION

CONTINUE FROM SECTION 7.3 ITEM 2 DATASETS

1. **2ND HYBRID MIGRATION**
   The description for this process are as in section 7.3 item 3 above This second Hybrid Migration was performed using the velocity model built from velocity analyses 3 (section 7.3 item 4 above)

2. **FOURTH PASS PRE-STACK MIGRATION VELOCITY ANALYSES**
   The fourth pass velocity analyses were performed at 0.5 km grid using the gathers from the 2nd Hybrid migration.
   The velocities were picked at 1km grid, QC'ed and better interpolated for the subsequent fast track stacks. The 0.5 km grid velocities were later picked for Production Hybrid Migration velocity model.
   The rms velocities were SEG-Y on DVD as well as FTP to Santos site

3. **NMO CORRECTIONS**
   Initially, the third pass velocities (V3 in item 7.3.4 above) were used to compute the normal moveout (NMO) corrections prior to stack. Finally, the fourth pass velocities were used to create another set of stack.

   EXPONENTIAL GAIN CORRECTION on archive gathers only
   Exponential gain of 4dB/sec at water-bottom time + 1sec and 3dB/sec for the next 5sec was applied on the un-NMO gathers for archive only. The gathers were then NMO and SEG-Y archive onto 3 200gB USB disk caddies.

4. **OUTER AND INNER MUTE**
   The same mute as in above item 7.2.6 were applied on this dataset

5. **FULL AND ANGLE STACKS**
   2 full raw stack volumes were created, using velocity for V3 and V4 respectively. Near and far stack volume with V4 velocities were also produced.

6. **POST STACK ZERO PHASING FILTER**
   The zero-phasing filter as applied in item 7.2.9 was applied on the full, near and far stack volumes.

7. **TIME VARIANT FILTER**
   The time variant filter as in item 7.2.10 was applied on the full, near and far stack volumes

8. EXPONENTIAL GAIN CORRECTION

The exponential gain in item 7.2.11 was applied on all 3 stack volumes

9. SOURCE AND CABLE STATIC CORRECTION

A total of +8 msec source and streamer static correction was applied to mean sea level (MSL) datum. This was applied to all 3 stack volumes

10. ARCHIVE 2ND HYBRID MIGRATION STACK TO SEG-Y DLT TAPES (3 VOLUMES)

1 copy of each full, near and far 2nd Hybrid Migrated Stack volumes were archived to DLT tapes in SEG-Y format and sent to Santos. A copy of the full stack was sent to Inpex in Japan and a cut version for P52 area full stack was sent to Unocal.

7.5 PRODUCTION PRE-STACK HYBRID MIGRATION SEQUENCE

CONTINUE FROM SECTION 7.1 ITEM 18 – FLOOD DATASETS

19. BAD CABLE EDITS

Migration 'smiles' were noticed on the fast-track volumes. After some intensive investigations, bad cables (spikes on group of traces) that were not stated in observer's log were found on some sail lines in the south-eastern part of the survey. These spikes were edits on the FLOOD gathers prior to archives and final migration.

20. SPHERICAL DIVERGENCE REMOVAL & REAPPLY

Prior to archive, NMO was removed and sorted to CDP order. The single velocity function spherical divergence was removed and re-applied with V1 velocities.

21. ARCHIVE FLOOD GATHERS TO SEG-Y 3590 TAPES

The FLOOD gathers were archived to 3590 tapes (10 Gbytes) in SEG-Y format. See Appendix B6 for details of tapes archived

22. SCALEMUL

Scalemul as described in 7.3.1 was decided to apply to the final 12.5X12.5m bin grid gathers.

23. FREESURF

Free surface Multiple Attenuation is a process that attempts to remove all multiples created by reflection off the water/air interface at the sea surface. In addition to direct water bottom multiples and water layer peg legs, direct multiples from deeper horizons are addressed (not the case with WEMA). Interbeds are not addressed.

The multiple energy is predicted by auto-convolution of the original data. The predicted multiple model is then subtracted from the original data.

There are 3 methods of estimating the model:-

* 1D - Single trace auto-convolution is used on stack data.
* 1.5D - 2D autoconvolution is performed on shot records. This assumes a locally flat earth but includes all offsets.
* 2D - Shots and receivers are autoconvolved. This is applicable if the earth is not composed of flat reflectors.

In each case, a non-iterative solution is used.

The auto-convolution automatically predicts the seabed reflectivity but multiplies the source signature by itself. Prior to subtraction, the effect of the source signature must be estimated and removed from the model. This is done using time and space varying matching filters; optionally, the far field signature of the gun array may be removed deterministically before the matching filters are derived. This 'model' of the multiples is then subtracted from the original data in order to reveal the underlying primaries.

Parameters used for this process only were:
NMO removed
Spherical divergence removed
Data corrected to M.S.L.
NMO with water velocity of 1506m/s

Water-bottom	start time
0 to 1.6 sec	3200
1.6 sec and deeper	2 X water-bottom time

1D modelling

24. FOOTPRINT REMOVAL
Acquisition Footprint removal was also decided to be applied prior to the final migration.

25. REMOVE SPHERICAL DIVERGENCE
The spherical divergence was removed prior to migration

26. FINAL HYBRID MIGRATION
The migration aperture was tested and 2.5kilometer was selected for the final Hybrid migration. The velocity model was built from the 0.5km grid V4 velocities after better interpolated, smoothed and converted to depth.

27. FIFTH PASS FINAL HYBRID MIGRATION VELOCITY ANALYSES
They were performed in the same manner as the fourth pass velocity analyses at 0.25 km intervals.
The velocities were picked, QC and better interpolated and output at 0.125km for final stacks.

28. PRE-STACK EXPONENTIAL GAIN
The following gain were derived and applied to the final gathers prior to NMO and stack.

Water-bottom Time (wbt)	Gain in dB
Wbt + 0.0sec	0
Wbt + 1.0sec	8
Wbt + 2.5sec	20
Wbt + 3.5sec	28
Wbt + 6.0sec	32

29. NORMAL MOVEOUT CORRECTION
The fifth pass velocities were used to compute the normal moveout (NMO) corrections prior to stack. These velocities were save in Western Velocity format as well as SEG-Y onto DVD.

30. ARCHIVES FINAL HYBRID MIGRATION GATHERS

The final gathers (with NMO) were archived onto 3590 tapes in SEG-Y format.
2 copies were produced, 1 copy with just P52 area was entitled to Unocal.
These gathers were also SEG-Y to disk and copied to 3 200gB USB disk caddies.

31. ANGLE MUTES

The same angle mutes as in above item 7.2.6 were used to generate the full, near and far stacks

32. FULL AND ANGLE STACKS (1/FOLD NORMALISATION)

The full, near, far and an additional volume known as optimum full stack with pre-stack AGC 1000ms were created.
1 copies of the each full, near and far while 2 copies of the raw full optimum stack were SEG-Y onto DLT 4 tapes

33. POST STACK ZERO PHASING FILTER

The zero-phasing filter as in item 7.2.9 was applied on the full, near, far and optimum stack volumes

34. TIME VARIANT FILTER

The time variant filter as in item 7.2.10 was applied on the full, near, far and optimum stack volumes

35. SOURCE AND CABLE STATIC CORRECTION

A total of +8 msec source and streamer static correction was applied to mean sea level (MSL) datum. This was applied to all 3 stack volumes

36. ARCHIVE FINAL HYBRID MIGRATED STACK TO SEG-Y DLT TAPES (4 VOLUMES)

4 copies of each full, near and far final Hybrid migrated stack volumes were archived to DLT4 (35GB) tapes in SEG-Y format. See Appendix B7 to B9 for details of tapes archived.

7.6 OPTIONAL PROCESSING

7.6.1 AOK Processing For 163 Sq Km

CONTINUE FROM SECTION 7.5 ITEM 28 – FINAL HYBRID GATHERS

AOK is a method to correct NMO seismic velocities based on attributes derived from AVO analysis. Application of this method can improve the flatness of pre-stack NMO corrected seismic gathers. This can lead to significant improvements in the reliability of AVO interpretations and also provide a spatially and temporally densely sampled velocity field.

The input is NMO corrected CDP gathers - where the rms velocities have been typically estimated following a standard semblance based approach. The output consists of new NMO corrected CDP gathers derived from an updated rms velocity field based on the AOK velocity analysis method. Additionally, the updated velocity field is output as the trace that may be archived in SEGY format.

After the trials were conducted on 2 lines, an area of 163sq km was selected for AOK processing.
AOK was performed on inline range 7192 to 9048 and cross line range 1583 to 2285 of the final Hybrid Pre-stack Migration gathers.

The AOK gathers were SEG-Y on 1 USB disk caddy as well as on 14 3590 tapes.
Post stack zero-phasing, time variant filter and static correction to MSL were also apply to the 4 volumes of AOK stacks (full, near, far and optimum). These were then SEG-Y on DLT4 (35GByte) tapes.
SEG-Y of the AOK raw RMS, raw interval and conditional interval velocities were saved on 2 DVDs

7.6.2 Pore Pressure Prediction on 2 lines

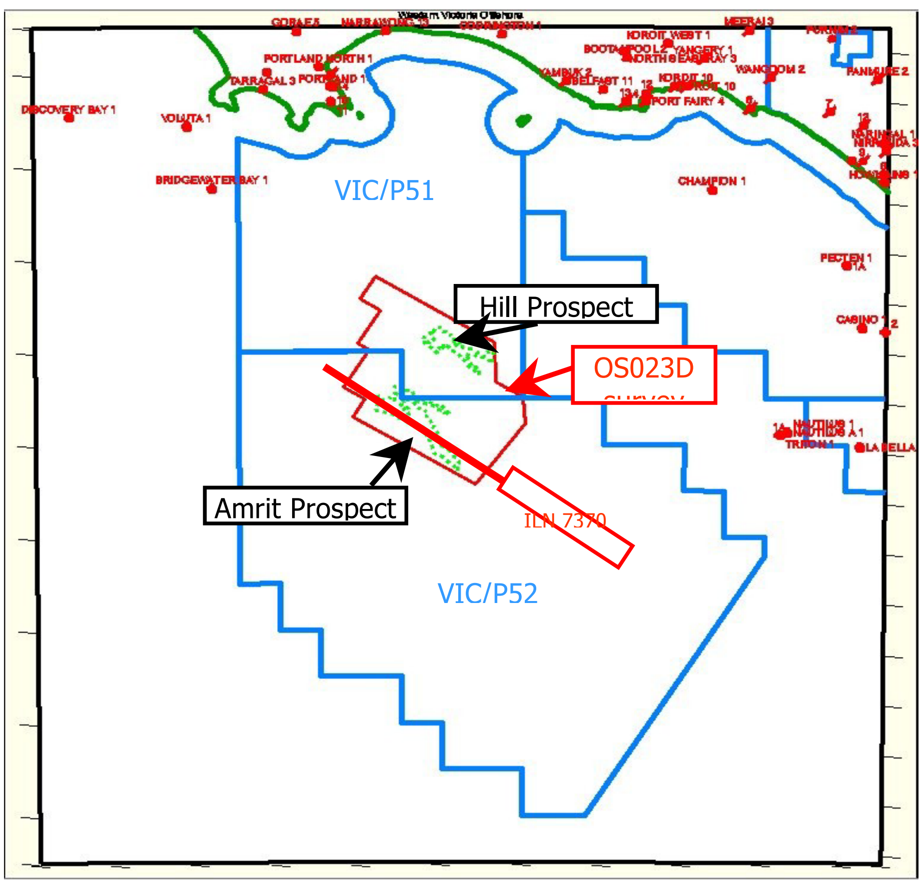
CONTINUE FROM SECTION 7.5 ITEM 28 – FINAL HYBRID GATHERS

Introduction

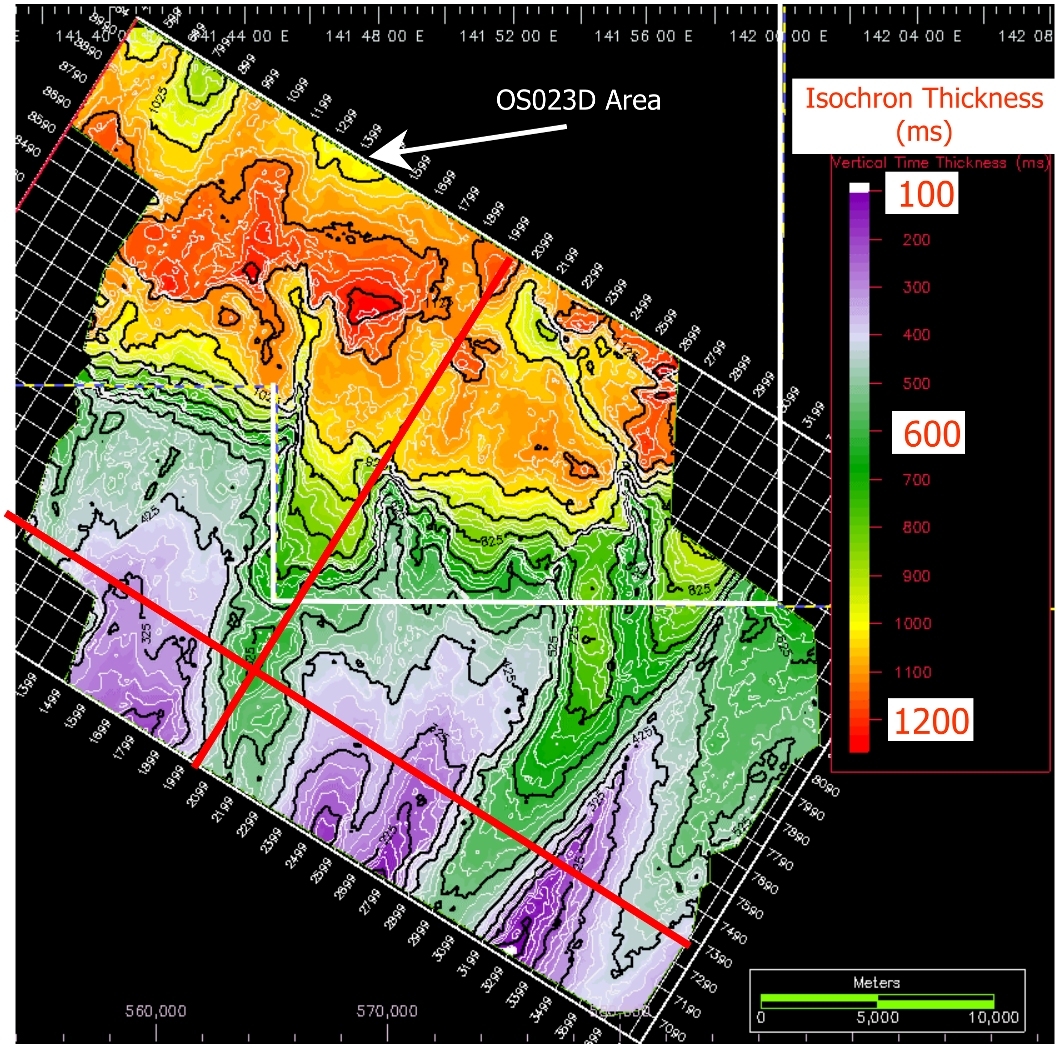
This report summarises the work performed to generate pore pressure estimates for two lines from the Amrit OS02 3D survey. Pore pressure estimates are obtained via high density seismic velocity estimation utilizing a technique suggested by Kan & Swan (2001). This followed an earlier paper by Swan (2001) who introduced the derivation of seismic velocities from AVO type measurements. In their work, the pore-pressure estimation from seismic velocity was based on the work of Hottman & Johnson (1965) who were first to demonstrate the link between pore-pressure and the deviation of elastic wave velocity away from a normal compaction trend. Eaton (1975) supplied an alternative, and more commonly used, relationship between pore-pressure and velocity when the cause of overpressure was under-compaction. The emphasis is placed on maximising both temporal and lateral resolution of the pressure estimates.

Location of Study

The VIC/P51 and P52 blocks together with the location of the OS02 3D survey are shown in the diagram below:



Two lines were chosen for the analysis: Inline 7370 and Crossline 2031. Their approximate location is shown in the map below which depicts the variations in Tertiary section thickness



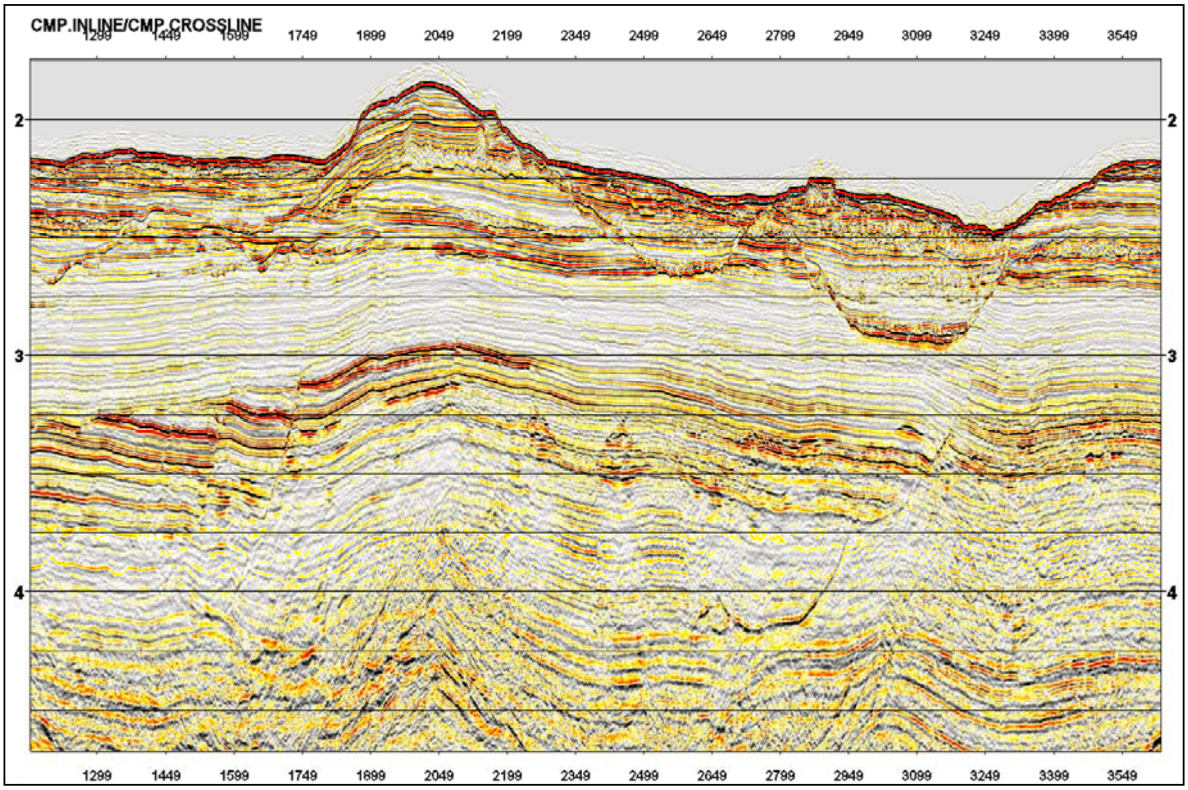
Methodology

To obtain the high-density velocity field, an extension to the standard Swan approach is used to derive a 3D velocity field, sampled 25m spatially and 4ms temporally. The extension consists of engineering a robust algorithm (Ratcliffe & Roberts, 2003) that is less sensitive to input velocity error in the presence of strong AVO anomalies such as phase reversals. Veritas's implementation of the technique is known as Amplitude Orientated Kinematics or AOK™

