SEISMIC DATA PROCESSING REPORT

for

APACHE ENERGY LTD

Survey	GIPPSLAND WEST Combined Time (PSTM) and Depth (PSDM) Processing Report for: Marie (2007), GBA02B(2002) and Bream(2006) 3D Seismic Surveys.
Location	Gippsland Basin, Australia, Vic/P42
Date	May 2008

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1   Introduction

The Marie 3D Seismic Survey was recorded by APACHE between March and May 2007. A total of 38874.6 sail line kms were acquired, comprising 107 live sequences. The survey was located in the Block:Vic/P42, Gippsland Basin, Offshore Victoria, Australia.

In addition to the Marie 3D, 2 adjoining 3Ds were reprocessed. These were the GBA02B and Bream 3Ds shot in 2002 and 2006 respectively. The processing flow used was consistent across all three surveys.

Principally two processing products were produced.

Fast-Track Pre-STM cube (FTC): A Pre-STM migrated cube was produced for the Marie 3D only.   After binning a total of 823 square kms was processed for this product. The acquisition covered 503 km^2, with the addition of 320 km^2 coming from data shot during the turns and the lead in and lead out.

Gathers used for Depth Imaging Input: These were essentially the demultiple gathers of all 3D data sets phase matched and merged together as one dataset. After binning a total of 1515 km^2 was processed for this data set.

The data was characterised by shallow water over the entire 3 survey range. The S/N ratio was generally good. The stratigraphy included the Lakes Entrance Formation, Latrobe Group Golden Beach and Strzelecki Groups. Noise in the data was typical of shallow water recording ie. short period multiples sourced from either the water bottom or shallow high impedance events. The key to the time processing was removal of these short period multiples, especially as their strength masked the (sometimes) weak primary data underneath.

Processing commenced in March 2007 and the final stack and binned gathers were delivered to Oil Hunters in August 2007 for subsequent depth imaging. Final archiving of all support products was then completed October 2007.

All processing was undertaken at the Fugro Seismic Imaging office in Perth, Western Australia.

1.1   Personnel

Fugro Seismic Imaging Pty Ltd
Michael Riha   Senior Geophysicist

Apache Energy Ltd
Paul Bouloudas   Senior Staff Geophysicist
Jim Ross   Exploration Manager