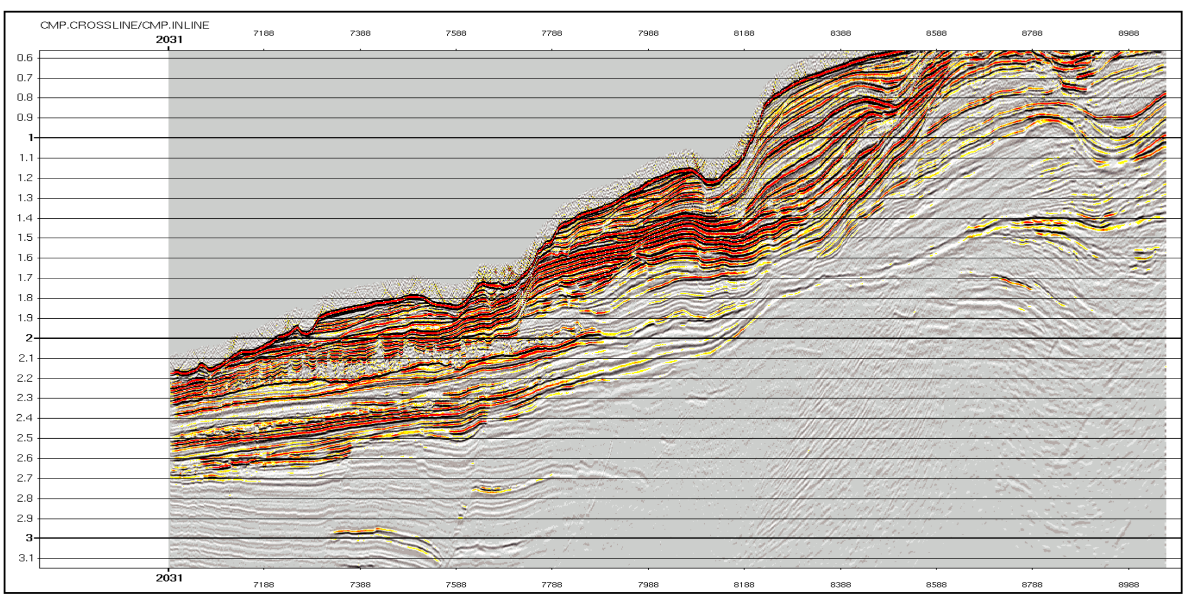
For the interval velocities of the Swan based velocity field to be meaningful, it is imperative that the geology is reasonably flat, the streamer offset is sufficient to provide raytraced incidence angles of at least 30°, and that the input data are imaged optimally. The latter demands that either prestack depth migrated, or raytraced, prestack time migrated input data are used. In the case of the Amrit 3D, the following processing sequence was applied to the data prior to geopressure velocity analysis:

- **Reformat to Tango internal format - 2ms; 6.5sec; 12.5m groups, 37.5m shots flip flop**
- Shot and trace edits
- Instrument Dephase (no gun and no cable ghost) - to output minimum phase
- 3Hz Low cut filter (zero phase)
- Spherical divergence V**2T using 1 average velocity function
- Swell Noise Attenuation (FXEDIT) - 2passes
- Resample to 4ms
- Linear noise removal (XRLIN)
- Velocity 1 (with mild Radon)
- Remove and reapply spherical divergence with V1 velocities.
- Tau-p Deconvolution on data with wbt less than 300ms
- Radon demultiple using XRMULT
- 3D Binning and Flood at 12.5 x12.5 m grid
- Edits Bad Cables and selected shots
- Scalemult
- Free Surface Multiple attenuation
- Footprint Removal
- PSDM /HYBRID Output 25 x 25 m Grid
- Residual Velocity Analysis 0.25 x 0.25 Km Grid
- AOK Analysis on selected lines il7370 and xl2031

Stacks of the 2 lines following application of the processing sequence above are shown below:

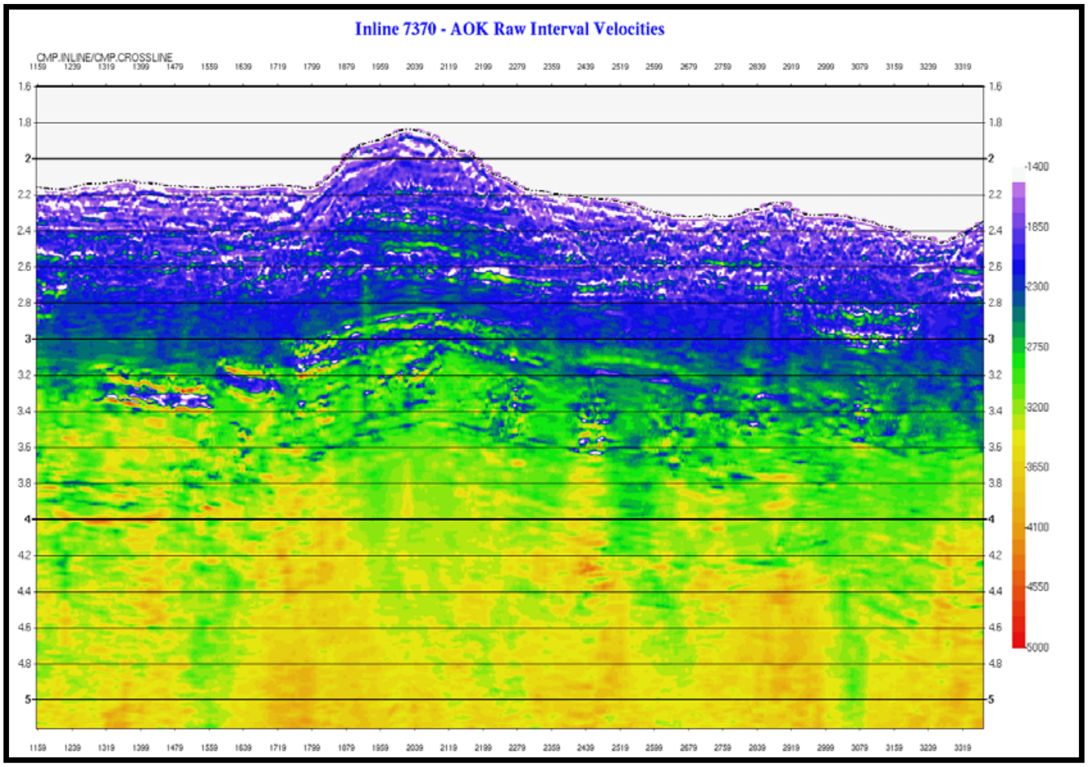


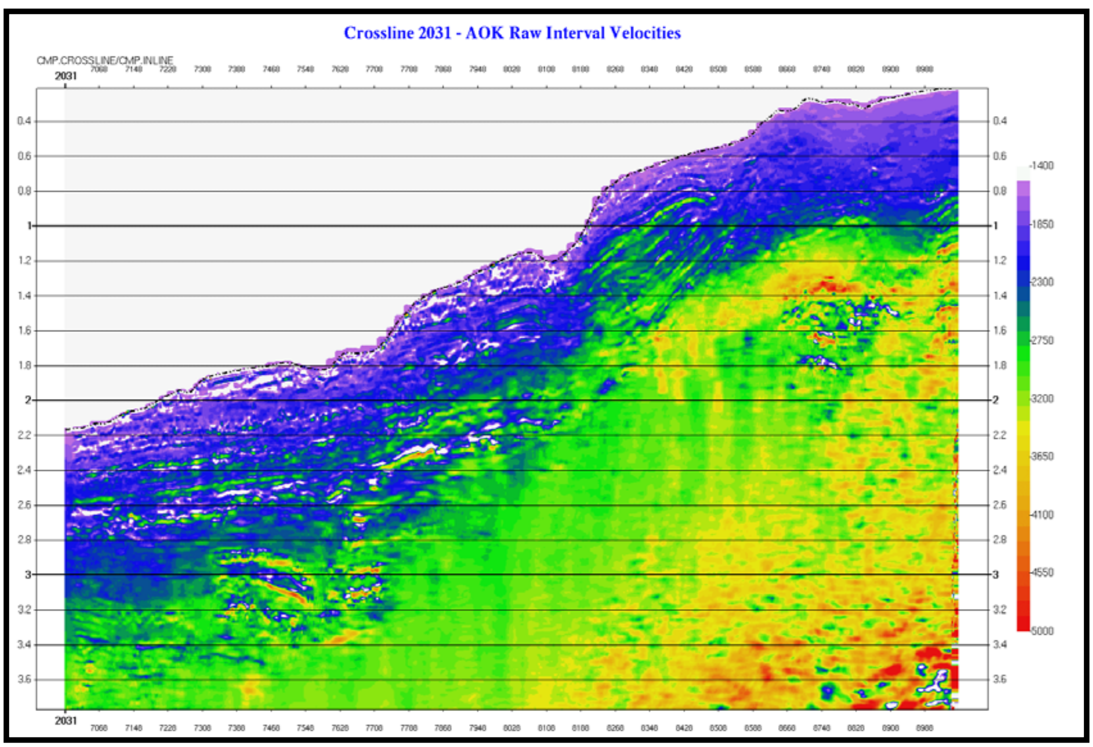
Inline 7370



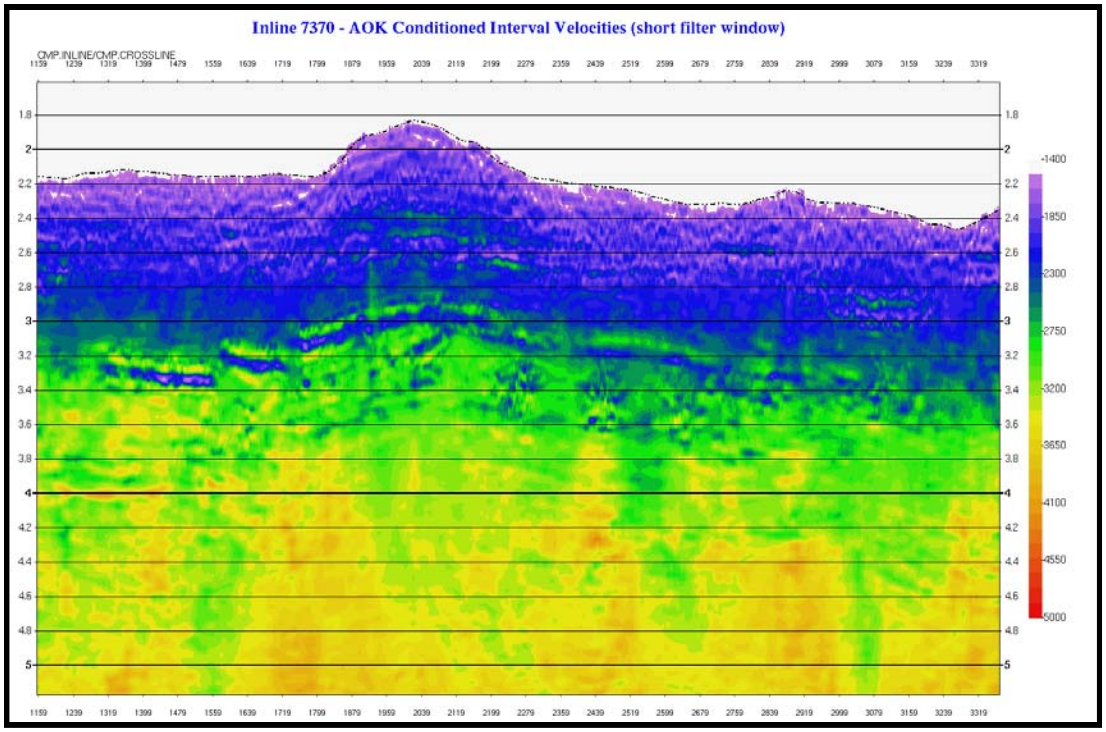
Crossline 2031

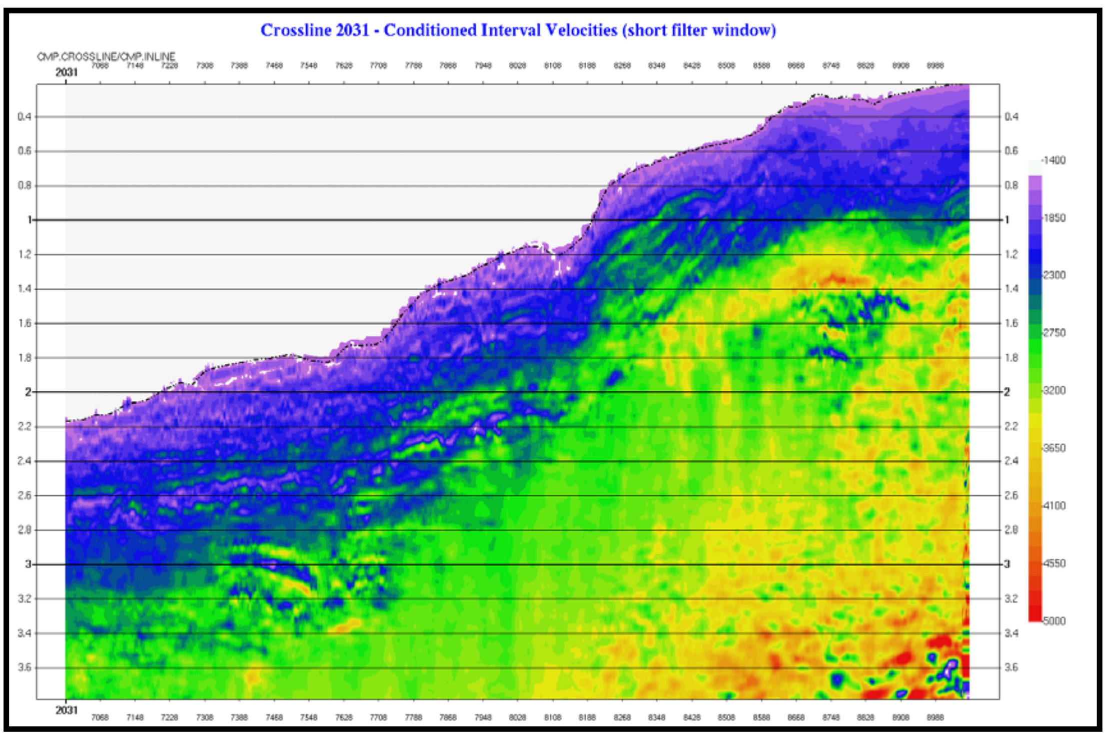
The AOK technique computes an RMS velocity based on AVO type measurements for every sample at each trace location. These RMS velocities may be Dix converted to interval velocities and displayed as ‘raw’ iso-velocity plots. These are shown for the 2 lines below:





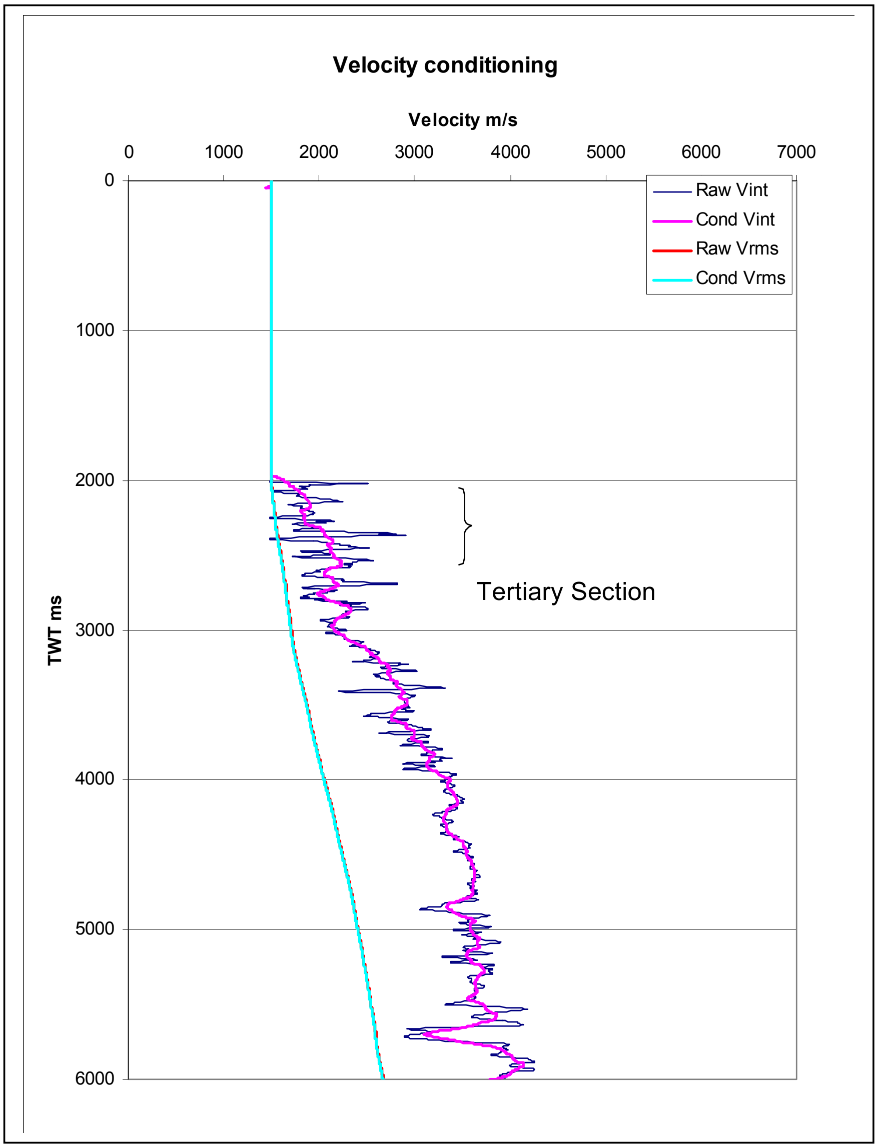
From the displays above, it is clear that there is considerable detailed information contained in these interval velocity estimates. In order to preserve resolution, the large lateral AVO averaging (half-spreadlength) is avoided. Instead, the lateral averaging of the AVO is determined by the measured signal quality, and the vertical interval velocities are conditioned by detection and correction of excessive slow or fast values immediately followed by compensating fast and slow velocities, respectively. This gives rise to the so-called 'conditioned' interval velocity profiles:



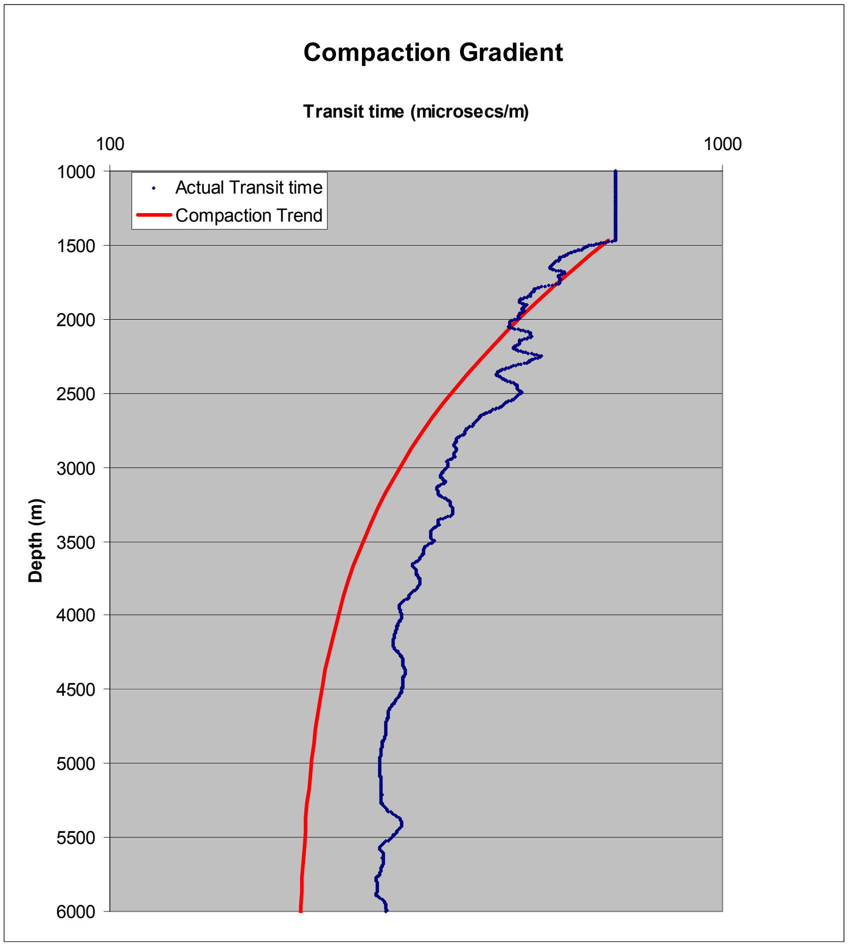


Derivation of Normal Compaction Gradient

Establishing a 'normal compaction' trend requires an analysis of the velocity gradient obtained from the AOK measurements in an area where there are believed to be 'clean' shales. Using information supplied from Santos, it was decided to use the deeper water near-surface section from crossline 2031 for this estimate. Shallower water tertiary sections were thought to contain significant 'contamination' from carbonate lithologies that might bias the measurements. The results from a particular location (inline 7200) are shown in the next two figures below.