1.2 Line Listing

REF.	MARIE3D	FSP	LSP	REF.	GBA02B 3D	FSP	LSP	REF.	BREAM 3D	FSP	LSP
2	GAP07A1296P010	1193	2511	110	VP421216P001	2315	944	155	G06A-1440p2-004	1001	1862
3	GAP07A1024P011	2023	812	111	VP421008P002	1001	2960	156	G06A-1744p1-005	1898	1004
4	GAP07A1312P012	1193	2533	112	VP421232P003	2807	949	157	G06A-1456p1-006	1001	1944
5	GAP07A1040P013	2045	760	113	VP421024P004	1007	1632	158	G06A-1760p1-007	1896	1003
6	GAP07A1328P014	1193	2556	114	VP421248P005	2804	954	159	G06A-1472p1-008	1001	1942
7	GAP07A1056P015	2068	1420	115	VP421024A006	1622	2957	160	G06A-1776p1-009	1893	1003
8	GAP07A1344P016	1455	2789	116	VP421200P007	2811	939	161	G06A-1488p1-010	1001	1939
9	GAP07A1072P017	2090	720	117	VP421040P008	1016	2956	162	G06A-1744p2-012	1399	1229
10	GAP07A1360P018	1194	1939	118	VP421184P009	2811	2501	163	G06A-1488f1-013	1001	1938
11	GAP07A1376P020	1194	2623	119	VP421184A010	2180	934	164	G06A-1776f2-014	1891	1003
12	GAP07A1104P021	2135	1029	120	VP421056P011	1019	2953	165	G06A-1504p1-015	1001	1938
13	GAP07A1392P022	1194	2645	121	VP421168P012	2815	929	166	G06A-1792p1-016	1888	1003
14	GAP07A1120P023	2157	828	122	VP421072P013	1022	2647	167	G06A-1520p1-017	1001	1934
15	GAP07A1408P024	1194	2668	123	VP421264P014	2802	959	168	G06A-1808p1-018	1889	1003
16	GAP07A1136P025	1899	1044	124	VP421088P015	1027	2949	169	G06A-1520f1-019	1001	1931
17	GAP07A1424P026	1029	2840	125	VP421280P016	2800	964	170	G06A-1824p1-020	1885	1003
18	GAP07A1152P027	2482	822	126	VP421104P017	1032	2947	171	G06A-1536p1-021	1001	1932
19	GAP07A1440P028	1195	2712	127	VP421296P018	2798	969	172	G06A-1824f1-022	1883	1003
20	GAP07A1168P029	2454	1074	128	VP421120P019	1037	2945	173	G06A-1552p1-023	1001	1931
21	GAP07A1456P030	935	3004	129	VP421312P020	2796	974	174	G06A-1840p1-024	1881	1003
22	GAP07A1184P031	2507	851	130	VP421120J021	1037	2945	175	G06A-1568p1-025	1001	1929
23	GAP07A1472P032	935	2757	131	VP421328P022	2794	2036	176	G06A-1856p1-026	1881	1004
24	GAP07A1200P033	2529	860	132	VP421328A023	1780	979	177	G06A-1584p1-027	1001	1928
25	GAP07A1488P034	1195	2780	133	VP421136P024	1042	2943	178	G06A-1856f1-028	1883	1003
26	GAP07A1216P035	2292	1085	134	VP421344P025	2792	984	179	G06A-1856f2-030	1879	1003
27	GAP07A1504P036	965	2802	135	VP421152P026	1047	2940	180	G06A-1872p1-031	1876	1003
28	GAP07A1232P037	2314	1085	136	VP421360P027	2789	989	181	G06A-1520u2-034	1147	1891
29	GAP07A1520P038	965	2793	137	VP421152J028	1047	2940	182	G06A-1872u1-035	1518	1004
30	GAP07A1248P039	2336	846	138	VP421216A029	2809	2306	183	G06A-1504u1-036	1068	1910
31	GAP07A1376A041	2420	2867	139	VP421072A030	2638	2951	184	G06A-1840u1-037	1572	1004
32	GAP07A1136A042	2349	1890	140	VP421184B031	2510	2171	185	G06A-1520u3-038	1152	1920
33	GAP07A1056A043	1429	575	141	VP421328B032	2045	1771	186	G06A-1840u2-039	1513	1199
34	GAP07A1536A044	1067	3015	142	VP421520P033	1665	2891	187	G06A-1872u2-040	1513	1003
35	GAP07A1264P045	2359	965	143	VP421376P034	2787	994	188	G06A-1872u3-041	1512	1002
36	GAP07A1552P046	966	2791	144	VP421504P035	1660	2893	189	G06A-1504u2-042	1001	1817
37	GAP07A1280P047	2571	1086	145	VP421376J036	2787	994	190	G06A-1504u4-046	1118	1682
38	GAP07A1568P048	1196	2791	146	VP421488P037	1655	2895	191	G06A-1824u2-047	1512	1004
39	GAP07A1088A049	2341	885	147	VP421376K038	2787	994	192	G06A-1824u3-049	1513	1199
40	GAP07A1584P050	966	2790	148	VP421472P039	1650	2897	193	G06A-1584f2-050	1001	1924
41	GAP07A1024A051	2253	1082	149	VP421392P040	2785	1502	194	G06A-1888p1-051	1875	1003
42	GAP07A1376B052	964	2623	150	VP421408P042	2783	1507	195	G06A-1600p1-052	1001	1922
43	GAP07A1008A053	2230	940	151	VP421456A043	1646	2899	196	G06A-1904p1-053	1873	1003
44	GAP07A1360A054	964	2775	152	VP421424P044	2779	1512	197	G06A-1616p1-054	1002	1919
45	GAP07A1280J055	2571	1086	153	VP421440P045	1644	2902	198	G06A-1840u3-055	1572	1004
46	GAP07A1424J056	1194	2690					199	G06A-1520u6-056	1111	1699
47	GAP07A1600P057	1924	788					200	G06A-1520u7-057	1108	1656
48	GAP07A1904P058	875	2027					201	G06A-1168p1-058	1497	1003
49	GAP07A1616P059	1924	638					202	G06A-1616f1-059	1001	1918
50	GAP07A1920P060	774	2016					203	G06A-1184p1-060	1540	1004
51	GAP07A1632P061	1924	894					204	G06A-1632p1-061	1001	1916
52	GAP07A1936P062	774	2030					205	G06A-1200p1-062	1646	1003
53	GAP07A1648P063	1925	650					206	G06A-1632f1-063	1001	1916