AOK rms, raw interval and conditioned interval velocities for crossline 2031,inline 7200



The compaction gradient was computed according to an exponential trend that was defined to be asymptotic to a constant value at great depth relating to the velocity of shale when fully compacted. Normally, the compaction trend would be verified against sonic transit times from well data to identify, for example, the presence of anisotropy and its influence in the purely seismic derived trend. However, the absence of nearby well data meant that such a comparison was difficult to make.

The difference between the measured transit time and the compaction function, $\Delta\Delta T$, is then used to compute the pressure gradient given by:

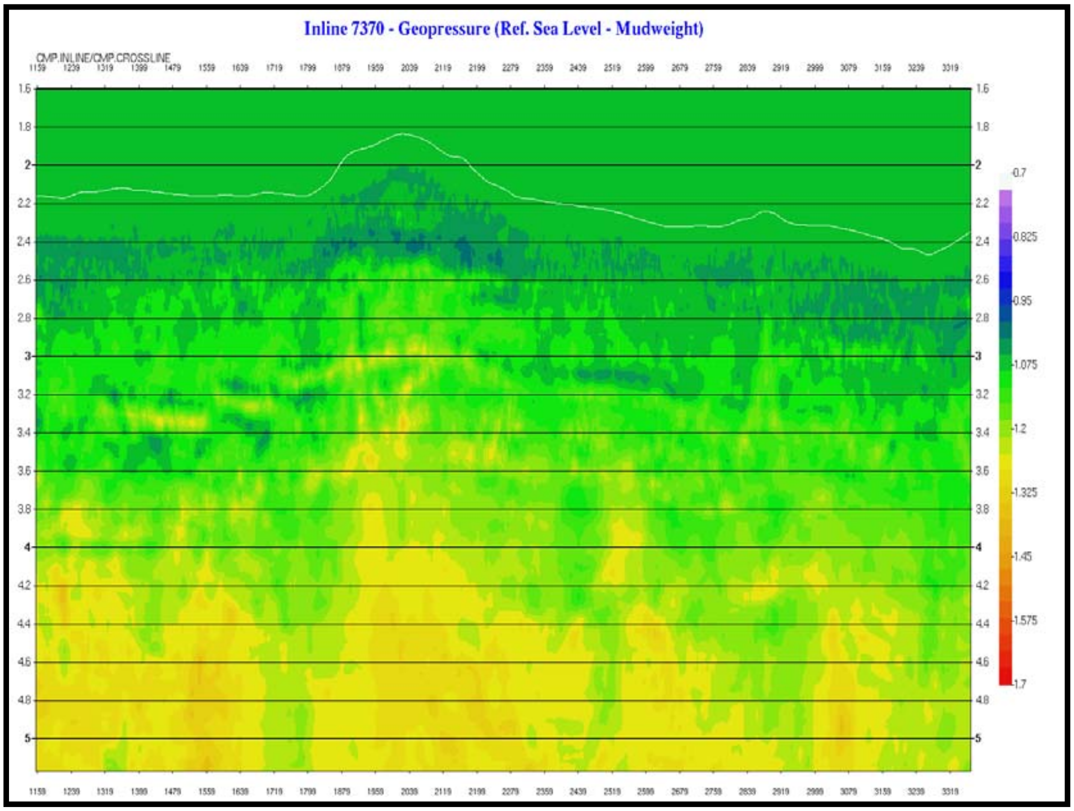
$$P(z)/z = R_w + C_1 * \Delta\Delta T + C_2 * (\Delta\Delta T)^2$$

Where:
R_w is the hydrostatic pore pressure.
C_1 and C_2 are constants.

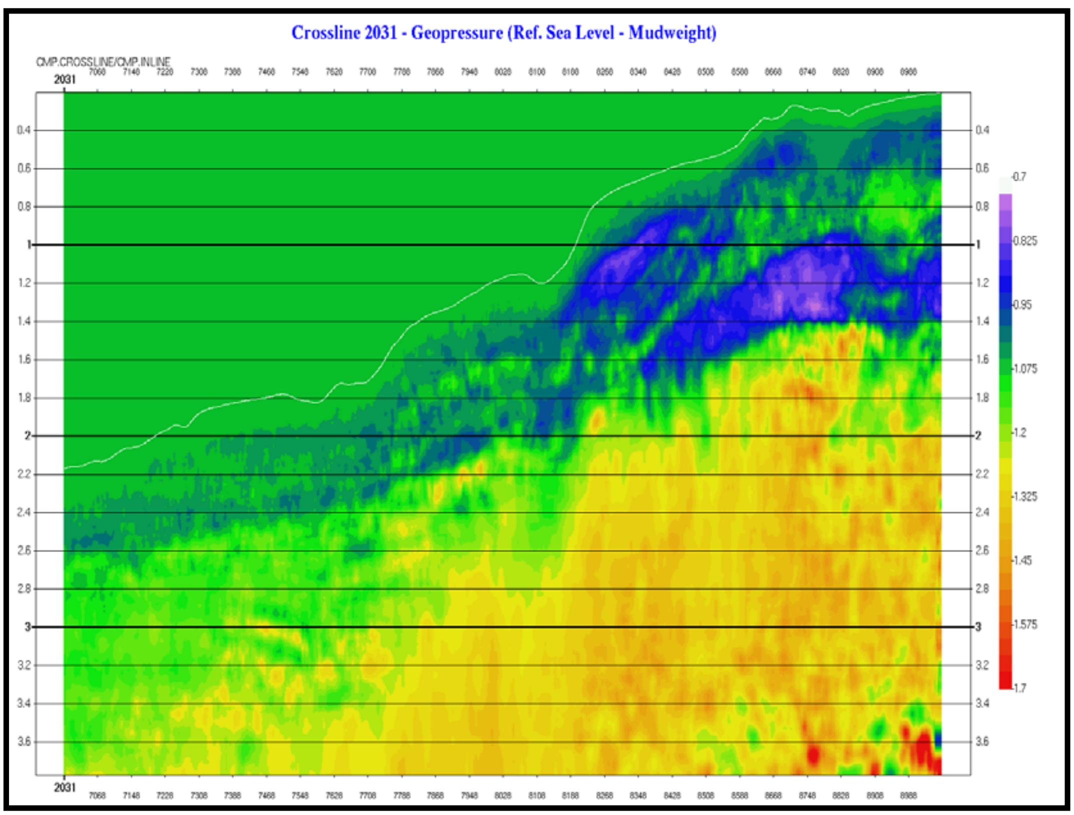
For the current test lines, the following values were used: $R_w = 11.5$, $C_1 = 0.04$, $C_2 = -0.00004$

Note that the pore pressure gradient calculated above will be inherently referenced to seabed. In order to covert this to a more meaningful mud weight density, the local seabed depth is incorporated into the calibration. This is the value that is output from the final analysis and displayed in the following figures.

Inline 7370 – Estimated pore pressure gradient



Crossline 2031 – Estimated pore pressure gradient



7.6.3 SCALEMUL Prior to DMO Stack / Migration

CONTINUE FROM SECTION 7.2 ITEM 3 – FAST TRACK FLOOD GATHERS

The processing sequences from section 7.2 items 4 to 13 were repeated after scalmul as descripted in section 7.3 item 1 was applied.

The raw and final Scalemul DMO Migrated stacks were SEG-Y archived on 2 DLT tapes.

8. QUALITY CONTROL

8.1 PROCEDURES / METHODS

Quality control procedures were conducted at every phase of this processing project. The following are the QC steps taken on a regular basis for each of the major processing phases posted in APR DP Reporting Database in Production QC Report and status Folder.

1. “Nav-Loading And Obs Log Reading”
2. “Nav QC – Cable Plt, Shtpt Plt and midpt Plt”
3. “Nav-QC – fold contributions”
4. “QC - onboard near trace ”
5. “Production Processing Flow QC – shot displays bef & aft FXEDIT & HRLIN”
6. “Seismic vs nav trace headers QC on near trace”
7. “QC – water-depth map”
8. “Near trace cube QC – with and without tidal correction”
9. “Check cable depths recorded in acquisition event report ”
10. “Veritas Picked Vel 1 – 2D isovel and XRMULT stack”
11. “Fast-track DMO Stacks Of Velocity Lines”
12. “Polygon of VIC/P52 ”
13. “Fast-track Fold Maps QC Before & After FLOOD “
14. “Fast-track migration velocity”
15. “Fast-track DMO/Post Migration stack QC ”
16. “Fast-track Initial Hybrid Migrated stack QC”
17. “Production Fold Maps QC Before & After FLOOD”
18. “Fast-track 2nd Hybrid velocity and stack QC
19. “QC bad cable spikes found in South-Eastern part of survey
20. “Production Footprint Removal QC offset
21. “Production Hybrid Migration QC offset timeslices
22. “QC returned tape to verify missing data
23. “Final Hybrid Migration Residual velocities
24. “Final raw, full, near, far and optimum stack QC”
25. “Segy trace headers”
26. “Fast-track Scalmul DMO/Post Migration stacks
27. “Final Pre-Stack Hybrid Migration NMO gathers SEGY QC
28. “AOK gathers and stack
29. “Production FLOOD gathers SEGY QC

APPENDIX A – FIELD DATA LINE LIST

A1 LINE LISTING

NO	LINE	FSP	LSP	DIR	KM	NOTES	INFILL
1	1008A	2342	1511	301	249.3		
2	1008P	1520	878	301	192.6		
3	1024A	2356	2052	301	91.2		
4	1024B	2061	1676	301	115.5		
5	1024P	1685	878	301	242.1		
6	1040A	2370	2324	301	13.8		
7	1040P	2333	878	301	436.5		
8	1056P	2384	878	301	451.8		
9	1072A	2153	2083	301	21		
10	1072P	2398	2144	301	76.2	SP 2143-2093 block edit d/t gun problems	
		2092	878		364.2		
11	1088P	2412	878	301	460.2		
12	1104A	1001	1186	121	55.5		
13	1104P	2425	937	301	446.4		
14	1120P	2439	878	301	468.3		
15	1136P	2453	878	301	472.5		
16	1152J	2467	878	301	476.7		476.7
17	1152P	2467	878	301	476.7		
18	1168P	2481	878	301	480.9		
19	1184P	2495	878	301	485.1		
20	1200A	1301	1233	301	20.4		
21	1200P	2509	1292	301	365.1	SP 1291-1243 Airleak on gunstring 1	
		1242	878		109.2		
22	1216A	1319	1220	301	29.7	SP 1219-1114 NTBP d/t no new coverage	
		1113	878		70.5		
23	1216P	2522	1310	301	363.6	SP 1309-1230 :Spectra Crash	
		1229	1104		37.5		
24	1232P	2536	1104	301	429.6		
25	1248J	2550	1104	301	433.8		433.8
26	1248P	2550	1104	301	433.8		

NO	LINE	FSP	LSP	DIR	KM	NOTES	INFILL
27	1264P	1227	2687	121	438		
28	1280P	1227	3009	121	534.6		
29	1296A	2529	3025	121	148.8		
30	1296P	1227	2538	121	393.3		
31	1312P	1227	3042	121	544.5		
32	1328P	1227	3058	121	549.3		
33	1344P	1226	3075	121	554.7		
34	1360P	1226	3091	121	559.5		
35	1376P	1227	3107	121	564		
36	1392J	1226	1525	121	89.7	SP 1526-1558:gunstring 8 MF problem	89.7
		1559	3124		469.5		469.5
37	1392K	1516	1568	121	15.6		15.6
38	1392P	1226	3124	121	427.05	Cable 7,8 NTBP d/t telemetry problems	
39	1408P	1226	3140	121	574.2		
40	1424P	1226	3156	121	579		
41	1440A	1226	1689	121	138.9		
42	1440P	1680	3159	121	443.7		
43	1456A	1863	2702	121	251.7		
44	1456P	1226	1872	121	193.8	SP 1873-2692: airleak gunstring 1	
		2693	3157		139.2		
45	1472A	2012	2200	121	56.4		
46	1472B	2191	2771	121	174		
47	1472P	1226	2015	121	236.7	SP 2016-2761:stop recording d/t whale sightings	
		2762	3156	122	118.2		
48	1488P	1226	3154	121	578.4		
49	1504J	1226	3152	121	577.8		577.8
50	1504K	1226	3152	121	577.8		577.8
51	1504P	1226	3152	121	577.8		
52	1520P	3027	1236	301	537.3		
53	1536P	3025	1236	301	536.7		
54	1552P	3024	1236	301	536.4		
55	1568P	3022	1236	301	535.8		
56	1584P	3020	1236	301	535.2		
57	1600P	3018	1236	301	534.6		

NO	LINE	FSP	LSP	DIR	KM	NOTES	INFILL
58	1616A	3016	2636	301	114		
59	1616P	2643	1236	301	422.1		
60	1632A	2225	1236	301	296.7		
61	1632J	3015	1236	301	533.7		533.7
62	1632P	3015	2216	301	239.7	SP 2215-1595 bad d/t gunstring problems	
		1594	1410		55.2		
63	1648P	3013	1236	301	533.1		
64	1664P	3011	1249	301	528.6		
65	1680P	3009	1236	301	531.9		
66	1696A	1822	1236	301	153.825	Cable 2 NTBP d/t telemetry prob	
67	1696B	1812	1265	301	143.588	Cable 2 NTBP d/t telemetry prob	
68	1696P	3007	1813	301	358.2		
69	1712A	1688	1236	301	118.65	Cable 2 NTBP d/t even fibers dropout	
70	1712P	3006	1679	301	398.1		
71	1728A	1359	1889	121	119.25	Cable 2 & 8 NTBP d/t telemetry prob	
72	1728B	1643	1236	301	91.575	Cable 2 & 8 NTBP d/t telemetry prob	
73	1728P	3004	1634	301	411		
74	1744P	3002	1236	301	529.8		
75	1760J	3000	1236	301	529.2		529.2
76	1760K	3000	2550	301	101.25	Cable 2 & 8 NTBP d/t telemetry prob	101.25
77	1760P	3000	1236	301	529.2		
78	1776P	1359	3121	121	528.6		
79	1792P	1359	3120	121	528.3		
80	1808B	2995	2663	301	74.7	Cable 2 & 8 NTBP d/t telemetry prob	
81	1808P	1359	2918	121	467.7		
82	1824P	1359	3116	121	527.1		
83	1840P	1359	3114	121	526.5		
84	1856J	1359	3112	121	525.9		525.9
85	1856P	1359	3112	121	525.9		
86	1872A	2348	2479	121	34.3875	Cable 2 NTBP d/t no even fibers	

NO	LINE	FSP	LSP	DIR	KM	NOTES	INFILL
87	1872P	1595	2357	121	228.6	SP 2358-2469: Spectra crash	
		2470	3111		192.3		
88	1888B	2747	2874	121	28.575	Cable 2 & 8 NTBP d/t telemetry prob	
89	1888P	1595	2756	121	348.3	SP 2757-2864 NTBP d/t compressor down	
		2865	3109		73.2		
90	1904P	1595	3107	121	453.6		
91	1920P	1595	3105	121	453		
92	1936P	1595	3103	121	452.4		
93	1952P	1595	3102	121	452.1		
94	1968P	1596	3100	121	451.2		
95	1984A	2316	2456	121	36.75	Cable 2 NTBP d/t telemetry prob	
96	1984P	1596	2325	121	218.7	SP 2326-2456: Full lockup	
		2457	3098		192.3		
97	2000P	1596	3096	121	450		
98	2016A	1826	2429	121	158.288	Cable 2 NTBP d/t telemetry prob	
99	2016B	1816	2439	121	140.175	Cable 2 & 8 NTBP d/t optics dead	
100	2016P	1596	1825	121	68.7	Gap SP 1826-2429 d/t vessel turning	
		2430	3094		199.2		
101	2032J	1596	3093	121	449.1		449.1
102	2032P	1596	3093	121	449.1		

Total CMP Kilometres : 38,065.200
Total Infill CMP Kilometres : 4,780.050
Total Prime CMP Kilometres : 33,8285.100
Total full fold CMP Kilometres : 30,929.900
Total full fold square Kilometres : 773.248

APPENDIX B - DELIVERABLE ITEMS

B0 DELIVERABLE LISTING

No.	Data Type	Format	Media Type	Tape ID.
1.	FASTTRACK RAW AND FINAL DMO/MIGRATED STACK	SEG-Y	DLT4	SANFASTMIG_01 SANFMIGRAW_01R (REPLACEMENT TAPE)
	FASTTRACK RAW AND FINAL DMO/MIGRATED STACK (P52 AREA ONLY FOR UNOCAL)	SEG-Y	DLT4	SANFMIG_U01
	FASTTRACK RAW AND FINAL SCALEMUL/ DMO/MIGRATED STACK	SEG-Y	DLT4	SCALFMIGRAW_01 SCALFMIGTVS_01
2.	NEAR TRACE CUBE	SEG-Y	DLT4	SANNTG_V01 SANNTG_V02
3.	FASTTRACK INITIAL HYBRID MIGRATED STACK – FINAL FULL, NEAR & FAR VOLUMES	SEG-Y	DLT4	SANHYBRID_MIGTVS01 SANHYBRID_NRTVS01 SANHYBRID_FRTVS01
4.	INTERPOLATED VELOCITY MODEL FOR 2ND HYBRID MIG	SEG-Y	DLT4 AND DVD)	NEWINTPVEL01 (RMS) NINTPINTVEL01 (INTERVAL)
5.	FASTTRACK 2ND HYBRID PRESTK MIG FINAL FULL STACK VOLUME	SEG-Y	DLT4 (2copies and 2copies cut version)	HYBRID_MIG2TVS01 (each for Inpex & Santos) H_ MIG2TVS_U03 (each for Unocal & Santos)
	FASTTRACK 2ND HYBRID PRESTK MIG FINAL NEAR & FAR STACK VOLUMES	SEG-Y	DLT4	P2NRTVFZPS01 P2FRTVFZPS01
	FASTTRACK 2ND HYBRID PRESTK MIG GATHERS	SEG-Y	3 USB DISK CADDIES	TOTAL 310 SEGY FILES (APPROX 2GB SIZE FILE)
6.	PRODUCTION FLOOD GATHERS 12.5X12.5M GRID	SEG-Y	3590 TAPES (248 TAPES)	FLDGSY001 TO FLDGSY248