54	GAP07A1952P064	875	2010			207	G06A-1216p1-064	1694	1003
55	GAP07A1664P065	1925	658			208	G06A-1648p1-065	1001	1915
56	GAP07A1968P066	774	2004			209	G06A-1232p1-066	1774	1004
57	GAP07A1680A068	1925	680			210	G06A-1664p1-067	1001	1912
58	GAP07A1984P069	774	1980			211	G06A-1248p1-068	1766	1003
59	GAP07A1696P070	1915	660			212	G06A-1680p1-069	1001	1909
60	GAP07A2000P071	774	1990			213	G06A-1248f1-072	1856	1003
61	GAP07A1712P072	1890	660			214	G06A-1680f3-073	1001	1907
62	GAP07A2016P073	860	2025			215	G06A-1680f4-074	1001	1906
63	GAP07A1728P074	1890	647			216	G06A-1264p1-075	1902	1003
64	GAP07A2032P075	774	2016			217	G06A-1696p1-076	1001	1903
65	GAP07A1744P076	1875	642			218	G06A-1280p1-077	1980	1003
66	GAP07A2048P077	775	2016			219	G06A-1712p1-078	1021	1900
67	GAP07A1760P078	1825	660			220	G06A-1296p1-079	1978	1003
68	GAP07A2064P079	775	2010			221	G06A-1728p3-080	1001	1899
69	GAP07A1776P080	1820	705			222	G06A-1296f1-081	1975	1003
70	GAP07A2080P081	751	2032			223	G06A-1728f1-082	1001	1897
71	GAP07A1792P082	1895	896			224	G06A-1152p1-083	1496	1003
72	GAP07A2096P083	846	1990			225	G06A-1728f2-084	1001	1896
73	GAP07A1808P084	1875	668			226	G06A-1152f1-085	1499	1003
74	GAP07A2112P085	942	1970			227	G06A-1424p1-086	1001	1949
75	GAP07A1824P086	1875	663			228	G06A-1136p1-087	1501	1003
76	GAP07A2128P087	1037	1985			229	G06A-1408p1-088	1001	1951
77	GAP07A1840P088	1867	896			230	G06A-1120p1-089	1505	1003
78	GAP07A2144P089	1133	2000			231	G06A-1392p1-090	1001	1953
79	GAP07A1856P090	1876	630			232	G06A-1104p1-091	1505	1003
80	GAP07A2160P091	1228	2010			233	G06A-1376p1-092	1001	1956
81	GAP07A1872P092	1876	600			234	G06A-1104f1-093	1505	1003
82	GAP07A2176P093	1326	2009			235	G06A-1360p1-094	1001	1958
83	GAP07A1888P094	1896	896			236	G06A-1088p1-095	1506	1004
84	GAP07A1728J096	1695	895			237	G06A-1344p1-096	1001	1959
85	GAP07A2000J097	774	2040			238	G06A-1088f1-097	1509	1003
86	GAP07A1680J098	1885	1010			239	G06A-1072p1-098	1511	1003
87	GAP07A1760J100	1875	830			240	G06A-1344f1-099	1001	1962
88	GAP07A2048A101	775	2105			241	G06A-1328p1-101	1001	1962
89	GAP07A1616J102	1894	894			242	G06A-1328f1-103	1001	1964
90	GAP07A1936J103	774	2070			243	G06A-1056p3-104	1515	1004
91	GAP07A1600J104	1924	810			244	G06A-1312p1-105	1001	1963
92	GAP07A2128J105	1037	1970			245	G06A-1056f1-106	1517	1003
93	GAP07A1872J106	1876	896			246	G06A-1312f1-107	1001	1964
94	GAP07A1904J107	1150	1935			247	G06A-1040p2-109	1517	1003
95	GAP07A1312J108	1990	2533			248	G06A-1312f2-110	1001	1968
96	GAP07A1056J109	2068	1083			249	G06A-1024p1-111	1521	1004
97	GAP07A1424K110	1275	2690			250	G06A-1312f3-112	1001	1968
98	GAP07A1216J111	2090	1085			251	G06A-1008p1-113	1523	1003
99	GAP07A1520J112	1195	2793			252	G06A-1312f4-114	1001	1969
100	GAP07A1264J113	2359	1085			253	G06A-1008f1-115	1524	1003
101	GAP07A1488J114	1195	2420			254	G06A-1312f5-116	1001	1790
102	GAP07A1088J115	2000	1083			255	G06A-1904f1-117	1869	1003
103	GAP07A1376J116	1194	2023			256	G06A-2224p1-118	1001	1808
104	GAP07A1808J117	1693	896			257	G06A-1920p1-119	1867	1003
105	GAP07A2096J118	1076	1804			258	G06A-2240p1-120	1001	1807
106	GAP07A1712J119	1600	895			259	G06A-1936p1-121	1867	1003
107	GAP07A2160J120	1458	1804			260	G06A-2256p1-122	1001	1804
108	GAP07A1648J121	1600	1470			261	G06A-1952p1-123	1867	1003
						262	G06A-2272p1-124	1001	1801

263	G06A-1952f1-125	1863	1003
264	G06A-2272f1-126	1001	1799
265	G06A-1968p1-127	1860	1003
266	G06A-2288p1-128	1001	1800
267	G06A-1984p1-130	1862	1004
268	G06A-2304p1-131	1001	1797
269	G06A-2000p1-132	1858	1003
270	G06A-2304f1-133	1001	1795
271	G06A-2000f1-134	1855	1003
272	G06A-2320p1-135	1001	1795
273	G06A-2016p1-136	1853	1004
274	G06A-2336p1-137	1001	1792
275	G06A-2016f1-138	1851	1004
276	G06A-2336f1-139	1001	1790
277	G06A-2032p1-140	1852	1003
278	G06A-2352p1-141	1001	1787
279	G06A-2032f1-142	1849	1003
280	G06A-2368p1-143	1001	1784
281	G06A-2384p1-145	1001	1784
282	G06A-2048p2-146	1846	1003
283	G06A-2384f1-147	1001	1783
284	G06A-2048f1-148	1845	1003
285	G06A-2384f2-149	1001	1783
286	G06A-2064p1-150	1843	1004
287	G06A-2384f3-151	1001	1780
288	G06A-2080p1-152	1842	1003
289	G06A-2384f4-153	1022	1778
290	G06A-2080f1-154	1842	1003
291	G06A-2400p1-155	1086	1799
292	G06A-2096p1-156	1839	1003
293	G06A-2416p1-157	1145	1805
294	G06A-2112p1-158	1836	1003
295	G06A-2432p1-159	1145	1779
296	G06A-2112f1-160	1833	1004
297	G06A-2432f1-161	1212	1879
298	G06A-2128p1-162	1833	1004
299	G06A-2448p1-163	1288	1965
300	G06A-2128f1-164	1835	1003
301	G06A-2464p1-165	1380	1995
302	G06A-2144p1-166	1831	1003
303	G06A-2480p1-167	1429	1995
304	G06A-2144f1-168	1828	1003
305	G06A-2480f1-169	1420	1994
306	G06A-2160p1-170	1825	1004
307	G06A-2496p1-171	1510	1995
308	G06A-2160f1-172	1825	1004
309	G06A-2496f1-173	1600	1995
310	G06A-2176p1-174	1824	1215
311	G06A-2512p1-175	1650	1995
312	G06A-2176p2-176	1224	1004
313	G06A-2512f1-177	1690	1995
314	G06A-2192p1-178	1821	1003
315	G06A-2208p1-179	1001	1810
316	G06A-2192f1-180	1819	1004
317	G06A-2208f1-181	1001	1812
318	G06A-2192f2-182	1817	1004

319	G06A-2208f2-183	1001	1814
320	G06A-1952f2-184	1861	1704
321	G06A-2000F2-186	1855	1730
322	G06A-1696p2-187	1634	1901
323	G06A-2032f2-188	1849	1730
324	G06A-1728f3-189	1001	1725
325	G06A-1440p3-193	1850	1946
326	G06A-1792f1-194	1887	1003
327	G06A-1344f2-195	1001	1306
328	G06A-2192f3-196	1300	1004
329	G06A-1328f2-197	1300	1550
330	G06A-1104f2-198	1508	1003

2 Acquisition Parameters

DESCRIPTION	DETAILS
Survey Name:	Marie 3D
Data recorded by:	Western Geco
Date recorded:	March - May 2007
Vessel:	M/V Western Trident
***General**:*	
Field CMP Interval	6.25m
Nominal Fold	54
Recording Format:	SEGD (3590 media)
***Seismic source**:*	
Type	Air gun Array
Volume	3000 cu.in.
Pressure:	2000 psi
Depth:	7m +/- 1.0 m
Shot interval:	18.75 m flip flop
Gun delay:	0ms
***Recording system**:*	
Type:	TRIAQC Version V (Q-clone)
Record length:	6000 ms
Sample interval:	2 ms
Number of Channels:	8*320
Near Channel:	1
Low Cut Filter:	2 Hz @ 12 db/Octave
High Cut Filter:	206 Hz @ 264 dB/Octave
Polarity:	First break is negative
Recording Delay:	0 ms
***Receivers**:*	
Number of Streamers	8
Centre near group to centre far group:	3987.5m
Streamer depth:	8m +/- 1m
Number of groups:	2560
Group interval:	12.5 m
Streamer Separation:	100m