No.	Data Type	Format	Media Type	Tape ID.
7.	PRODUCTION HYBRID PRESTK MIG – RAW AND FINAL FULL, NEAR, FAR & OPTIMUM STACK VOLUMES	SEG-Y	DLT4 (2copies + 1 copy for Japan)	PSDMSTKRAW (2copies) FSTKTVFZP (2 copies) AGCSTKTVFZP 3 copies NRSTKTVFZP 3 copies FRSTKTVFZP 3 copies
8.	PRODUCTION HYBRID PRESTK MIG - FINAL FULL, NEAR, FAR & OPTIMUM STACK VOLUMES (P52 ONLY)	SEG-Y	DLT4 (for Unocal)	P52_FSTKTVFZP P52_AGCSTKTVFZP P52_NRSTKTVFZP P52_FRSTKTVFZP
9.	PRODUCTION HYBRID PRESTK MIGRATED GATHERS	SEG-Y	61 3590 TAPES 32 3590 TAPES (cut copy for Unocal) 3 caddies	PSDMCMP01 TO 61 UNOCMP01 TO 32 311 SEGY DISK FILES (APPROX 2GB /FILE)
10.	FINAL MIGRATION VELOCITY FIELD (RMS & INTERVAL) RESIDUAL VELOCITY FIELD	SEG-Y FILES & SEG-Y & WESTERN FORMAT	3 DVD EACH CD	FVELINTPSMRMS_PT1 TO PT6 FVELINTPSMINT_PT1 TO PT6 RESIDV_INTPTVRMS.SGY JC7_PSDM2RESV.WES
11.	AOK GATHERS AOK FINAL FULL, NEAR, FAR AND OPTIMUM FULL STACK VOLUMES	SEG-Y	14 3590 TAPES + 1 CADDY DLT4	AOKCMP01 TO 14 75 SEG-Y DISK FILES AOKSTKSTVFZP ANRSTKSTVFZP AFRSTKSTVFZP AGCSTKSTVFZP
12.	AOK VELOCITIES RMS RAW INTERVAL CONDITIONED INTERVAL	SEG-Y	DVD (54 FILES) (54 FILES) (54 FILES)	 *_AOKVRMS.SGY *_RVINT.SGY *_CVINT.SGY

B1 FASTTRACK RAW, FINAL DMO MIGRATED STACK SEG-Y TAPE LOG

CLIENT : SANTOS LIMITED
AREA : SANTOS VIC P51/P52 OS02 3D
PROCESS : 1. RAW DMO/ MIGRATED STACK
2. FINAL DMO/ MIGRATED STACK (WITH TVF/TVS)
3. FINAL DMO/ MIGRATED STACK (WITH TVF/TVS) VP52 ONLY
4. RAW SCALEMUL/ DMO/MIGRATED STACK
5. FINAL SCALEMUL/ DMO/MIGRATED STACK

DATA LENGTH : 6.5 SEC
SAMPLE RATE : 4 MSEC
FORMAT : SEG-Y DLT4 35GB DENSITY
TAPE ID : 1) SANFMIGRAW_01R SUBLINE 6990 – 9064 (1371220 TRACES)
2) SANFASTMIG_01 SUBLINE 6990 – 9064 (13771220 TRACES)
3) SANFMIG_U01 SUBLINE 6990 – 8552 (733563 TRACES)
4) SCALFMIGRAW_01 SUBLINE 6990 – 9064
5) SCALFMIGTVS_01 SUBLINE 6990 – 9064

DEFINED HEADER ENTRIES

SEGY TRACE HEADERS OF FAST TRACK SCALMULT MIGRATED STACK
(With time variant filter/exponential gain/source and cable depth corrections applied)

VALUE	BYTES	BINNED DATA DEFINITION
1	001 - 004	Trace number within line. Starts with 1 per data set
1	005 - 008	Trace number within a tape. Starts with 1 on each tape
1500	009 - 012	Original Field Record Number
0	013 - 016	
6990	017-020	Inline Number (Binned) - Shot Number for unbinned
1395	021 - 024	Crossline Number (Binned) - CMP Number for unbinned
0	025 - 028	
0	029 - 030	
0	031 - 032	
1	033 - 034	Number of horizontally stacked traces (number of traces summed)
0	035 - 036	
0	037 - 040	
-7	041 - 044	
0	045 - 048	
-5	049 - 052	Source Elevation (m) relative to SRD -ve for below SRD
0	055 - 056	
0	059 - 060	
0	061 - 064	

VALUE	BYTES	BINNED DATA DEFINITION
0	065 - 068	
1	069 - 070	Scalar to be applied to numbers in fields 41-68 eg 1,10,100 or -10 for division
1	071 - 072	Co-ordinate Scalar to be applied to numbers in fields 73-88
554896	073 - 076	CMP x coordinates (units as per bytes 71-72)
5689595	077 - 080	CMP y coordinates (units as per bytes 71-72)
0	081 - 084	
0	085 - 088	
1	089 - 090	Coordinate units: 1 = metric [m], 2 = seconds of arc, 3 = Imperial [ft]
0	091 - 092	
3333	099 - 100	Source Static Correction (microseconds)
4667	101 - 102	Receiver Static Correction (microseconds)
0	103 - 104	
6500	105 - 106	Tmax (in msec)
0	107 - 108	
0	109 - 110	Time of First Sample (msec)
1626	115 - 116	Number of Samples
4000	117 - 118	Sample interval in micro seconds for this trace (msec)
0	119 - 120	
0	121 - 122	
0	123 - 124	
554896	125 - 128	Bin Centre x coordinates (CMP X)
5689595	129 - 132	Bin Centre y coordinates (CMP Y)
0	141 - 142	
0	143 - 144	
0	145 - 146	
0	147 - 148	
0	149 - 150	
0	151 - 152	
0	153 - 154	
0	155 - 156	
0	157 - 158	
0	159 - 160	
0	161 - 162	
0	163 - 164	
0	165 - 166	
0	167 - 168	

VALUE	BYTES	BINNED DATA DEFINITION
554896	181 - 184	Bin Centre x coordinates (CMP X)
5689595	185 - 188	Bin Centre y coordinates (CMP Y)
995	189 - 192	Inline for Post Stack Data - Shot No for Binned data
1395	193 - 196	Crossline for Post Stack Data - CMP No for unbinned data
22038	197 - 200	Inline (Western Geco): 5 digits no
2038	201 - 204	Crossline (Western Geco): 4 digits no
0	205 - 206	
0	207 - 208	
0	209 - 212	
0	213 - 216	
0	217 - 220	
0	225 - 228	
0	229 - 232	
0	233 - 236	

B2 NEAR TRACE CUBE TAPELOG

CLIENT : SANTOS LIMITED
AREA : SANTOS VIC P51/P52 OS02 3D
PROCESS : NEAR TRACE CUBE 6.25M x 25.0M GRID
DATA LENGTH : 6.5 SEC
SAMPLE RATE : 2 MSEC
FORMAT : SEG-Y DLT4 35GB DENSITY
TAPE ID : 1) SANNTG_V01 (INLINE: 6990-8032, TOTAL 2518254 traces)
2) SANNTG_V02 (INLINE: 8034-9066, TOTAL 2515697 traces)

DEFINED HEADER ENTRIES

SEGY TRACE HEADERS OF NEAR TRACE VOLUME

VALUE	BYTES	BINNED DATA DEFINITION
1	001 - 004	Trace number within line. Starts with 1 per data set
1	005 - 008	Trace number within a tape. Starts with 1 on each tape
2179	009 - 012	Shotpoint Number
1	013 - 016	Trace No within Original Record (channel)
6990	017-020	Inline Number (Binned) - Shot Number for unbinned
4823	021 - 024	Crossline Number (Binned) - CMP Number for unbinned
0	025 - 028	
1	029 - 030	
0	031 - 032	
1	033 - 034	Number of horizontally stacked traces (Number of traces summed)
0	035 - 036	
0	037 - 040	
-7	041 - 044	Receiver Elevation (m) relative to SRD -ve for below SRD
0	045 - 048	
-5	049 - 052	Source Elevation (m) relative to SRD -ve for below SRD
0	055 - 056	
0	059 - 060	
0	061 - 064	
0	065 - 068	
1	069 - 070	Scalar to be applied to numbers in fields 41-68 eg 1,10,100 or -10 for division
1	071 - 072	Co-ordinate Scalar to be applied to numbers in fields 73-88
565850	073 - 076	Shot x coordinates (units as per bytes 71-72)
5689954	077 - 080	Shot y coordinates (units as per bytes 71-72)
565491	081 - 084	Receiver x coordinates (units as per bytes 71-72)

VALUE	BYTES	BINNED DATA DEFINITION
5682773	085 - 088	Receiver y coordinates (units as per bytes 71-72)
1	089 - 090	Coordinate units: 1 = metric [m], 2 = seconds of arc, 3 = Imperial [ft]
1500	091 - 092	Water Velocity used in processing at this bin location
3333	099 - 100	Source Static Correction (microseconds)
4667	101 - 102	Receiver Static Correction (microseconds)
0	103 - 104	
6500	105 - 106	Tmax(in msec)
0	107 - 108	
0	109 - 110	Time of First Sample (msec)
3251	115 - 116	Number of Samples
2000	117 - 118	Sample interval in micro seconds for this trace (msec)
0	119 - 120	
0	121 - 122	
0	123 - 124	
565664	125 - 128	Bin Centre x coordinates (CMP X)
5682838	129 - 132	Bin Centre y coordinates (CMP Y)
0	141 - 142	
0	143 - 144	
0	145 - 146	
0	147 - 148	
0	149 - 150	
0	151 - 152	
0	153 - 154	
0	155 - 156	
0	157 - 158	
0	159 - 160	
0	161 - 162	
0	163 - 164	
0	165 - 166	
0	167 - 168	
565664	181 - 184	Bin Centre x coordinates (CMP X)
5682838	185 - 188	Bin Centre y coordinates (CMP Y)
995	189 - 192	Inline for Post Stack Data - Shot No for Binned data
4823	193 - 196	Crossline for Post Stack Data - CMP No for unbinned data
22038	197 - 200	Inline (Western Geco): 5 digits no
2038	201 - 204	Crossline (Western Geco): 4 digits no

VALUE	BYTES	BINNED DATA DEFINITION
0	205 - 206	
0	207 - 208	
0	209 - 212	
1734	213 - 216	CMP water depth (units see bytes 69-72)
69904823	217 - 220	CMP Number in Processing
3463	221 - 224	Shotpoint Number
2032089	233 - 236	Sail Line Suffix with Seq No

B3 FAST TRACK INITIAL HYBRID MIGRATED STACK TAPELOG

CLIENT	:	SANTOS LIMITED
AREA	:	SANTOS VIC P51/P52 OS02 3D
PROCESS	:	MIGRATED STACK (WITH TVF/ZERO PHASE/GAIN & SSD APPLIED)
DATA LENGTH	:	6.5 SEC
SAMPLE RATE	:	4 MSEC
FORMAT	:	SEG-Y DLT4 35GB DENSITY
TAPE ID	:	1) SANHYBRID_MIGTVS01 SUBLINE 995 – 2032 (1413982 TRACES) 2) SANHYBRID_NRTVS01 SUBLINE 995 – 2032 (1376723 TRACES) 3) SANHYBRID_FRTVS01 SUBLINE 995 – 2032 (1404232 TRACES)

DEFINED HEADER INFORMATION

NAME	FORMAT	FIRST BYTE	NUMBER OF BYTES
LINECOUNT	INT	1	4
REELCOUNT	INT	5	4
SP	BINARY	9	4
CONSTANT	BINARY	13	4
INLINE	BINARY	17	4
CROSSLINE	BINARY	21	4
FOLD	BINARY	33	2
CDPX	BINARY	73	4
CDPY	BINARY	77	4
CDPX	BINARY	125	4
CDPY	BINARY	129	4
CDPX	BINARY	181	4
CDPY	BINARY	185	4
SUBLINE	BINARY	189	4
CROSSLINE	BINARY	193	4
WESINLINE	BINARY	197	4 (5 DIGITS NO.)
WESINLINE	BINARY	201	4 (4 DIGITS NO.)

B4 FAST TRACK INTERPOLATED VELOCITY MODEL TAPELOG

CLIENT	:	SANTOS LIMITED
AREA	:	SANTOS VIC P51/P52 OS02 3D
PROCESS	:	FAST TRACK INTERPOLATED INTERVAL/ RMS VELOCITY MODEL FOR 2nd HYBRID MIG
DATA LENGTH	:	6.5 SEC
SAMPLE RATE	:	4 MSEC
FORMAT	:	SEG-Y DLT4 35GB DENSITY
TAPE ID	:	1) NINTPINTVEL01 INLINE 6990 – 9064(1779132 TRACES) CROSSLINE 459 – 3885(Increment 2)
		2) NEWINTPVEL01 INLINE 1026 – 2026(1602601 TRACES) CROSSLINE 561 – 3761(Increment 2)

DEFINED HEADER INFORMATION

NAME	FORMAT	FIRST BYTE	NUMBER OF BYTES
LINECOUNT	INT	1	4
REELCOUNT	INT	5	4
SP	BINARY	9	4
CONSTANT	BINARY	13	4
INLINE	BINARY	17	4
CROSSLINE	BINARY	21	4
CDPX	BINARY	73	4
CDPY	BINARY	77	4
CDPX	BINARY	125	4
CDPY	BINARY	129	4
CDPX	BINARY	181	4
CDPY	BINARY	185	4
SUBLINE	BINARY	189	4
CROSSLINE	BINARY	193	4
WESINLINE	BINARY	197	4 (5 DIGITS NO.)
WESINLINE	BINARY	201	4 (4 DIGITS NO.)

B5 FAST TRACK 2ND HYBRID MIGRATED STACK (TVS) TAPELOG

CLIENT : SANTOS LIMITED
AREA : SANTOS VIC P51/P52 OS02 3D
PROCESS : 2nd HYBRID MIGRATED STACK
(WITH TVF/ZERO PHASE/GAIN & SSD APPLIED)
DATA LENGTH : 6.5 SEC
SAMPLE RATE : 4 MSEC
FORMAT : SEG-Y DLT4 35GB DENSITY
TAPE ID : 1) HYBRID_MIG2TVS01 (1413982 TRACES)
2) H_MIG2TVS_U03 (758239 TRACES)
3) P2NRTVFZPS01 SUBLINE 995 - 2032(1417550 TRACES)
4) P2fRTVFZPS01 SUBLINE 995 - 2032(1417550 TRACES)

SEGY TRACE HEADERS OF FAST TRACK 2ND HYBRID MIGRATED STACK (25MX25M)

(With time variant filter/ zero phase filter/ exponential gain/ source and cable depth corrections applied)

VALUE	BYTES	BINNED DATA DEFINITION
1	001 - 004	Trace number within line. Starts with 1 per data set
1	005 - 008	Trace number within a tape. Starts with 1 on each tape
1500	009 - 012	Original Field Record Number
0	013 - 016	
6990	017-020	Inline Number (Binned) - Shot Number for unbinned
1395	021 - 024	Crossline Number (Binned) - CMP Number for unbinned
0	025 - 028	
0	029 - 030	
0	031 - 032	
1	033 - 034	Number of horizontally stacked traces (number of traces summed)
0	035 - 036	
0	037 - 040	
-7	041 - 044	Receiver Elevation (m) relative to SRD -ve for below SRD
0	045 - 048	
-6	049 - 052	Source Elevation (m) relative to SRD -ve for below SRD
0	055 - 056	
0	059 - 060	
0	061 - 064	
0	065 - 068	
1	069 - 070	Scalar to be applied to numbers in fields 41-68 eg 1,10,100 or –10 for division
1	071 - 072	Co-ordinate Scalar to be applied to numbers in fields 73-88
554896	073 - 076	CMP x coordinates (units as per bytes 71-72)
5689595	077 - 080	CMP y coordinates (units as per bytes 71-72)

VALUE	BYTES	BINNED DATA DEFINITION
0	081 - 084	
0	085 - 088	
1	089 - 090	Coordinate units: 1 = metric [m], 2 = seconds of arc, 3 = Imperial [ft]
0	091 - 092	
3333	099 - 100	Source Static Correction (microseconds)
4667	101 - 102	Receiver Static Correction (microseconds)
0	103 - 104	
6500	105 - 106	Tmax (in msec)
0	107 - 108	
0	109 - 110	Time of First Sample (msec)
1626	115 - 116	Number of Samples
4000	117 - 118	Sample interval in micro seconds for this trace (msec)
0	119 - 120	
0	121 - 122	
0	123 - 124	
554896	125 - 128	Bin Centre x coordinates (CMP X)
5689595	129 - 132	Bin Centre y coordinates (CMP Y)
0	141 - 142	
0	143 - 144	
0	145 - 146	
0	147 - 148	
0	149 - 150	
0	151 - 152	
0	153 - 154	
0	155 - 156	
0	157 - 158	
0	159 - 160	
0	161 - 162	
0	163 - 164	
0	165 - 166	
0	167 - 168	
554896	181 - 184	Bin Centre x coordinates (CMP X)
5689595	185 - 188	Bin Centre y coordinates (CMP Y)
995	189 - 192	Inline for Post Stack Data - Shot No for Binned data
1395	193 - 196	Crossline for Post Stack Data - CMP No for unbinned data
22038	197 - 200	Inline (Western Geco): 5 digits no
2038	201 - 204	Crossline (Western Geco): 4 digits no
0	205 - 206	
0	207 - 208	
0	209 - 212	

VALUE	BYTES	BINNED DATA DEFINITION
0	213 - 216	
0	217 - 220	
0	225 - 228	
0	229 - 232	
0	233 - 236	

B6 FLOOD GATHERS TAPELOG

CLIENT : SANTOS LIMITED
AREA : SANTOS VIC P51/P52 OS02 3D
PROCESS : FLOOD GATHERS
DATA LENGTH : 6.5 SEC
SAMPLE RATE : 4 MSEC
FORMAT : SEG-Y/ 3590 TAPE

INLINE RANGE	CROSSLINE RANGE	TAPE NUMBER
6984 – 6999	1354 – 3783	FLDGSY001
7000 – 7008	1356 – 3786	FLDGSY002
7009 – 7017	1355 – 3784	FLDGSY003
7018 – 7027	1355 – 3783	FLDGSY004
7028 – 7037	1356 – 3786	FLDGSY005
7038 – 7046	1354 – 3784	FLDGSY006
7047 – 7056	1355 – 3785	FLDGSY007
7057 – 7065	1355 – 3785	FLDGSY008
7066 – 7074	1356 – 3787	FLDGSY009
7075 – 7084	1355 – 3788	FLDGSY010
7085 – 7094	1355 – 3788	FLDGSY011
7095 – 7103	1355 – 3790	FLDGSY012
7104 – 7113	1354 – 3790	FLDGSY013
7114 – 7123	1355 – 3791	FLDGSY014
7124 – 7133	1355 – 3793	FLDGSY015
7134 – 7143	1355 – 3792	FLDGSY016
7144 – 7153	1355 – 3794	FLDGSY017
7154 – 7163	1354 – 3796	FLDGSY018
7164 – 7173	1353 – 3796	FLDGSY019
7174 – 7182	1353 – 3798	FLDGSY020
7183 – 7191	1354 – 3798	FLDGSY021
7192 – 7201	1353 – 3798	FLDGSY022
7202 – 7210	1353 – 3800	FLDGSY023
7211 – 7219	1353 – 3799	FLDGSY024
7220 – 7228	1354 – 3801	FLDGSY025
7229 – 7238	1353 – 3804	FLDGSY026
7239 – 7247	1354 – 3804	FLDGSY027
7248 – 7257	1353 – 3804	FLDGSY028
7258 – 7267	1354 – 3807	FLDGSY029
7268 – 7276	1354 – 3808	FLDGSY030
7277 – 7285	1354 – 3808	FLDGSY031
7286 – 7295	1354 – 3810	FLDGSY032
7296 – 7305	1352 – 3810	FLDGSY033

INLINE RANGE	CROSSLINE RANGE	TAPE NUMBER
7306 – 7315	1352 – 3813	FLDGSY034
7316 – 7324	1139 – 3812	FLDGSY035
7325 – 7333	999 – 3812	FLDGSY036
7334 – 7341	999 – 3814	FLDGSY037
7342 – 7349	999 – 3812	FLDGSY038
7350 – 7357	999 – 3812	FLDGSY039
7358 – 7365	999 – 3812	FLDGSY040
7366 – 7373	1000 – 3814	FLDGSY041
7374 – 7381	999 – 3812	FLDGSY042
7382 – 7389	999 – 3814	FLDGSY043
7390 – 7397	999 – 3815	FLDGSY044
7398 – 7405	1001 – 3817	FLDGSY045
7406 – 7413	1000 – 3817	FLDGSY046
7414 – 7422	1029 – 3820	FLDGSY047
7423 – 7430	1001 – 3820	FLDGSY048
7431 – 7438	1001 – 3820	FLDGSY049
7439 – 7446	999 – 3820	FLDGSY050
7447 – 7454	999 – 3821	FLDGSY051
7455 – 7462	999 – 3822	FLDGSY052
7463 – 7470	1000 – 3822	FLDGSY053
7471 – 7478	1002 – 3824	FLDGSY054
7479 –7486	1003 – 3824	FLDGSY055
7487 –7494	1000 – 3825	FLDGSY056
7495 –7502	999 – 3826	FLDGSY057
7503 –7510	1000 – 3828	FLDGSY058
7511 –7518	999 – 3826	FLDGSY059
7519 –7526	999 – 3828	FLDGSY060
7527 –7534	997 – 3828	FLDGSY061
7535 –7542	997 – 3827	FLDGSY062
7543 –7550	999 – 3828	FLDGSY063
7551 –7558	998 – 3828	FLDGSY064
7559 –7566	997 – 3829	FLDGSY065
7567 –7574	999 – 3829	FLDGSY066
7575 – 7582	999 – 3828	FLDGSY067
7583 – 7590	998 – 3829	FLDGSY068
7591 – 7598	997 – 3829	FLDGSY069
7599 – 7606	999 – 3833	FLDGSY070
7607 – 7614	997 – 3832	FLDGSY071
7615 – 7622	997 – 3834	FLDGSY072
7623 – 7630	999 – 3835	FLDGSY073
7631 – 7638	998 – 3837	FLDGSY074
7639 – 7646	997 – 3836	FLDGSY075

INLINE RANGE	CROSSLINE RANGE	TAPE NUMBER
7647 – 7654	998 – 3837	FLDGSY076
7655 – 7662	1000 – 3837	FLDGSY077
7663 – 7670	1040 – 3836	FLDGSY078
7671 – 7678	1040 – 3837	FLDGSY079
7679 – 7686	999 – 3838	FLDGSY080
7687 – 7694	997 – 3838	FLDGSY081
7695 – 7702	998 – 3801	FLDGSY082
7703 – 7710	998 – 3842	FLDGSY083
7711 – 7718	997 – 3841	FLDGSY084
7719 – 7726	998 – 3841	FLDGSY085
7727 – 7734	999 – 3844	FLDGSY086
7735 – 7742	1002 – 3844	FLDGSY087
7743 – 7750	1016 – 3845	FLDGSY088
7751 – 7758	1018 – 3845	FLDGSY089
7759 – 7766	999 – 3847	FLDGSY090
7767 – 7774	997 – 3848	FLDGSY091
7775 – 7782	998 – 3850	FLDGSY092
7783 – 7790	999 – 3850	FLDGSY093
7791 – 7798	999 – 3850	FLDGSY094
7799 – 7806	997 – 3851	FLDGSY095
7807 – 7814	999 – 3851	FLDGSY096
7815 – 7822	999 – 3851	FLDGSY097
7823 – 7830	998 – 3851	FLDGSY098
7831 – 7838	997 – 3852	FLDGSY099
7839 – 7846	999 – 3852	FLDGSY100
7847 – 7854	999 – 3853	FLDGSY101
7855 – 7862	999 – 3853	FLDGSY102
7863 – 7870	997 – 3858	FLDGSY103
7871 – 7878	999 – 3857	FLDGSY104
7879 – 7886	997 – 3857	FLDGSY105
7887 – 7894	999 – 3858	FLDGSY106
7895 – 7902	999 – 3859	FLDGSY107
7903 – 7910	997 – 3858	FLDGSY108
7911 – 7918	998 – 3859	FLDGSY109
7919 – 7926	998 – 3860	FLDGSY110
7927 – 7934	995 – 3864	FLDGSY111
7935 – 7942	995 – 3864	FLDGSY112
7943 – 7950	997 – 3862	FLDGSY113
7951 – 7958	998 – 3864	FLDGSY114
7959 – 7966	998 – 3864	FLDGSY115
7967 – 7974	998 – 3865	FLDGSY116
7975 – 7982	997 – 3864	FLDGSY117

INLINE RANGE	CROSSLINE RANGE	TAPE NUMBER
7983 – 7990	1000 – 3866	FLDGSY118
7991 – 7998	999 – 3868	FLDGSY119
7999 – 8006	998 – 3867	FLDGSY120
8007 – 8014	997 – 3871	FLDGSY121
8015 – 8022	801 – 3873	FLDGSY122
8023 – 8029	800 – 3874	FLDGSY123
8030 – 8036	800 – 3873	FLDGSY124
8037 – 8043	801 – 3872	FLDGSY125
8044 – 8050	800 – 3871	FLDGSY126
8051 – 8057	831 – 3873	FLDGSY127
8058 – 8064	822 – 3874	FLDGSY128
8065 – 8071	801 – 3873	FLDGSY129
8072 – 8078	800 – 3871	FLDGSY130
8079 – 8085	800 – 3874	FLDGSY131
8086 – 8092	800 – 3873	FLDGSY132
8093 – 8099	800 – 3872	FLDGSY133
8100 – 8106	801 – 3875	FLDGSY134
8107 – 8113	800 – 3874	FLDGSY135
8114 – 8120	800 – 3877	FLDGSY136
8121 – 8127	799 – 3876	FLDGSY137
8128 – 8134	800 – 3877	FLDGSY138
8135 – 8141	799 – 3879	FLDGSY139
8142 – 8148	800 – 3880	FLDGSY140
8149 – 8155	801 – 3879	FLDGSY141
8156 – 8162	800 – 3879	FLDGSY142
8163 – 8169	801 – 3881	FLDGSY143
8170 – 8176	800 – 3881	FLDGSY144
8177 – 8183	799 – 3881	FLDGSY145
8184 – 8190	800 – 3882	FLDGSY146
8191 – 8197	799 – 3885	FLDGSY147
8198 – 8204	799 – 3884	FLDGSY148
8205 – 8211	799 – 3883	FLDGSY149
8212 – 8218	800 – 3880	FLDGSY150
8219 – 8225	801 – 3880	FLDGSY151
8226 – 8232	801 – 3880	FLDGSY152
8233 – 8239	801 – 3856	FLDGSY153
8240 – 8247	802 – 3856	FLDGSY154
8248 – 8254	800 – 3855	FLDGSY155
8255 – 8261	799 – 3830	FLDGSY156
8262 – 8268	800 – 3829	FLDGSY157
8269 – 8275	800 – 3832	FLDGSY158
8276 – 8282	799 – 3831	FLDGSY159

INLINE RANGE	CROSSLINE RANGE	TAPE NUMBER
8283 – 8289	800 – 3830	FLDGSY160
8290 – 8296	801 – 3830	FLDGSY161
8297 – 8303	800 – 3832	FLDGSY162
8304 – 8311	800 – 3831	FLDGSY163
8312 – 8318	799 – 3804	FLDGSY164
8319 – 8325	800 – 3806	FLDGSY165
8326 – 8332	802 – 3806	FLDGSY166
8333 – 8340	802 – 3804	FLDGSY167
8341 – 8348	801 – 3780	FLDGSY168
8349 – 8356	799 – 3783	FLDGSY169
8357 – 8364	799 – 3781	FLDGSY170
8365 – 8372	802 – 3773	FLDGSY171
8373 – 8380	801 – 3758	FLDGSY172
8381 – 8388	800 – 3758	FLDGSY173
8389 – 8396	801 – 3757	FLDGSY174
8397 – 8404	800 – 3733	FLDGSY175
8405 – 8412	800 – 3733	FLDGSY176
8413 – 8420	803 – 3734	FLDGSY177
8421 – 8428	804 – 3733	FLDGSY178
8429 – 8436	803 – 3732	FLDGSY179
8437 – 8444	803 – 3709	FLDGSY180
8445 – 8452	803 – 3710	FLDGSY181
8453 – 8460	803 – 3708	FLDGSY182
8461 – 8468	803 – 3681	FLDGSY183
8469 – 8476	803 – 3684	FLDGSY184
8477 – 8484	802 – 3683	FLDGSY185
8485 – 8492	804 – 3682	FLDGSY186
8493 – 8500	803 – 3659	FLDGSY187
8501 – 8508	803 – 3660	FLDGSY188
8509 – 8516	804 – 3659	FLDGSY189
8517 – 8525	803 – 3658	FLDGSY190
8526 – 8535	803 – 3199	FLDGSY191
8536 – 8545	802 – 3177	FLDGSY192
8546 – 8555	799 – 3176	FLDGSY193
8556 – 8565	799 – 3153	FLDGSY194
8566 – 8575	801 – 3153	FLDGSY195
8576 – 8585	799 – 3154	FLDGSY196
8586 – 8595	799 – 3154	FLDGSY197
8596 – 8605	799 – 3132	FLDGSY198
8606 – 8615	799 – 3132	FLDGSY199
8616 – 8625	462 – 3129	FLDGSY200
8626 – 8634	461 – 3110	FLDGSY201

INLINE RANGE	CROSSLINE RANGE	TAPE NUMBER
8635 – 8643	460 – 3112	FLDGSY202
8644 – 8652	461 – 3112	FLDGSY203
8653 – 8661	461 – 3090	FLDGSY204
8662 – 8670	460 – 3093	FLDGSY205
8671 – 8679	462 – 3092	FLDGSY206
8680 – 8688	461 – 3070	FLDGSY207
8689 – 8697	460 – 3070	FLDGSY208
8698 – 8706	462 – 3071	FLDGSY209
8707 – 8715	461 – 3071	FLDGSY210
8716 – 8724	460 – 3049	FLDGSY211
8725 – 8733	463 – 3050	FLDGSY212
8734 – 8742	461 – 3050	FLDGSY213
8743 – 8751	460 – 3050	FLDGSY214
8752 – 8760	460 – 3029	FLDGSY215
8761 – 8769	461 – 3030	FLDGSY216
8770 – 8778	460 – 3026	FLDGSY217
8779 – 8787	462 – 3028	FLDGSY218
8788 – 8796	462 – 3027	FLDGSY219
8797 – 8805	460 – 3008	FLDGSY220
8806 – 8814	461 – 3007	FLDGSY221
8815 –8823	462 – 3008	FLDGSY222
8824 – 8832	460 – 3007	FLDGSY223
8833 – 8841	460 – 2985	FLDGSY224
8842 – 8850	462 – 2987	FLDGSY225
8851 – 8859	462 – 2987	FLDGSY226
8860 – 8868	463 – 2965	FLDGSY227
8869 – 8877	462 – 2966	FLDGSY228
8878 – 8886	462 – 2966	FLDGSY229
8887 – 8895	461 – 2945	FLDGSY230
8896 – 8904	460 – 2947	FLDGSY231
8905 – 8913	463 – 2946	FLDGSY232
8914 – 8923	462 – 2924	FLDGSY233
8924 -8932	460 – 2923	FLDGSY234
8933 – 8941	462 – 2924	FLDGSY235
8942 – 8951	462 – 2923	FLDGSY236
8952 – 8960	460 – 2904	FLDGSY237
8961 – 8969	461 – 2904	FLDGSY238
8970 – 8979	460 – 2902	FLDGSY239
8980 – 8989	459 – 2884	FLDGSY240
8990 – 8998	459 – 2884	FLDGSY241
8999 – 9008	459 – 2861	FLDGSY242
9009 – 9018	459 – 2863	FLDGSY243

INLINE RANGE	CROSSLINE RANGE	TAPE NUMBER
9019 – 9028	460 – 2863	FLDGSY244
9029 – 9038	460 – 2862	FLDGSY245
9039 – 9048	461 – 2839	FLDGSY246
9049 – 9058	462 – 2840	FLDGSY247
9059 – 9072	463 – 2839	FLDGSY248

SEGY TRACE HEADERS OF FLOOD GATHERS		
VALUE	**BYTES**	**BINNED DATA DEFINITION**
1	001 - 004	Trace Seq No within Line
1	005 - 008	Trace Sequence No within archive
682	009 - 012	Original Field Record Number
369	013 - 016	Trace No within Original Record (channel)
7000	017 - 020	Inline Number (binned) - Shot Number for Unbinned
2501	021 - 024	Xline Number (Binned) - CMP Number for 2D/unbinned data
1	025 - 028	Trace No within CMP
1	029 - 030	Trace Identification Code 1=seismic data
0	031 - 032	Vertically Summed Traces to achieve this
0	033 - 034	Stack Word
1	035 - 036	Original Data 1 = production data, 2 = flex data, 3=interpolated
276	037 - 040	Offset [m]
-7	041 - 044	Receiver Elevation (m) relative to SRD -ve for below SRD
-0.06975	045 - 048	Surface Elevation at Source (Tidal height if SRD=MSL) **Floating point value
-5	049 - 052	Source Elevation (m) relative to SRD -ve for below SRD
3	055 - 056	Receiver Cable Identifier (same as acquisition)
2	059 - 060	Source Identified (same as acquisition)
1846	061 - 064	Water depth at shot in [m]
1821	065 - 068	Water depth at receiver in [m] (optional)
1	069 - 070	Scalar to be applied to numbers in fields 41-68 eg 1,10,100 or -10 for division
1	071 - 072	Co-ordinate Scalar to be applied to numbers in fields 73-88
566810	073 - 076	Shot x coordinates (units as per bytes 71-72)
5682372	077 - 080	Shot y coordinates (units as per bytes 71-72)
566535	081 - 084	Receiver x coordinates (units as per bytes 71-72)
5682345	085 - 088	Receiver y coordinates (units as per bytes 71-72)
1	089 - 090	Co-ordinate Units
1500	091 - 092	Water Velocity used in processing at this bin location
3333	099 - 100	Source Static Correction (microseconds)
4667	101 - 102	Receiver Static Correction (microseconds)
8093	103 - 104	Total Static Applied Source + Receiver + Tidal
6500	105 - 106	
48	107 - 108	Total Gun/Recorder Delay
0	109 - 110	Time of First Sample
1626	115 - 116	Number of Samples
4000	117 - 118	Sample interval in micro seconds for this trace
0	119 - 120	Gain type of field instrument
0	121 - 122	Instrument gain constant
0	123 - 124	Instrument early or initial gain in [dB]

VALUE	BYTES	BINNED DATA DEFINITION
566673	125 - 128	Bin Centre x coordinates (CMP X)
5682353	129 - 132	Bin Centre y coordinates (CMP Y)
100	141 - 142	Cut-off frequency of anti-alias filter in [Hz] (-3 dB point) processing
72	143 - 144	The slope of the anti-alias filter processing(db/oct)
0	145 - 146	Notch filter frequency. Normally = 0
0	147 - 148	Notch filter slope. Normally = 0
3	149 - 150	Cut-off frequency of low-cut filter in [Hz] (-3 dB point) processing
0	151 - 152	Cut-off frequency of high-cut filter in [Hz] (-3 dB point) processing
18	153 - 154	Low Cut Slope (dB/ Oct)
0	155 - 156	High Cut Slope (dB/ Oct)
2002	157 - 158	Year data recorded (four digits)
350	159 - 160	Julian day of the year of recording
23	161 - 162	Hour of day of recording using 24 hour clock (hh)
32	163 - 164	Minute of hour of recording (mm)
28	165 - 166	Second of minute of recording (ss)
2	167 - 168	Time basis code: 1 = local, 2 = GMT, 3 = other
566673	181 - 184	Bin Centre x coordinates (CMP X) using scalars in locn 71
5682353	185 - 188	Bin Centre y coordinates (CMP Y) using scalars in locn 71
2237	189 - 192	Inline for Post Stack Data - Shot No for Binned Data
70002501	193 - 196	Xline Number for Post Stack Data - CMP Number for 2D /unbinned data
1	205 - 206	Verification Tidal and Residual Statics Applied
		0=No 1=Yes (Default=1)
0	207 - 208	Verification Gun and Cable Statics to SRD applied 0=no 1=yes (Default=0)
		0=No 1=yes (Default=0)
0	209 - 212	Tidal statics (in microseconds for total trace)
1834	213 - 216	CMP water depth (units see bytes 69-72)
70002501	217 - 220	CMP Number in Processing
0	225 - 228	Residual Statics Source Correction
0	229 - 232	Residual Statics Receiver Correction
2032089	233 - 236	Sail Line Suffix with Seq No

B7 FINAL HYBRID MIGRATED STACK TAPELOG

CLIENT : SANTOS LIMITED
AREA : SANTOS VIC P51/P52 OS02 3D
PROCESS : FINAL HYBRID MIGRATED STACK(RAW/FULL/AGC/NEAR/FAR) (WITH TIME VARIANT FILTER/ZERO PHASE FILTER/ SOURCE AND CABLE DEPTH CORRECTIONS APPLIED)
DATA LENGTH : 6.5 SEC
SAMPLE RATE : 4 MSEC
FORMAT : SEG-Y DLT4 35GB DENSITY
TAPE ID : 1) RAW STACK: PSDMSTKRAW (SUBLINE 6984-9072)
2) FULL STACK: FSTKTVFZP (SUBLINE 6984-9072)
3) OPTIMUM STACK: AGCSTKTVFZP (SUBLINE 6984-9072)
4) NEAR STACK: NRSTKTVFZP (SUBLINE 6984-9072)
5) FAR STACK: FRSTKTVFZP (SUBLINE 6984-9072)

SEGY TRACE HEADERS OF PRESTK HYBRID MIGRATED STACK
(With time variant filter/ zero phase filter/ source and cable depth corrections applied)

VALUE	BYTES	BINNED DATA DEFINITION
1	001 – 004	Trace number within line. Starts with 1 per data set
1	005 – 008	Trace number within a tape. Starts with 1 on each tape
1236	009 – 012	Original Field Record Number
0	013 – 016	
8012	017-020	Inline Number (Binned) - Shot Number for unbinned
999	021 – 024	Crossline Number (Binned) - CMP Number for unbinned
0	025 – 028	
0	029 – 030	
0	031 – 032	
1	033 – 034	Number of horizontally stacked traces (number of traces summed)
0	035 – 036	
0	037 – 040	
-7	041 – 044	Receiver Elevation (m) relative to SRD -ve for below SRD
0	045 – 048	
-5	049 – 052	Source Elevation (m) relative to SRD -ve for below SRD
0	055 – 056	
0	059 – 060	
0	061 – 064	
0	065 – 068	
1	069 – 070	Scalar to be applied to numbers in fields 41-68 eg 1,10,100 or -10 for division
1	071 – 072	Co-ordinate Scalar to be applied to numbers in fields 73-88
557494	073 – 076	CMP x coordinates (units as per bytes 71-72)
5703047	077 – 080	CMP y coordinates (units as per bytes 71-72)

VALUE	BYTES	BINNED DATA DEFINITION
0	081 – 084	
0	085 – 088	
1	089 – 090	Coordinate units: 1 = metric [m], 2 = seconds of arc, 3 = Imperial [ft]
0	091 – 092	
3333	099 – 100	Source Static Correction (microseconds)
4667	101 – 102	Receiver Static Correction (microseconds)
0	103 – 104	
6500	105 – 106	Tmax (in msec)
0	107 – 108	
0	109 – 110	Time of First Sample (msec)
1626	115 – 116	Number of Samples
4000	117 – 118	Sample interval in micro seconds for this trace (msec)
0	119 – 120	
0	121 – 122	
0	123 – 124	
557494	125 – 128	Bin Centre x coordinates (CMP X)
5703047	129 – 132	Bin Centre y coordinates (CMP Y)
0	141 – 142	
0	143 – 144	
0	145 – 146	
0	147 – 148	
0	149 – 150	
0	151 – 152	
0	153 – 154	
0	155 – 156	
0	157 – 158	
0	159 – 160	
0	161 – 162	
0	163 – 164	
0	165 – 166	
0	167 – 168	
557494	181 – 184	Bin Centre x coordinates (CMP X)
5703047	185 – 188	Bin Centre y coordinates (CMP Y)
8012	189 – 192	Inline for Post Stack Data - Shot No for Binned data
999	193 – 196	Crossline for Post Stack Data - CMP No for unbinned data
0	205 – 206	
0	207 – 208	
0	209 – 212	