DESCRIPTION	DETAILS
Survey Name:	GBA02B 3D
Data recorded by:	Western Geco
Date recorded:	Jul - Aug 2002
Vessel:	M/V Geco Beta
General:	
Field CMP Interval	6.25m
Nominal Fold	61
Recording Format:	SEGD 8015 rev. 2 (3590 media)
Seismic source:	
Type	Air gun Array
Volume	3542 cu.in.
Pressure:	2000 psi
Depth:	6m +/- 0.5 m
Shot interval:	18.75 m flip flop
Gun delay:	0ms
Recording system:	
Type:	TRIAQC Version 1.6c
Record length:	6000 ms
Sample interval:	2 ms
Number of Channels:	8*368
Near Channel:	1
Low Cut Filter:	3 Hz @ 18 db/Octave
High Cut Filter:	180 Hz @ 72 dB/Octave
Polarity:	First break is negative
Recording Delay:	5.6 ms
Receivers:	
Number of Streamers	8
Centre near group to centre far group:	4562.5
Streamer depth:	8m +/- 1m
Number of groups:	2944
Group interval:	12.5 m
Streamer Separation:	100m

DESCRIPTION	DETAILS
Survey Name:	Bream 3D
Data recorded by:	Veritas
Date recorded:	Apr – Jul 2006
Vessel:	M/V Veritas Viking 2
General:	
Field CMP Interval	6.25m
Nominal Fold	60
Recording Format:	SEGD 8036 24 bit (3590 media)
Seismic source:	
Type	Air gun Array
Volume	4450 cu.in.
Pressure:	2000 psi
Depth:	6m +/- 0.5 m
Shot interval:	18.75 m flip flop
Gun delay:	0ms
Recording system:	
Type:	SYNTRAK
Record length:	6000 ms
Sample interval:	2 ms
Number of Channels:	8*360
Near Channel:	1
Low Cut Filter:	3 Hz @ 12 db/Octave
High Cut Filter:	206Hz @ 276 dB/octave
Polarity:	First break is negative
Recording Delay:	5.6 ms
Receivers:	
Number of Streamers	8
Centre near group to centre far group:	4487.5
Streamer depth:	7m +/- 0.5m
Number of groups:	2880
Group interval:	12.5 m
Streamer Separation:	75m

3   Parameter Testing

Initial processing parameter testing was performed on line VP421216P001 (GBA02B 3D) which was available in the first data shipment. Evaluation of the test results was overseen by Paul Bouloudas. Confirmation tests were performed on test lines from the Marie and Bream data sets as they became available. Appendix A documents aspects of seismic processing subject to parameter review, or examined to confirm that no adverse effect resulted.

4 Processing Sequence Diagram

Field Tape Transcription
↓
Seismic Nav. Merge
↓
Instrument Delay Static
↓
Zero Phase conversion
↓
Low cut filter
↓
t^2 Gain
↓
Shot-Trace Edits
↓
Despike
↓
De-swell
↓
Tau-P linear noise removal
↓
SRME (2D)
↓
Tau-P Decon
↓
Spherical Divergence Correction
↓

First Pass Velocity Analysis

Adjacent Trace Sum
↓
Resample
↓
Radon Demultiple
↓

Second Pass Velocity Analysis

Surface consistent Scaling
↓
Tide Statics
↓
Binning
↓ *Marie 3D only*
Interpolation
↓
Phase Only Inverse Q
↓

Final (3) Pass Velocity Analysis

Pre-STM

NMO
↓
Residual Radon
↓
Residual Gain
↓
Mute
↓
Stack
↓
Amplitude only Inverse Q
↓
Gun and Cable static compensation
↓
Filter
↓
Scale

ARCHIVE: Final pre-stack time migration, filtered scaled (FTC) (Marie)

Phase Matching
↓
Phase Only Inverse Q
↓
Inelastic Gain

ARCHIVE: Gathers used for depth imaging input (GBA02B,Bream,Marie)

Stack
↓
Post stack Kirchoff Migration
↓
Gun and Cable Static correction
↓
Filter
↓
Scale

ARCHIVE: Post Stack Migrated Cube (BRUTE CUBE) (GBA02B,Bream,Marie)

5   Processing Description

5.1   Transcription

The supplied field tapes were copied directly to disk, without transcription from SEGD format. The practice of preserving a pristine field tape image ensures that the field tapes need only be read once in a processing project. The field tape images are later converted to Fugro Seismic Imaging internal format - trace sequential with samples in 32 bit IEEE floating point.

5.2   Seismic Navigation Merge.

The seismic trace headers were updated with easting and northing values from the supplied navigation files. The acquisition time in the navigation files and seismic headers were compared to ensure a correct match (with a tolerance of 3 seconds). The water depth (depth at sounder) was updated and the sea floor two way time calculated using a water velocity of 1500m/s. Trace offsets were calculated using the source and receiver coordinates.

Navigation Parameters	
Spheroid:	WGS 84 6378137.000 298.2572236
Projection type:	UTM SOUTHERN Hemisphere
Projection Zone:	55S
Longitude of CM:	147 degrees E

5.3   Instrument Delay Static Correction

This was applicable to the GBA02B survey only. A -5.6ms static correction was applied to compensate for the field filter delay.

5.4   Zero Phase Conversion

A filter was designed to convert the supplied far field signature to its zero phase equivalent. The effect of applying this filter to the data is to remove the phase rotations caused by the recording instruments, and to collapse the effective source signature. The phase corrections make the wavelet more symmetrical. Note that the de-phase output was zero phase as deconvolution tests had shown to be of no benefit (in fact deleterious) and therefore the data could be processed as zero phase. The modelled far field signature were supplied by APACHE. The designature filters included corrections for the source ghost. A listing of the modelled far field signature is included in section 14 of this report and Figure 1 shows their amplitude and phase characteristics.
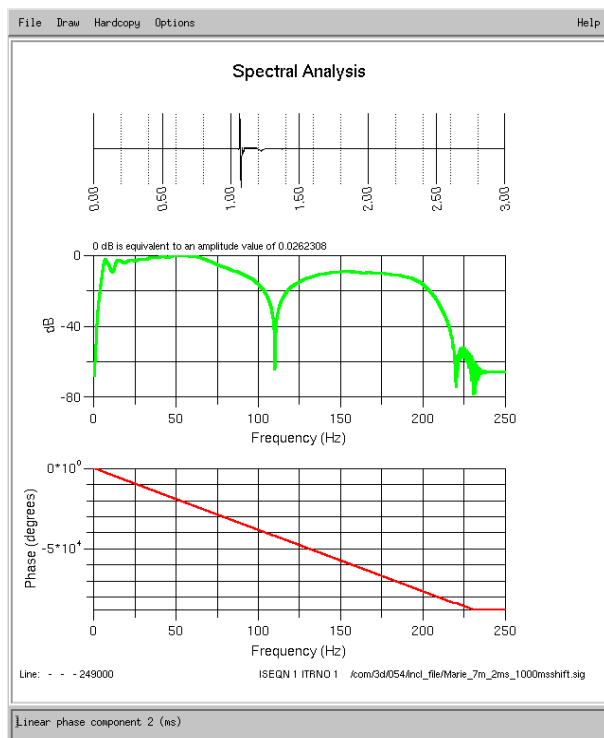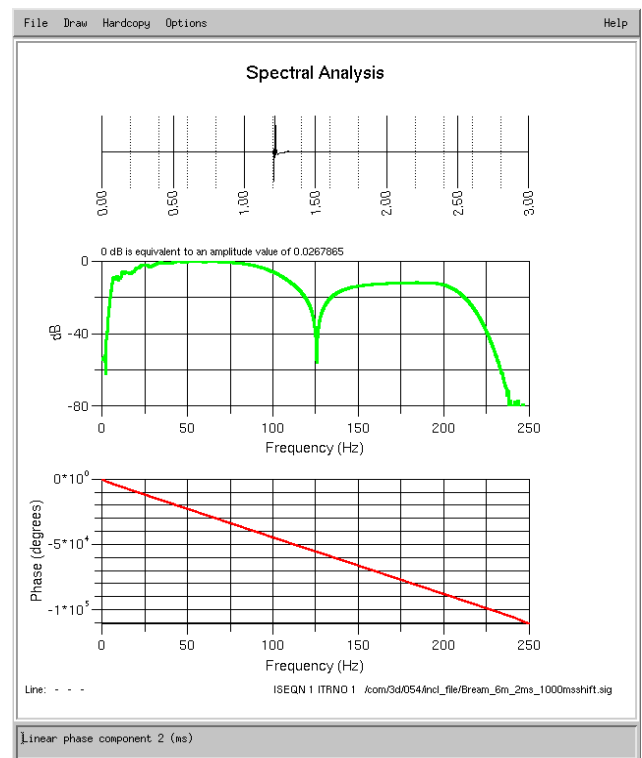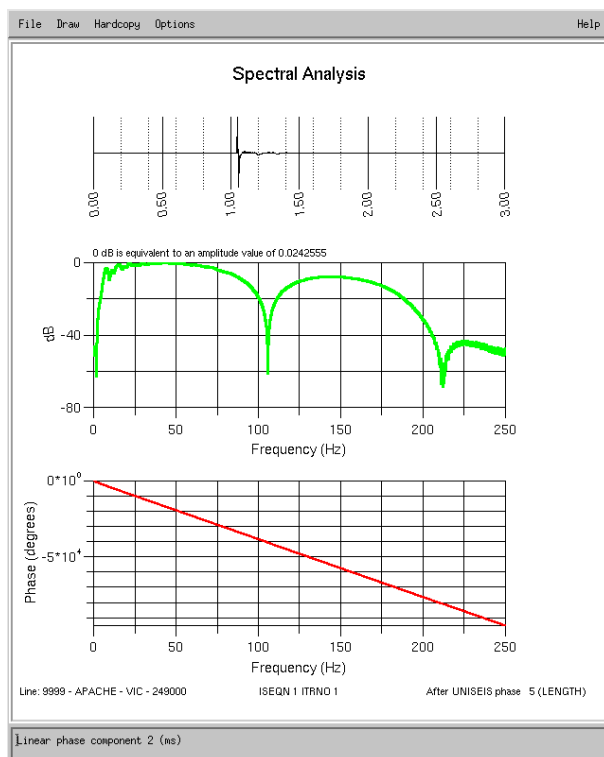
Figure 1. Modelled Source Signatures for the GBA02B, Bream and Marie 3D surveys (clockwise). Note modelled source notches are included at 107,125 and 107 Hz corresponding to gun depths of 7, 6 and 7m respectively.