B8 FINAL HYBRID MIGRATED STACK TAPELOG (P52 ONLY)

CLIENT	:	SANTOS LIMITED
AREA	:	SANTOS VIC P52 ONLY OS02 3D
PROCESS	:	FINAL HYBRID MIGRATED STACK(FULL/AGC/NEAR/FAR) (WITH TIME VARIANT FILTER/ZERO PHASE FILTER/ SOURCE AND CABLE DEPTH CORRECTIONS APPLIED)
DATA LENGTH	:	6.5 SEC
SAMPLE RATE	:	4 MSEC
FORMAT	:	SEG-Y DLT4 35GB DENSITY
TAPE ID	:	1) FULL STACK: P52_FSTKTVFZP (SUBLINE 6984-8522) 2) OPTIMUM STACK: P52_AGCSTKTVFZP (SUBLINE 6984-8522) 3) NEAR STACK: P52_NRSTKTVFZP (SUBLINE 6984-8522) 4) FAR STACK: P52_FRSTKTVFZP (SUBLINE 6984-8522)

DEFINED HEADER INFORMATION

NAME	FORMAT	FIRST BYTE	NUMBER OF BYTES
LINECOUNT	INT	1	4
REELCOUNT	INT	5	4
SP	BINARY	9	4
CONSTANT	BINARY	13	4
INLINE	BINARY	17	4
CROSSLINE	BINARY	21	4
FOLD	BINARY	33	2
CDPX	BINARY	73	4
CDPY	BINARY	77	4
CDPX	BINARY	125	4
CDPY	BINARY	129	4
CDPX	BINARY	181	4
CDPY	BINARY	185	4
SUBLINE	BINARY	189	4
CROSSLINE	BINARY	193	4

B9 FINAL HYBRID NMO GATHERS TAPELOG

CLIENT : SANTOS LIMITED
AREA : SANTOS VIC P51/P52 OS02 3D
PROCESS : FINAL HYBRID NMO GATHERS
DATA LENGTH : 6.5 SEC
SAMPLE RATE : 4 MSEC
FORMAT : SEG-Y/ 3590 TAPE

TAPE NUMBER	SUBLINE	RANGE
PSDMCMP01	6984	7028
PSDMCMP02	7030	7066
PSDMCMP03	7068	7106
PSDMCMP04	7108	7146
PSDMCMP05	7148	7186
PSDMCMP06	7188	7224
PSDMCMP07	7226	7264
PSDMCMP08	7266	7304
PSDMCMP09	7306	7340
PSDMCMP10	7342	7374
PSDMCMP11	7376	7408
PSDMCMP12	7410	7442
PSDMCMP13	7444	7476
PSDMCMP14	7478	7510
PSDMCMP15	7512	7542
PSDMCMP16	7544	7576
PSDMCMP17	7578	7608
PSDMCMP18	7610	7640
PSDMCMP19	7642	7674
PSDMCMP20	7676	7708
PSDMCMP21	7710	7740
PSDMCMP22	7742	7772
PSDMCMP23	7774	7804
PSDMCMP24	7806	7836
PSDMCMP25	7838	7868
PSDMCMP26	7870	7900
PSDMCMP27	7902	7932
PSDMCMP28	7934	7966
PSDMCMP29	7968	7998
PSDMCMP30	8000	8030
PSDMCMP31	8032	8060
PSDMCMP32	8062	8090
PSDMCMP33	8092	8120
PSDMCMP34	8122	8150

TAPE NUMBER	SUBLINE	RANGE
PSDMCMP35	8152	8180
PSDMCMP36	8182	8210
PSDMCMP37	8212	8240
PSDMCMP38	8242	8270
PSDMCMP39	8272	8300
PSDMCMP40	8302	8330
PSDMCMP41	8332	8362
PSDMCMP42	8364	8394
PSDMCMP43	8396	8426
PSDMCMP44	8428	8458
PSDMCMP45	8460	8490
PSDMCMP46	8492	8524
PSDMCMP47	8526	8564
PSDMCMP48	8566	8604
PSDMCMP49	8606	8642
PSDMCMP50	8644	8678
PSDMCMP51	8680	8714
PSDMCMP52	8716	8750
PSDMCMP53	8752	8786
PSDMCMP54	8788	8824
PSDMCMP55	8826	8862
PSDMCMP56	8864	8900
PSDMCMP57	8902	8938
PSDMCMP58	8940	8978
PSDMCMP59	8980	9018
PSDMCMP60	9020	9058
PSDMCMP61	9060	9072

SEGY TRACE HEADERS OF FINAL GATHERS

VALUE	BYTES	BINNED DATA DEFINITION
1	001 – 004	Trace Seq No within Line
1	005 – 008	Trace Sequence No within archive
1904	009 – 012	Original Field Record Number
0	013 – 016	
8012	017 – 020	Inline Number (binned) - Shot Number for Unbinned
2001	021 – 024	Crossline Number (Binned) - CMP Number for 2D/unbinned data
1	025 – 028	Trace No within CMP
1	029 – 030	Trace Identification Code 1=seismic data
0	031 – 032	Vertically Summed Traces to achieve this
0	033 – 034	Stack Word
1	035 – 036	Original Data 1 = production data, 2 = flex data, 3=interpolated
268	037 – 040	Offset [m]
-7	041 – 044	Receiver Elevation (m) relative to SRD -ve for below SRD
0	045 – 048	0
-5	049 – 052	Source Elevation (m) relative to SRD -ve for below SRD
0	055 – 056	Receiver Cable Identifier (same as acquisition)
0	059 – 060	Source Identified (same as acquisition)
0	061 – 064	Water depth at shot in [m]
0	065 – 068	Water depth at receiver in [m] (optional)
1	069 – 070	Scalar to be applied to numbers in fields 41-68 eg 1,10,100 or -10 for division
1	071 – 072	Co-ordinate Scalar to be applied to numbers in fields 73-88
0	073 – 076	Shot x coordinates (units as per bytes 71-72)
0	077 – 080	Shot y coordinates (units as per bytes 71-72)
0	081 – 084	Receiver x coordinates (units as per bytes 71-72)
0	085 – 088	Receiver y coordinates (units as per bytes 71-72)
1	089 – 090	Co-ordinate Units
1500	091 – 092	Water Velocity used in processing at this bin location
3333	099 – 100	Source Static Correction (microseconds)
4667	101 – 102	Receiver Static Correction (microseconds)
0	103 – 104	Total Static Applied Source + Receiver + Tidal
6500	105 – 106	
0	107 – 108	Total Gun/Recorder Delay
0	109 – 110	Time of First Sample
1626	115 – 116	Number of Samples
4000	117 – 118	Sample interval in micro seconds for this trace
0	119 – 120	Gain type of field instrument
0	121 – 122	Instrument gain constant
0	123 – 124	Instrument early or initial gain in [dB]

VALUE	BYTES	BINNED DATA DEFINITION
568103	125 – 128	Bin Centre x coordinates (CMP X)
5696390	129 – 132	Bin Centre y coordinates (CMP Y)
100	141 – 142	Cut-off frequency of anti-alias filter in [Hz] (-3 dB point) processing
72	143 - 144	the slope of the anti-alias filter processing(dB/ Oct)
0	145 - 146	Notch filter frequency. Normally = 0
0	147 - 148	Notch filter slope. Normally = 0
3	149 - 150	Cut-off frequency of low-cut filter in [Hz] (-3 dB point) processing
0	151 - 152	Cut-off frequency of high-cut filter in [Hz] (-3 dB point) processing
18	153 - 154	Low Cut Slope (dB/ Oct)
0	155 - 156	High Cut Slope (dB/ Oct)
0	157 - 158	
0	159 - 160	
0	161 - 162	
0	163 - 164	
971	169 - 172	Outer trace Mute
2107	173 - 176	Inner trace Mute
568103	181 - 184	Bin Centre x coordinates (CMP X) using scalars in locn 71
5696390	185 - 188	Bin Centre y coordinates (CMP Y) using scalars in locn 71
1904	189 - 192	Original Field Record Number
80122001	193 - 196	CMP Number in Processing
1	205 - 206	Verification Tidal and Residual Statics applied 0=No 1=Yes (Default=1)
0	207 - 208	Verification Gun and Cable Statics to SRD applied 0=no 1=yes (Default=0)
0	209 - 212	Tidal statics (in microseconds for total trace)
878	213 - 216	CMP water depth (units see bytes 69-72)
80122001	217 - 220	CMP Number in Processing

SANTOS LIMITED
PRODUCTION FINAL HYBRID NMO GATHERS SEGY DISK FILES
ON 3 CADDIES

NO	1ST SUBLINE	LAST SUBLINE	1ST XL	LAST XL
1	6990 - 6998	1355 - 3783	288505	1.95E+09
2	7000 - 7006	1357 - 3785	274580	1.85E+09
3	7008 - 7014	1355 - 3785	276148	1.86E+09
4	7016 - 7022	1357 - 3783	268314	1.81E+09
5	7024 - 7030	1355 - 3783	267795	1.81E+09
6	7032 -7038	1355 - 3785	274478	1.85E+09
7	7040 - 7046	1355 - 3783	275180	1.86E+09
8	7048 - 7054	1355 - 3785	271031	1.83E+09
9	7056 - 7062	1355 - 3785	271966	1.83E+09
10	7064 - 7070	1355 - 3787	276073	1.86E+09
11	7072 - 7078	1355 - 3785	273263	1.84E+09
12	7080 - 7086	1355 - 3787	267587	1.80E+09
13	7088 - 7094	1355 - 3787	271793	1.83E+09
14	7096 - 7102	1355 - 3789	274718	1.85E+09
15	7104 - 7110	1355 - 3789	257679	1.74E+09
16	7112 - 7118	1357 - 3791	263192	1.77E+09
17	7120 - 7126	1355 - 3791	269417	1.82E+09
18	7128 - 7134	1355 - 3793	270888	1.83E+09
19	7136 - 7142	1355 - 3791	268763	1.81E+09
20	7144 - 7150	1355 - 3793	270796	1.83E+09
21	7152 - 7158	1355 - 3795	275939	1.86E+09
22	7160 - 7166	1355 - 3795	262866	1.77E+09
23	7168 - 7174	1353 - 3795	267830	1.81E+09
24	7176 - 7182	1353 - 3797	274785	1.85E+09
25	7184 - 7190	1355 - 3797	276977	1.87E+09
26	7192 - 7198	1353 - 3797	272043	1.83E+09
27	7200 - 7206	1353 - 3799	271620	1.83E+09
28	7208 - 7214	1353 - 3799	276245	1.86E+09
29	7216 - 7222	1355 - 3799	277031	1.87E+09
30	7224 - 7230	1353 - 3801	271447	1.83E+09
31	7232 - 7238	1353 - 3803	272555	1.84E+09
32	7240 - 7246	1355 - 3803	277853	1.87E+09
33	7248 - 7254	1353 - 3803	273301	1.84E+09
34	7256 -7262	1355 - 3807	266585	1.80E+09
35	7264 - 7270	1355 - 3805	277031	1.87E+09
36	7272 - 7278	1355 - 3807	277622	1.87E+09
37	7280 - 7286	1355 - 3807	273261	1.84E+09
38	7288 - 7294	1355 - 3809	272932	1.84E+09
39	7296 - 7302	1353 - 3809	263844	1.78E+09

NO	1ST SUBLINE	LAST SUBLINE	1ST XL	LAST XL
39	7296 - 7302	1353 - 3809	263844	1.78E+09
40	7304 - 7310	1353 - 3813	266445	1.80E+09
41	7312 - 7318	1387 - 3811	272060	1.83E+09
42	7320 - 7326	1099 - 3811	280573	1.89E+09
43	7328 - 7332	999 - 3811	229159	1.55E+09
44	7334 - 7338	999 - 3811	237213	1.60E+09
45	7340 - 7344	999 - 3813	239469	1.61E+09
46	7346 - 7350	1001 - 3811	239444	1.61E+09
47	7352 - 7356	1001 - 3811	239328	1.61E+09
48	7358 - 7362	999 - 3811	237998	1.61E+09
49	7364 - 7368	1001 - 3811	237216	1.60E+09
50	7370 - 7374	1001 - 3813	239282	1.61E+09
51	7376 - 7380	999 - 3811	239259	1.61E+09
52	7382 - 7386	999 - 3813	237263	1.60E+09
53	7388 - 7392	999 - 3813	236950	1.60E+09
54	7394 - 7398	999 - 3815	237548	1.60E+09
55	7400 - 7404	1001 - 3817	240446	1.62E+09
56	7406 - 7410	1001 - 3817	238312	1.61E+09
57	7412 - 7416	1003 - 3817	225242	1.52E+09
58	7418 - 7422	1029 - 3819	230142	1.55E+09
59	7424 - 7428	1003 - 3819	237759	1.60E+09
60	7430 - 7434	1001 - 3819	235143	1.59E+09
61	7436 - 7440	999 - 3819	238016	1.61E+09
62	7442 - 7446	999 - 3819	240249	1.62E+09
63	7448 - 7452	999 - 3821	243659	1.64E+09
64	7454 - 7458	1001 - 3821	241034	1.63E+09
65	7460 - 7464	999 - 3821	237779	1.60E+09
66	7466 - 7470	1001 - 3821	237240	1.60E+09
67	7472 - 7476	1003 - 3821	239987	1.62E+09
68	7478 - 7482	1003 - 3823	243479	1.64E+09
69	7484 - 7488	1005 - 3823	241370	1.63E+09
70	7490 - 7494	1001 - 3825	238280	1.61E+09
71	7496 - 7500	999 - 3825	238172	1.61E+09
72	7502 - 7506	1001 - 3825	240274	1.62E+09
73	7508 - 7512	1001 - 3827	244068	1.65E+09
74	7514 - 7518	999 - 3825	244794	1.65E+09
75	7520 - 7524	1001 - 3827	238550	1.61E+09
76	7526 - 7530	999 - 3827	242286	1.63E+09
77	7532 - 7536	997 - 3827	245053	1.65E+09
78	7538 - 7542	999 - 3827	243624	1.64E+09
79	7544 - 7548	999 - 3827	239527	1.62E+09
80	7550 - 7554	999 - 3827	237477	1.60E+09

NO	1ST SUBLINE	LAST SUBLINE	1ST XL	LAST XL
81	7556 - 7560	997 - 3827	239984	1.62E+09
82	7562 - 7566	999 - 3829	243873	1.64E+09
83	7568 - 7572	999 - 3829	242223	1.63E+09
84	7574 - 7578	1001 - 3827	238237	1.61E+09
85	7580 - 7584	999 - 3827	236984	1.60E+09
86	7586 - 7590	999 - 3829	241526	1.63E+09
87	7592 - 7596	997 - 3829	246639	1.66E+09
88	7598 - 7602	1001 - 3833	245360	1.65E+09
89	7604 - 7608	999 - 3833	241082	1.63E+09
90	7610 - 7614	997 - 3831	241869	1.63E+09
91	7616 - 7620	999 - 3833	241231	1.63E+09
92	7622 - 7626	1001 - 3833	244658	1.65E+09
93	7628 - 7632	999 - 3835	243039	1.64E+09
94	7634 - 7638	999 - 3837	238437	1.61E+09
95	7640 - 7644	997 - 3835	237996	1.61E+09
96	7646 - 7650	999 - 3835	244057	1.65E+09
97	7652 - 7656	1001 - 3837	243681	1.64E+09
98	7658 - 7662	1001 - 3837	240117	1.62E+09
99	7664 - 7668	1043 - 3835	235398	1.59E+09
100	7670 - 7674	1041 - 3837	234835	1.58E+09
101	7676 - 7680	1045 - 3837	236195	1.59E+09
102	7682 - 7686	999 - 3837	242717	1.64E+09
103	7688 - 7692	997 - 3837	239706	1.62E+09
104	7694 - 7698	997 - 3807	234056	1.58E+09
105	7700 - 7704	1001 - 3801	235599	1.59E+09
106	7706 - 7710	999 - 3841	243996	1.65E+09
107	7712 - 7716	997 - 3841	244368	1.65E+09
108	7718 - 7722	997 - 3841	241993	1.63E+09
109	7724 - 7728	999 - 3841	238226	1.61E+09
110	7730 - 7734	1001 - 3843	238838	1.61E+09
111	7736 - 7740	1019 - 3843	242662	1.64E+09
112	7742 - 7746	1019 - 3845	243830	1.64E+09
113	7748 - 7752	1017 - 3845	240273	1.62E+09
114	7754 - 7758	1019 - 3845	236378	1.59E+09
115	7760 - 7764	999 - 3845	239846	1.62E+09
116	7766 - 7770	999 - 3847	243923	1.65E+09
117	7772 - 7776	997 - 3847	245155	1.65E+09
118	7778 - 7782	999 - 3849	241308	1.63E+09
119	7784 - 7788	999 - 3849	241280	1.63E+09
120	7790 - 7794	999 - 3849	243517	1.64E+09
121	7796 - 7800	997 - 3849	244354	1.65E+09
122	7802 - 7806	997 - 3851	242879	1.64E+09

NO	1ST SUBLINE	LAST SUBLINE	1ST XL	LAST XL
123	7808 - 7812	999 - 3851	240690	1.62E+09
124	7814 - 7818	999 - 3851	240982	1.63E+09
125	7820 - 7824	999 - 3851	244700	1.65E+09
126	7826 - 7830	999 - 3851	246033	1.66E+09
127	7832 - 7836	997 - 3851	243766	1.64E+09
128	7838 - 7842	999 - 3851	241287	1.63E+09
129	7844 - 7848	999 - 3851	243143	1.64E+09
130	7850 - 7854	1001 - 3853	244533	1.65E+09
131	7856 - 7860	999 - 3853	243652	1.64E+09
132	7862 - 7866	997 - 3847	242102	1.63E+09
133	7868 - 7872	999 - 3857	240082	1.62E+09
134	7874 - 7878	999 - 3857	241813	1.63E+09
135	7880 - 7884	997 - 3857	243057	1.64E+09
136	7886 - 7890	997 - 3857	241454	1.63E+09
137	7892 - 7896	999 - 3857	240032	1.62E+09
138	7898 - 7902	999 - 3859	239010	1.61E+09
139	7904 - 7908	997 - 3857	243672	1.64E+09
140	7910 - 7914	999 - 3857	243993	1.65E+09
141	7916 - 7920	999 - 3859	242406	1.63E+09
142	7922 - 7926	999 - 3859	241035	1.63E+09
143	7928 - 7932	997 - 3859	242875	1.64E+09
144	7934 - 7938	995 - 3863	245415	1.66E+09
145	7940 - 7944	997 - 3863	243714	1.64E+09
146	7946 - 7950	997 - 3861	230085	1.55E+09
147	7952 - 7956	999 - 3863	234612	1.58E+09
148	7958 - 7962	999 - 3863	242417	1.63E+09
149	7964 - 7968	999 - 3865	239192	1.61E+09
150	7970 - 7974	999 - 3863	239525	1.62E+09
151	7976 - 7980	997 - 3863	244911	1.65E+09
152	7982 - 7986	999 - 3865	247271	1.67E+09
153	7988 - 7992	1001 - 3865	243434	1.64E+09
154	7994 - 7998	999 - 3867	240379	1.62E+09
155	8000 - 8004	999 - 3867	240784	1.62E+09
156	8006 - 8010	997 - 3871	246382	1.66E+09
157	8012 - 8016	999 - 3871	251383	1.70E+09
158	8018 - 8022	801 - 3873	249948	1.69E+09
159	8024 - 8028	801 - 3873	261316	1.76E+09
160	8030 - 8034	801 - 3873	258117	1.74E+09
161	8036 - 8040	803 - 3871	261325	1.76E+09
162	8042 - 8046	801 - 3871	264296	1.78E+09
163	8048 - 8052	801 - 3871	264539	1.78E+09
164	8054 - 8058	859 - 3873	255658	1.72E+09