5.5   Low Cut Filter

Identical to field filter low cut filters were applied to attenuate some swell noise and any DC bias that existed in the data.

Low Cut Filter	
Survey:	**Frequency limits:**
GBA02B	3 Hz at 18dB/Octave
BREAM	3 Hz at 12dB/Octave
MARIE	2 Hz at 12dB/Octave

5.6   Gain

Gain Parameters	
All Surveys:	*T^2 GAIN*
	Initial gain to be replaced with
	"Ursin" spherical divergence after
	demultiple

5.7   Trace Edits

Bad or noisy shots and traces listed in the Observers Logs were edited out. Bad traces were zeroed and bad shots were omitted.

5.8   De Spike

Analysis for large amplitude random noise was performed on each shot using a multi-channel window operator. Any noise found above a pre-defined threshold was scaled back to the average within the window.

De Spike	
Length of derivation window:	200ms
Length of averaging operator:	15 traces
Max permissible peak-to-medium ratio:	21
Max permissible derivation of mean from median:	9 standard deviations

5.9   De Swell

TFDN or Time Frequency De-noise was used in the frequency range 0-12Hz in order to perform de-swell. TFDN works by transforming all traces in a short sliding time window to the frequency domain. There, it compares the frequency content of each trace to the frequency content of neighbouring traces in order to identify anomalies. The comparison is working on a single frequency at a time and the phase is not altered.

If any frequency component in a given trace is larger than a threshold defined as a fraction of a computed attribute (i.e. Median,Average,Lower Quartile) TFDN attenuates the anomalous amplitude at that frequency of the current trace under investigation to the level of the threshold attribute.

TFDN Parameters	
Apply:	0-6000ms
Frequency Processing:	0-12Hz
No. of Neighbouring traces:	30
Time window:	500ms, 100ms move-up
Threshold:	3.5 * Median

5.10   Tau-P Linear Noise Removal

The data was transformed to the Tau-P domain using the linear transform. Strong linear noise trains with large dip can be differentiated from primary energy in the linear tau-p space, and these events are attenuated by muting in the Tau-P space - tapering from the primary to noise areas of the transform. A transform of -1400 to 3600ms, with increments of 8 ms (reference offset of 5000m).

Tau-P Mute Parameters	
Time (ms)	**Pass Mute Range (delta-t (ms))**
0	-1900 to-1300 & 1800 to 2400
1000	-1200 to -600 & 1100 to 1700
1500	-1120 to -520 & 1020 to 1620
2000	-1100 to -500 & 1000 to1600
6000	-1000 to -400 & 900 to 1500

5.11   SRME

SRME or **S**urface **R**elated **M**ultiple **E**limination uses the geometry of shot recording to estimate all possible multiples that can be generated by the surface. It was developed by the Delphi Consortium at Tu Delft in the Netherlands. One order of surface related multiples is predicted using auto-convolutions of input data. The predicted multiple energy is then removed from the input gathers by a process of cascaded adaptive subtraction.

Prior to forming the multiple estimate, it is necessary to interpolate new shots such that the shotpoint interval is equal to the group interval. The recorded data is then extrapolated to zero offset and regularized before constructing the multiple estimate by a series of convolutions and summation.