NO	1ST SUBLINE	LAST SUBLINE	1ST XL	LAST XL
165	8060 - 8064	823 - 3873	261818	1.77E+09
166	8066 - 8070	801 - 3873	264358	1.78E+09
167	8072 - 8076	801 - 3871	263231	1.78E+09
168	8078 - 8082	801 - 3873	260983	1.76E+09
169	8084 - 8088	801 - 3873	260382	1.76E+09
170	8090 - 8094	801 - 3873	261136	1.76E+09
171	8096 - 8100	803 - 3871	263709	1.78E+09
172	8102 - 8106	801 - 3875	257231	1.73E+09
173	8108 - 8112	801 - 3873	256600	1.73E+09
174	8114 - 8118	801 - 3877	262197	1.77E+09
175	8120 - 8124	799 - 3877	265132	1.79E+09
176	8126 - 8130	799 - 3875	263940	1.78E+09
177	8132 - 8136	801 - 3877	260990	1.76E+09
178	8138 - 8142	799 - 3879	260772	1.76E+09
179	8144 - 8148	801 - 3879	262903	1.77E+09
180	8150 - 8154	801 - 3879	265297	1.79E+09
181	8156 - 8160	801 - 3879	264677	1.78E+09
182	8162 - 8166	827 - 3879	256763	1.73E+09
183	8168 - 8172	801 - 3881	260569	1.76E+09
184	8174 - 8178	801 - 3881	265654	1.79E+09
185	8180 - 8184	799 - 3881	264228	1.78E+09
186	8186 - 8190	803 - 3881	261008	1.76E+09
187	8192 - 8196	799 - 3885	260856	1.76E+09
188	8198 - 8202	799 - 3883	263149	1.77E+09
189	8204 - 8208	799 - 3883	265939	1.79E+09
190	8210 - 8214	801 - 3879	265467	1.79E+09
191	8216 - 8220	801 - 3879	261180	1.76E+09
192	8222 - 8226	801 - 3879	260374	1.76E+09
193	8228 - 8232	801 - 3871	262398	1.77E+09
194	8234 - 8238	813 - 3855	260449	1.76E+09
195	8240 - 8244	833 - 3855	251162	1.69E+09
196	8246 - 8250	801 - 3855	259151	1.75E+09
197	8252 - 8256	801 - 3853	260810	1.76E+09
198	8258 - 8262	799 - 3829	262177	1.77E+09
199	8264 - 8268	803 - 3829	259713	1.75E+09
200	8270 - 8274	801 - 3831	256763	1.73E+09
201	8276 - 8280	799 - 3831	256063	1.73E+09
202	8282 - 8286	799 - 3829	258196	1.74E+09
203	8288 - 8292	803 - 3829	260036	1.75E+09
204	8294 - 8298	801 - 3831	260146	1.75E+09
205	8300 - 8304	801 - 3831	257320	1.74E+09
206	8306 - 8310	801 - 3803	254430	1.72E+09

NO	1ST SUBLINE	LAST SUBLINE	1ST XL	LAST XL
207	8312 - 8316	799 - 3803	256590	1.73E+09
208	8318 - 8322	801 - 3805	258843	1.75E+09
209	8324 - 8328	803 - 3805	256418	1.73E+09
210	8330 - 8334	803 - 3805	255749	1.72E+09
211	8336 - 8340	803 - 3803	254886	1.72E+09
212	8342 - 8346	831 - 3779	254692	1.72E+09
213	8348 - 8352	799 - 3783	252259	1.70E+09
214	8354 - 8358	799 - 3781	253143	1.71E+09
215	8360 - 8364	799 - 3781	255836	1.73E+09
216	8366 - 8370	803 - 3757	254858	1.72E+09
217	8372 - 8376	801 - 3757	251998	1.70E+09
218	8378 - 8382	801 - 3757	250105	1.69E+09
219	8384 - 8388	801 - 3757	252064	1.70E+09
220	8390 - 8394	803 - 3757	253606	1.71E+09
221	8396 - 8400	801 - 3733	252448	1.70E+09
222	8402 - 8406	801 - 3733	248106	1.67E+09
223	8408 - 8412	805 - 3733	244572	1.65E+09
224	8414 - 8418	803 - 3733	250741	1.69E+09
225	8420 - 8424	805 - 3733	252240	1.70E+09
226	8426 - 8430	805 - 3731	249376	1.68E+09
227	8432 - 8436	803 - 3709	244587	1.65E+09
228	8438 - 8442	803 - 3709	245189	1.65E+09
229	8444 - 8448	803 - 3709	248970	1.68E+09
230	8450 - 8454	803 - 3709	250193	1.69E+09
231	8456 - 8460	805 - 3707	248758	1.68E+09
232	8462 - 8466	805 - 3681	243646	1.64E+09
233	8468 - 8472	803 - 3681	243234	1.64E+09
234	8474 - 8478	803 - 3683	245877	1.66E+09
235	8480 - 8484	803 - 3683	246273	1.66E+09
236	8486 - 8490	913 - 3681	233395	1.57E+09
237	8492 - 8496	803 - 3659	238693	1.61E+09
238	8498 - 8502	803 - 3657	244447	1.65E+09
239	8504 - 8508	803 - 3659	247445	1.67E+09
240	8510 - 8514	805 - 3659	244880	1.65E+09
241	8516 - 8520	805 - 3659	240256	1.62E+09
242	8522 - 8528	803 - 3657	271158	1.83E+09
243	8530 - 8536	805 - 3177	265556	1.79E+09
244	8538 - 8544	803 - 3177	268991	1.81E+09
245	8546 - 8552	801 - 3175	266965	1.80E+09
246	8554 - 8560	799 - 3153	260914	1.76E+09
247	8562 - 8568	801 - 3153	261361	1.76E+09
248	8570 - 8576	801 - 3153	265993	1.79E+09

NO	1ST SUBLINE	LAST SUBLINE	1ST XL	LAST XL
249	8578 - 8584	799 - 3153	264915	1.79E+09
250	8586 - 8592	799 - 3153	259322	1.75E+09
251	8594 - 8600	801 - 3151	260077	1.75E+09
252	8602 - 8608	799 - 3131	261929	1.77E+09
253	8610 - 8616	803 - 3131	260019	1.75E+09
254	8618 - 8624	493 - 3109	266563	1.80E+09
255	8626 - 8630	461 - 3109	223240	1.51E+09
256	8632 - 8636	461 - 3111	225145	1.52E+09
257	8638 - 8642	461 - 3111	224334	1.51E+09
258	8644 - 8648	463 - 3111	222603	1.50E+09
259	8650 - 8656	461 - 3111	295313	1.99E+09
260	8658 - 8662	461 - 3091	222684	1.50E+09
261	8664 - 8668	461 - 3093	223983	1.51E+09
262	8670 - 8676	463 - 3091	294992	1.99E+09
263	8678 - 8684	461 - 3069	292095	1.97E+09
264	8686 - 8692	461 - 3069	295378	1.99E+09
265	8694 - 8700	461 - 3071	296421	2.00E+09
266	8702 - 8708	463 - 3071	291582	1.97E+09
267	8710 - 8716	461 - 3071	289766	1.95E+09
268	8718 - 8724	461 - 3049	294932	1.99E+09
269	8726 - 8732	463 - 3049	291504	1.97E+09
270	8734 - 8740	461 - 3049	286486	1.93E+09
271	8742 - 8748	461 - 3049	286738	1.93E+09
272	8750 - 8756	461 - 3029	291104	1.96E+09
273	8758 - 8764	463 - 3029	285333	1.92E+09
274	8766 - 8772	461 - 3029	282883	1.91E+09
275	8774 - 8780	461 - 3027	290602	1.96E+09
276	8782 - 8788	463 - 3027	290688	1.96E+09
277	8790 - 8796	463 - 3027	286355	1.93E+09
278	8798 - 8804	461 - 3007	285160	1.92E+09
279	8806 - 8812	461 - 3007	288718	1.95E+09
280	8814 - 8820	463 - 3007	284844	1.92E+09
281	8822 - 8828	461 - 3007	278062	1.88E+09
282	8830 - 8836	461 - 2985	285048	1.92E+09
283	8838 - 8844	463 - 2985	286862	1.93E+09
284	8846 - 8852	463 - 2987	284534	1.92E+09
285	8854 - 8860	463 - 2985	279969	1.89E+09
286	8862 - 8868	463 - 2965	283889	1.91E+09
287	8870 - 8876	463 - 2965	286352	1.93E+09
288	8878 - 8884	463 - 2965	278374	1.88E+09
289	8886 - 8892	461 - 2965	274871	1.85E+09
290	8894 - 8900	461 - 2947	280819	1.89E+09

NO	1ST SUBLINE	LAST SUBLINE	1ST XL	LAST XL
291	8902 - 8908	463 - 2945	281435	1.90E+09
292	8910 - 8916	463 - 2935	272031	1.83E+09
293	8918 - 8924	463 - 2923	271628	1.83E+09
294	8926 - 8932	461 - 2923	279312	1.88E+09
295	8934 - 8940	463 - 2923	277674	1.87E+09
296	8942 - 8948	463 - 2923	271886	1.83E+09
297	8950 - 8956	461 - 2903	271737	1.83E+09
298	8958 - 8964	461 - 2903	276618	1.87E+09
299	8966 - 8972	461 - 2903	273721	1.85E+09
300	8974 - 8980	461 - 2883	267536	1.80E+09
301	8982 - 8988	459 - 2883	271635	1.83E+09
302	8990 - 8996	461 - 2883	273527	1.84E+09
303	8998 - 9004	459 - 2861	268204	1.81E+09
304	9006 - 9012	461 - 2861	264959	1.79E+09
305	9014 - 9020	459 - 2863	269037	1.81E+09
306	9022 - 9028	461 - 2863	269658	1.82E+09
307	9030 - 9036	461 - 2861	264763	1.79E+09
308	9038 - 9044	463 - 2839	262966	1.77E+09
309	9046 - 9052	461 - 2839	267673	1.81E+09
310	9054 - 9060	463 - 2839	264271	1.78E+09
311	9062 - 9064	463 - 2839	101415	6.84E+08

B10 FINAL VELOCITY FIELD (MIGRATION AND STACK)

CLIENT : SANTOS LIMITED
AREA : SANTOS VIC P51/P52 OS02 3D
PROCESS : FINAL MIGRATION VELOCITY FIELD
DATA LENGTH : 6.5 SEC
SAMPLE RATE : 4 MSEC
FORMAT : SEG-Y FILES ON DVD
FILE NAME : FVELINTPSMRMS_PT1 TO PT6 (RMS)
FVELINTPSMINT_PT1 TO PT6 (INTERVAL)

PROCESS : FINAL STACKING VELOCITY FIELDS (Residual)
DATA LENGTH : 6.5 SEC
SAMPLE RATE : 4 MSEC
FORMAT : SEG-Y & ASCII FILES ON CD
FILE NAME : RESIDV_INTPTVRMS.SGY (INTERPOLATED RMS VEL IN SEGY)
JC7_PSDM2RESV.WES (PICKED RMS VEL IN WESTERN ASCII)

EXAMPLE VELOCITY FILE IN WESTERN FORMAT:

```
CLIENT SANTOS LIMITED
AREA VIC/P51-52 3D,VICTORIA AUSTRALIA
FINAL VELOCITY - GRID 0.25KM X 0.25KM
FORMAT WESTERN VELOCITIES FORMAT
COMM   WESTERN GECO - FINAL PROCESSING GRID
COMM   NUMBERING SYSTEM
SPNT   69921481      1481    555819   5689044      6992
VELF   69921481    0 2389 1495 2490 1497 2543 1500 2607 1507 2680 1520
VELF   69921481      2768 1535 2842 1552 2918 1577 3055 1617 3199 1647
VELF   69921481      3333 1675 3441 1717 3544 1753 3665 1799 3766 1844
VELF   69921481      3871 1887 4016 1927 4211 2017 4450 2110 4663 2187
VELF   69921481      4793 2235 5023 2297 5424 2408 5859 2533 6484 2705
SPNT   69921501      1501    556031   5688911      6992
VELF   69921501    0 2414 1492 2507 1497 2610 1507 2698 1520 2768 1540
VELF   69921501      2847 1557 2930 1577 3091 1617 3265 1660 3419 1727
VELF   69921501      3549 1767 3642 1792 3737 1815 3873 1878 3974 1921
VELF   69921501      4206 2025 4453 2142 4682 2221 4945 2286 5233 2368
VELF   69921501      5639 2470 6487 2691
```

B11. AOK GATHERS TAPELOG

CLIENT : SANTOS LIMITED
AREA : SANTOS VIC P51/P52 OS02 3D
PROCESS : AOK GATHERS
DATA LENGTH : 6.5 SEC
SAMPLE RATE : 4 MSEC
FORMAT : SEG-Y/ 3590 TAPE

NAME	FORMAT	FIRST BYTE	NUMBER OF BYTES
LINECOUNT	INT	1	4
REELCOUNT	INT	5	4
SP	BINARY	9	4
CONSTANT	BINARY	13	4
INLINE	BINARY	17	4
CROSSLINE	BINARY	21	4
TRSEQ	BINARY	25	4
OFFSET	BINARY	37	4
CDPX	BINARY	125	4
CDPY	BINARY	129	4
OUTER MUTE	BINARY	169	174
OFF MUTE	BINARY	173	176
CDPX	BINARY	181	4
CDPY	BINARY	185	4
SP	BINARY	189	4
CDPLBL	BINARY	193	4
CMPWDEPTHM	BINARY	213	4
CDPLBL	BINARY	217	4

TAPE NUMBER	INLINE RANGE	CROSSLINE RANGE
AOKCMP01	7192 - 7264	1583 - 2285
AOKCMP02	7266 - 7374	1583 - 2285
AOKCMP03	7376 - 7476	1583 - 2285
AOKCMP04	7478 - 7576	1583 - 2285
AOKCMP05	7578 - 7674	1583 - 2285
AOKCMP06	7676 - 7804	1583 - 2285
AOKCMP07	7806 - 7966	1781 - 2285
AOKCMP08	7968 - 8120	1781 - 2285
AOKCMP09	8122 - 8270	1781 - 2285
AOKCMP10	8272 - 8426	1781 - 2285
AOKCMP11	8428 - 8604	1781 - 2285
AOKCMP12	8606 - 8750	1781 - 2285
AOKCMP13	8752 - 8900	1781 - 2285
AOKCMP14	8902 - 9048	1781 - 2285

B11.1 AOK Stack Tapelog

CLIENT	:	SANTOS LIMITED
AREA	:	SANTOS VIC P51/P52 OS02 3D
PROCESS	:	FINAL HYBRID AOK STACK (FULL/AGC/NEAR/FAR) (WITH TIME VARIANT FILTER/ ZERO PHASE FILTER/ SOURCE AND CABLE DEPTH CORRECTIONS APPLIED) 1) AOK FULL STACK 2) AOK OPTIMUM STACK 3) AOK NEAR STACK 4) AOK FAR STACK
DATA LENGTH	:	6.5 SEC
SAMPLE RATE	:	4 MSEC
FORMAT	:	SEG-Y DLT4 35GB DENSITY
TAPE ID	:	1) AOKSTKSTVFZP SUBLINE 7192-9048 2) AGCSTKSTVFZP SUBLINE 7192-9048 3) ANRSTKSTVFZP SUBLINE 7192-9048 4) AFRSTKSTVFZP SUBLINE 7192-9048

DEFINED HEADER INFORMATION

NAME	FORMAT	FIRST BYTE	NUMBER OF BYTES
LINECOUNT	INT	1	4
REELCOUNT	INT	5	4
SP	BINARY	9	4
CONSTANT	BINARY	13	4
INLINE	BINARY	17	4
CROSSLINE	BINARY	21	4
FOLD	BINARY	33	2
CDPX	BINARY	73	4
CDPY	BINARY	77	4
CDPX	BINARY	125	4
CDPY	BINARY	129	4
CDPX	BINARY	181	4
CDPY	BINARY	185	4
SUBLINE	BINARY	189	4
CROSSLINE	BINARY	193	4

B12 <u>AOK VELOCITY FIELD</u>

CLIENT	:	SANTOS LIMITED
AREA	:	SANTOS VIC P51/P52 OS02 3D
PROCESS	:	AOK VELOCITY FIELD (RMS & INTERVAL)
DATA LENGTH	:	6.5 SEC
SAMPLE RATE	:	4 MSEC
FORMAT	:	SEG-Y FILES ON DVD (54 X 3 FILES)
FILE NAME	:	*_AOKVRMS.SGY (RMS VELOCITY)
		*_RVINT.SGY (RAW INTERVAL VELOCITY)
		*_CVINT.SGY (CONDITIONED INTERVAL VELOCITY)

APPENDIX C - TECHNOLOGY DESCRIPTIONS

TRANSCRIPTION AND RESAMPLE

The process of converting and/or demultiplexing the field data into Veritas DGC's internal trace sequential format. A minimum phase anti-alias filter is used to avoid temporal aliasing when resampling. This filter has a simple high cut form.

TRUE AMPLITUDE RECOVERY

This is a correction for amplitude losses which are due to the spherical spreading of the wavefront. Thus, as the amplitude of the recorded trace varies inversely with the radius of the advancing wavefront, each trace is multiplied by a function Velocity (V) and Time (T) (e.g. V^2T, VT, VT^2), where V is the seismic wave velocity and T is the two-way time. An additional exponential or linear gain correction may also be applied.

SHOT AND STREAMER DEPTH STATIC CORRECTIONS

Simple static corrections are made to compensate for the depths of the sources and receivers and shift the seismic data to a sea level datum. These statics are usually so small that the point of application is not significant.

SWELL NOISE ATTENUATION – FXEDIT

FXEDIT is used to detect and repair anomalously high amplitude windows of a trace via FX projection filtering. The program considers a group of traces at a time (commonly a common shot, receiver, channel or offset gather) over user specified time gates. Within each time window and frequency-by-frequency, a rolling median amplitude is calculated. The user specifies a threshold value such that any frequency component of any trace that has a window amplitude (relative to the rolling median value) above this threshold is flagged for repair. Each of the flagged frequency/window components is deleted and re-interpolated.

HIGH(ER) RESOLUTION LINEAR NOISE ATTENUATION – XRLIN

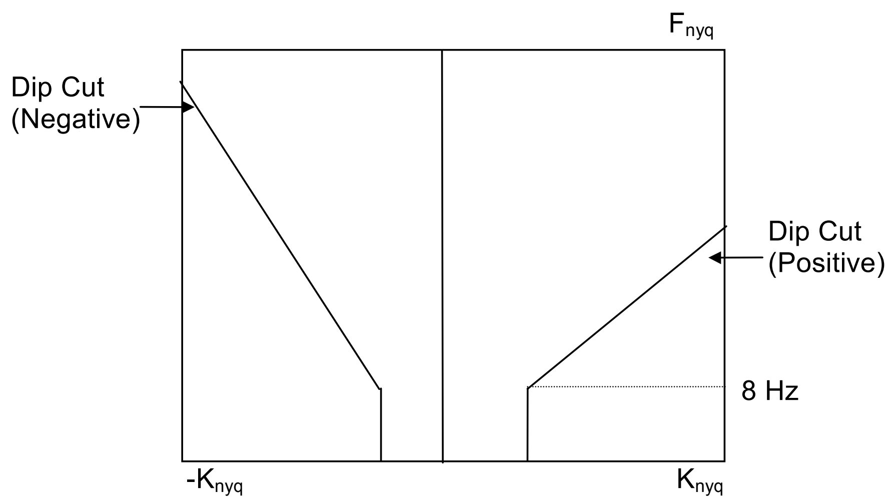
XRLIN performs noise removal and trace regularisation using a constrained, high-resolution, linear Radon transform.

The algorithm gives a better focussed representation of the data in the Radon domain compared to the conventional least-squares transform or to direct summation (as in the TAUP or TAUPF modules). The program is better able to preserve primary amplitudes as a function of offset whilst simultaneously giving a more complete noise removal than those approaches. It is also resistant to spatial aliasing and can therefore reduce the need for trace interpolation before noise removal. The algorithm honours the true offset of the data, so that linear noise trains can be accurately attenuated even in irregularly sampled land acquisition.

It is possible to use this module to generate output traces at different locations from the input traces, by specifying a different set of offsets for the inverse as opposed to the forward transform. If the input traces are irregularly sampled, for example, then the output, with or without noise removal, can be generated at a regularised set of trace locations.

SHOT DOMAIN FK VELOCITY FILTER

FK velocity filtering can be applied as either a two-dimensional T-X convolution of in the FK domain. The default attenuation at the specified dip value is 40 dB (for Cosine tapering). Low frequencies are protected by the use of “chimney” (see diagram) starting at a default value of 8 Hz.



There are two options for the construction of the filters:

(a) Cosine Tapering

A cosine shaped taper begins at a given percentage of the distance between K=0 and the Dip cut. 100% cosine tapers begin to taper at K=0 and, for example, 25% cosine tapers begin to taper at 75% of the distance from K=0 to the dip cut. The default value for attenuation at the dip cut is -40 dB.

(b) Cut / Slope Parameterisation (The “Power” option)

Here the Dip Cut value is specified and a dB/octave roll-off for the attenuation past that point.

WAVE EQUATION MULTIPLE ATTENUATION

WEMA uses the known water depths and the wave-equation to convert the recorded shot gather (or CDP gather) into an estimate of all the multiple energy that has at least one "bounce" within the water layer.

WEMA proceeds by subtracting this multiple estimate from the original gather using windowed, trace dependant cross-equalisation filters.

The process assumes a single constant water depth for each gather and is therefore mainly effective in areas without rapid water depth fluctuations.

SLAM – SURFACE LINEARISED MULTIPLE ATTENUATION

SLAM is a predictive deconvolution technique, to be applied in the Tau-P domain, designed specifically to remove simple water-bottom multiples and water-bottom peglegs.

The technique was developed by Lokshtanov et al. of Norsk Hydro and is also known in the industry under the name REMUL.

The method is derived from an approximation to the full reflection model in the tau-p domain. This approximation includes pure water bottom multiples and water bottom peg leg multiples, but neglects interbed multiples and free-surface multiples from deeper reflections. For a 1D assumption, this results in a single channel, second order operator and will remove both source and receiver side multiples. When lateral variation is included, a multi-channel operator is required due the coupling between incident and reflected waves of different slowness. This operator will correctly remove receiver side peglegs, but will only partially remove the source side pegleg multiples. These operators require an estimate of the water bottom reflectivity, which is extracted by isolating the water bottom reflection in the tau-p domain, but, unlike full free surface multiple attenuation methods, do not require knowledge of the source signature.

Reference: **Lokshtanov, D.E.**, 1995, Multiple suppression by single channel and multichannel deconvolution in the Tau-p domain, Expanded Abstracts, 65th SEG Meeting

SPIKING AND PREDICTIVE DECONVOLUTION

Veritas DGC's implementation of spiking and predictive deconvolutions follow the conventional Weiner - Levinson theory. Optimum minimum phase squared error filters are computed over a given design window for a given filter length. Multiple filters can be computed and applied in a time variant manner.

There are options for standard single trace deconvolution or filter computations using running averaged autocorrelations (averaging distance specified in metres), or also based on a whole shot averaged autocorrelation (ie. One deconvolution filter per shot).

The aim of the spiking deconvolution is to whiten the wavelet spectrum and increase resolution. Predictive Deconvolution uses autocorrelations to predict and subtract features like multiple reflections.

TAU-P DOMAIN DECONVOLUTION

In the X-T domain, reverberation energy on shot records is not periodic at non-zero offset because of the compression effects of NMO. To combat this, prestack deconvolution may also be applied in the Tau-P domain where reverberation is periodic at all p values (assuming a flat waterbottom). Shot records are transformed to the Tau-P domain using a projection slice algorithm (TAUPF) with a sufficient p range to provide an accurate inverse transform. Gap deconvolution, as described above, is applied in this domain before the inverse transform is performed. The gap may vary as a function of p according to a supplied constant velocity value.

Autocorrelations may be averaged across traces prior to computing the deconvolution operator. The averaging may be chosen to be across an entire group of traces (shot record, for example), or across specified ranges of offsets (3 filters per shot, for example) or across a running average of user specified length (different filter for each trace computed from smoothed autocorelations). Excessive averaging is not recommended in the Tau-P domain as the period of the multiples is changing for every p value.

MULTIPLE ATTENUATION BASED ON MOVEOUT DIFFERENCES

For multiple attenuation based on moveout difference between primary and multiple reflections, the critical step is to determine the primary and multiple velocities. Usually the multiple velocity is specified as a time variant percentage of the primary velocities.

(a) ZMULT – FK Demultiple

The CDP gather is moveout corrected using the multiple velocity. This forces primary energy to be over corrected and multiples to be either flattened or under corrected. The moveout corrected gather is transformed to the FK domain where primaries will be in the negative K quadrant and multiples in the positive K quadrant. The positive quadrant is then simply zeroed and the data is inverse transformed back to the T-X domain. The original moveout correction is then removed and CDP gathers with attenuated multiples is the result.

(b) PMULT – Radon Demultiple

PMULT decomposes the moveout corrected CDP gather into parabolic Radon domain (ie, parabolic curvature versus zero offset time). Parabolic curvature is specified in terms of differential moveout (far offset time - near offset time).

A curvature range is specified for the transform and then a subset of this range is specified for either preservation or subtraction. Usually, the multiple range is specified for subtraction. In this mode the multiple range is inverse transformed to the T-X domain and subtracted from the original gather.

Other important parameters used in PMULT are the number of curvature samples (p traces) used in the transform and / or the maximum frequency used to automatically compute the number of p traces.

(C) 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.

3D BINNING

Variations in ocean currents result in marine 3D data recorded with trace midpoints that are distributed in an irregular manner. Irregularities in recording geometries also occur in land, transition zone and OBC surveys because of obstructions such as oil platforms, roads, fences, topography etc. All surveys may have gaps in coverage caused by misfires, noisy channels etc. Many seismic processing algorithms and interpretation systems expect the data to be on a regular grid in (X,Y), to have uniform offset distributions at each CMP and to be sufficiently closely sampled to avoid spatial aliasing of the data.

Conventional processing of these data therefore assigns traces to regular CMP bins. The regular grid of rectangular CMP bins is defined by a user-determined origin, bin dimensions in the inline and crossline directions and the number of bins in the inline and crossline direction. The grid is Cartesian and real world co-ordinates are projected on to this flat grid. The data is 'binned' after merging the navigation and seismic data. Traces are assigned to a CMP bin if its' mid-point lies within the rectangular area defined by the bin centre and the inline and crossline dimensions of the bin. The trace is given the CMP bin number together with the (X,Y) coordinate information of the bin centre.

This binning of the data causes irregular fold of coverage with some bins missing offsets while other bins have duplicate traces.

FLOOD – FOLD LEVELLING FOR OPTIMUM OFFSET DISTRIBUTION

Fold Levelling for Optimised Offset Distribution (FLOOD) is a replacement for flexible binning which fully recognises the irregularly distributed positions of the traces and the dip of the data. Instead of binning the data and then analysing the fold distribution, interpolation techniques are used to resample data from its' original irregular mid-point spacing to a regular grid of traces whose mid-points lie at bin centres.

If duplicate offset traces fall within the same bin, the trace nearest the bin centre is preserved. If no trace lies within the bin, a new trace is formed at the bin centre by interpolation from the nearest traces with the same offset. The process may be run in either the inline or crossline direction (or both), but crossline is the normal practice for marine data.

Optionally, all the original live traces may also be interpolated from their initial irregular positions to the regular bin centres. This option may be run in either inline or crossline direction. However, inline interpolation to the bin centre may often be better achieved using the BINCENT program before FLOOD.

Three interpolation algorithms are available; a standard, linear method for non-aliased data a tau-p method for steep dip, aliased data and an advanced FX interpolator for steep dip, aliased data. All three algorithms are designed for irregular input trace spacing and use the live trace actual mid points for the interpolation. None of the methods require a dip model.

A maximum distance is set for valid interpolation, so if crossline ‘holes’ are too large, interpolation of missing data will not occur. The program works in the common offset domain.

FLOOD offers higher resolution and accuracy than conventional flexible binning. Traces within a CDP, which are to be stacked, now lie at the bin centre and the smearing caused by mid-point scatter around the bin is eliminated. Prestack and stacked data lie on a regular (x,y) grid as expected by various migration and noise suppression algorithms. The interpolation is dip and amplitude sensitive whereas the trace copying in flexible binning is a zero dip, constant amplitude approximation. Interpolated traces are thus a more accurate representation of the true reflectivity at the bin centre. High frequencies, steep dips and true amplitudes are enhanced by use of FLOOD instead of flexible binning.

FLOOD can be used before 3D DMO to improve the stability of DMO on modern wide tow marine surveys. Interpolation of the data onto a regular grid in (x,y) improves the accuracy of the numerical integration in 3D DMO, thus eliminating many of the DMO artifacts caused by irregular geometry.

DIP MOVEOUT CORRECTION (DMO)

The aim of DMO is to convert all the data recorded at the non-zero offsets to appear as if it were recorded at zero offset. Veritas DGC has two DMO algorithms, FK DMO (after Hale) and Kirchhoff DMO. Both algorithms operate on common offset planes or volumes, and both have a time variant velocity option. These algorithms can be applied in 2D or full 3D models. The only user parameters of importance is the dip limit and the option of anti-aliasing filters in Kirchhoff DMO.

MOVES – Pre-Stack Time Migration

Migration for **O**ptimum **V**elocity **E**valuation and **S**tacking (MOVES) is a processing technique which utilises dip moveout, and zero offset migration applied pre-stack to simplify the interpretation of primary events for stacking – providing a suitable velocity field for migration.

It is performed using the PSPS (Phase Shift Plus Stolt) algorithm in common offset domain after DMO using a single time-variant velocity function. The PSPS algorithm accurately copes with vertical velocity variations but has no response to lateral variations.

MOVES the method: after pre-processing, a single average velocity function is selected to apply NMO, DMO and a reversible zero offset PSPS offset migration to each binned offset separately. NMO is removed from and velocity analysis performed on time and spatially corrected data to produce a valid migration velocity field. The data is then stacked with the full velocity field. After stack the data is reverse PSPS migrated with the same average velocity function used before stack. The data is then re-migrated using any available algorithm (e.g. Explicit) with the full velocity field.

UTMOST – Pre-Stack Time Migration

Ultimate **T**ime **M**igration for **O**ptimum **St**acking (UTMOST) is a full pre-stack Kirchhoff time migration algorithm that uses ray-traced travel times. It replaces NMO, DMO and zero-offset migration with one processing step. It migrates the data using actual X,Y locations and provides a better and more accurate sub-surface image then MOVES.

Migration may be viewed as the process of flattening and stacking diffraction surfaces (see figure 1). The better the migration algorithm is at computing the corrections necessary to flatten these shapes the sharper and more detailed the final image will be. In conventional processing many assumptions are made and the corrections are not optimal.

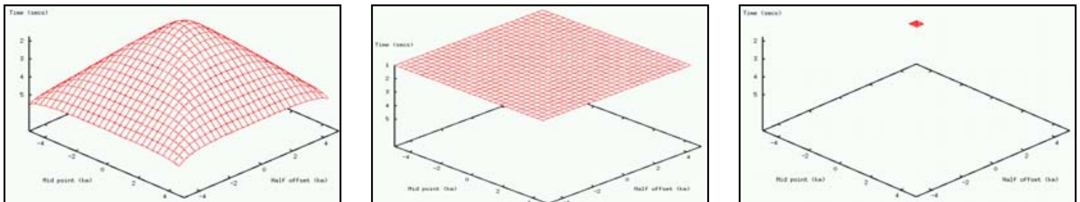


Figure 1: Migration may be viewed as diffraction flattening and summation.

Kirchhoff pre-stack time migration may be implemented so as not to make any assumptions on the shape of the diffraction surfaces. Veritas implementation of pre-stack time migration (prestm3d) falls into this category. Provided lateral velocity variations are small Kirchhoff pre-stack time migration will often give as good an answer as pre-stack depth migration.

Kirchhoff migration may be implemented in a variety of ways. Prestm3d is based on the following implementation details:

1. For any input trace the migration "corrections" are based on the time varying velocity at the mid-point of the input trace. A trace at a different mid-point will be migrated using a potentially different velocity function.

2. The corrections are based on the actual source and receiver locations. Travel-times from the shot and receiver to the imaging point (output target) are computed and added together to form the corrections.

3. Each input trace is "sprayed" after corrections and summed into all output target locations.

4. The amplitude weights are based on Schneider's (1978) paper.

5. A derivative filter is also applied before summing into the output volume.

6. Anti-aliasing is applied to minimize aliasing noise on the output image. The anti-aliasing is based on the paper by Lumley et. al. (1994) but modified to handle finite offsets better.

KIRCHHOFF PRE-STACK TIME MIGRATION PROCESSING FLOW

After pre-processing velocities are picked to form a smooth velocity field to be used for the first pass of prestm3d. Gathers are output from the migration on a user-specified grid, say, every 1 km. Inverse NMO is then performed on the migrated gathers before picking new velocities. These velocities are picked from data that is close to its correct spatial location and should thus be more accurate than velocities picked from conventional processing.

The data is then migrated with the spatially varying velocity field either outputting to a sparse grid for another iteration of velocity estimation or to the full output volume. After the last iteration a final fine-tuning of velocities is performed before stacking the data.

MENTOR AND PRE-STACK DEPTH MIGRATION

MENTOR (**M**aximum **EN**tropy **TO**mography for **R**eflections) is a reflection tomography algorithm that automatically builds an interval velocity depth model that can be used in pre-stack depth migration. The process begins with a PICKER module, which automatically picks any coherent energy on the pre-stack seismic data. This picker also measures the local apparent dips and the event times and dips are stored in a database. Concurrently, the "best" initial interval velocity model is constructed using all available information (wells, stacking velocities, horizon interpretations, etc.). The MENTOR module then ray traces through this initial model and compare the travel times of the ray-tracing to those actually picked from the data. The inversion algorithm within MENTOR then sets about iteratively changing the initial velocity model (constrained by maximum entropy rather than least square), so that the errors between the ray-traced travel times and the actual travel times are reduced. More technical details can be obtained in the papers by Dr. Peter Whiting in 1998 (68th Ann. Internat. Mtg. Soc. Expl. Geophys., Expanded Abstracts, 1226-1229; Exploration Geophysics, 29, 649-653). Details of actual steps involved are discussed in section 4.2.

Pre-Stack Depth Migration is generally useful in overcoming the problem of poor stack quality in normal processing where the assumed straight ray path of normal move-out (NMO) and Dip-moveout (DMO) could not handle the presence of significant lateral velocity variations. The algorithm used in this project is the Kirchhoff common-offset approach and it has been optimised to run efficiently on the NEC SX-5 Super computer.

VERTICAL VELOCITY UPDATING

Vertical Velocity Updating is another technique that can be used to build an interval velocity depth model for pre-stack depth migration. It is horizon based and proceeds in a top down layer-cake fashion. Using an initial velocity model input gathers are pre-stack migrated down to the depth of the first horizon in the model. The resultant depth gathers are interactively analysed for flatness and the model updated as required. The process is repeated with the updated velocity model and iterated as required until the first layer velocity model is satisfactory. The entire process is then repeated with the migration being done down to the second layer. After the second layer's velocity model has been updated satisfactorily then the third layer is done and so on down successive layers until the final interval velocity depth model has been built.

In practice, Vertical Velocity Updating is very time consuming and reasonable limits need to be maintained as to the number of layers and the number of update iterations. Veritas uses VIEWS software for interactive vertical updating analysis. Apart from being used to pre-stack depth migrate the data, the vertical updated model may also be used as the initial model for Mentor (see above) reflection tomography.

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.

COMMON DEPTH POINT STACK

Stack is the summation of traces within each CDP producing a single stacked trace for each input gather record. The stack is normalised and mute zone compensated to account for the smaller number of live traces in the mute zone and for uneven fold of coverage. This recovery scaling is usually 1/n or 1/√n, where n is the number of live traces at that two - way time value.

ZERO OFFSET TIME MIGRATION

Veritas DGC has the following range of time migration algorithms:

STOLT or FK Migration

Very efficient but inaccurate in the presence of velocity variations.

PSPS (Phase Shift plus STOLT)

An extension of STOLT where the migration is performed in a series of constant velocity time strips. A phase-shift is used to move to the bottom of each strip. Stolt migration is used within each strip. PSPS migration accurately copes with vertical variations but has no response to lateral velocity variations.

Kirchhoff Migration

The conventional non-recursive Kirchhoff summation algorithm. The migration is based on local RMS velocities and has a somewhat weak response for both temporal and spatial velocity variations.

FD Migration

Finite Difference migration is performed in the T-X domain using an approximate form of the wave equation. This is a recursive migration that steps down through the data in small time steps. It copes well with vertical velocity variations and lateral velocity variations (not too rapid) but is dip limited to 45^{o}. The dip limitation is due to the approximation of the wave equation. The finite difference solution creates some noise through frequency dispersion.

Omega-X Migration

This is essentially the application of the FD migration in the frequency domain. In this domain the solution is achieved more accurately. There is less noise through frequency dispersion and a steeper dip response.

Phase Shift Migration

Phase-shift migration is a recursive FK domain migration that accurately migrates in the presence of vertical velocity variations. It has no response to lateral velocity variations. It is sometimes called Gazdag migration after its originator (see Gazdag, 1978). Phase shift migration is often considered to be the best possible migration when no lateral velocity variations exist.

PSPI

Phase shift plus interpolation (PSPI) is Gazdag's modification to Phase-shift migration so that it can cope with lateral velocity variations. Each recursive time step is migrated (using the phase-shift algorithm) for a range of constant velocities and a variable velocity response is obtained by interpolation of these results.

When lateral velocity variations exist, PSPI migration is probably the best available time migration.

Explicit Migration

Explicit migration is a new algorithm (effectively an upgrade to omega-x migration) capable of migrating dips up to 70 degrees. In testing, the steep dip response of this algorithm has been better that PSPI migration. The essence of the explicit technique are the filters used to perform the downward continuation. These filters are computed using

TAU-P FILTER

This technique is based on a rolling Tau-p transform. A number of traces around a centre trace are transformed to the Tau-p domain where coherent events are easily recognised. A coherent event trace is created for each centre trace and these are weighted by adding back a percentage of the original trace.

The important parameters are the range of dips to be transformed, the dips increment within the transform (no p traces), the number of traces to use around each centre trace and the percentage addback of the original traces (can be time variant).

TIME VARIANT BAND PASS FILTER

These filters are usually defined by a low high frequency and a low and high roll off slope in dB / Octave.

TRACE EQUALISATION

Options include:

- scaling functions - exponential linear
- whole trace balancing
- windowed balance - allows for window overlap. Arbitrary window sizes
- AGC - Automatic Gain Control - can be referenced to top, centre or bottom of window
- Time - variant AGC - window size can vary within time
- Running true-amplitude balancing, (RUNTRAMP) - traces are balanced to a spatially smooth amplitude trend.