SRME Parameters	
Type:	2D; 3D offsets re sampled to constant 2D increments
Group interval:	12.5m
SP interval (after interpolation):	12.5m
Adaptive subtraction – 1:	Common offset domain 1000 filter traces 80 ms filter 6000 ms window Mute modelled multiples above 1.8 times wb time
Adaptive subtraction – 2:	Common shot domain 30 filter traces 120 ms filter 600 ms window length 300ms window moveup

5.12   Tau-P Deconvolution

Deconvolution in the Tau-P domain proved superior to deconvolution applied in the TX domain.

Tau-P deconvolution Parameters	
Transform:	-1400 to 3100 increment 8ms
Reference offset:	5000m
Operator:	280ms
Gap:	32ms
Design Window:	100-3500ms
Apply window:	100-6000ms

5.13   Spherical Divergence (Ursin)

The previously applied t^2 gain function was removed and replaced with an offset and velocity dependent spherical divergence approximation as described by Bjorn Ursin (GEOPHYSICS Vol.55 No.4, pp492-496 1990).

5.14   First Pass Velocities

First pass velocities (1km interval) were determined using the Fugro Seismic Imaging Pty. Ltd. "MGIVA" interactive velocity analysis program. Each velocity analysis comprised a semblance display, a CDP stacked panel repeated 30 times with a suite of velocity functions, and a central CDP gather. The suite of functions were generated using 0%, +/-5 %, +/-10%, +/-15%, +/-20 %, +/-25%,+/-30% and +35% increments from a central velocity function.

The velocity analysis incorporated a map of all velocity locations, and the semblance display included functions from proximate lines. This enabled the velocities to be picked with knowledge of areal velocity trends. Velocity QC can be performed more effectively when discordant velocities are apparent on the map.

The first pass velocities were picked by FSI, and QC performed by APACHE.

5.15   Adjacent Trace Sum

Before decimating the shot records from 12.5m to 25.0m group interval, an adjacent trace summation was performed with alignment along NMO curves. The first pass velocities were used for this process.

Adjacent Trace Sum Parameters			
Survey:	GBA02B	Bream	Marie
Input traces:	368	360	320
Input trace interval:	12.5m		
Output traces:	184	180	160
Output trace interval:	25m		

5.16   Re-sample

Resample	
Resample:	2 to 4ms
Pre-filter:	110 Hz at 72dB/Octave

5.17   Radon Multiple Attenuation (Hi-Res Radon)

Attenuation of multiples was achieved by modelling and subtraction using a least squares, parabolic Radon transform. Normal moveout corrections were performed using the first pass velocities, and the CDP gathers transformed into the parabolic Tau-P domain. The segment of the Tau-P domain corresponding to primary reflections is muted, leaving the multiple energy to be transformed back into the T-X domain and subtracted from the original CDP gather. The Hi-resolution Radon option was invoked, where the resolution of the Radon transform is improved by adding weighting terms to the least squares solution, thus minimising the residual error. To further reduce the potential for aliasing, the Radon transform was performed on 160 fold gathers formed by F-X interpolation of new shots in the common offset domain. After demultiple, the interpolated traces were dropped from the processing stream.

Radon Demultiple Parameters			
Survey:	GBA02B	Bream	Marie
Input Data:	184 fold fx shot interpolated gathers	180 fold fx shot interpolated gathers	160 fold fx shot interpolated gathers
Preconditioning:	300ms AGC		
Reference offset:	5000m		
Frequency range:	4-80 Hz		
Minimum p:	-500 *(parabolic delta-t, at reference offset)*		
Maximum p:	+2500 *(parabolic delta-t, at reference offset)*		
No. of p traces:	300		
Delta-T cuts:	600,-300,300 2000,-200,200 3000,-200,200 4000,-200,150 6000,-200,150 (time(ms),delta-t cuts -ve to +ve)		
Radon Apply:	600ms full off taper to 1000ms full on		

5.18   Surface Consistent Amplitude Recovery

The amplitude of any trace is affected by various factors, including the shot strength, response and coupling of the receivers, trace offsets and the geology. Surface Consistent Amplitude Recovery (SCAMP) is designed to analyse amplitudes in a surface consistent manner. It estimates the amplitude variations due to various components and computes weighting levels for each component, using the Gauss-Seidel iterative method. The components selected to resolve extraneous amplitude variations were the shot strength, channel number (offset) and receiver response (virtual receiver location). The Gauss-Seidel iterations were performed on all lines simultaneously, providing a survey consistent solution. The inclusion of the offset component produces a solution which balances the mean amplitudes with offset. The scalars were modified by computing a running median, such that only local fluctuations in channel amplitude removed, and the smooth amplitude variation with offset preserved.

Surface Consistent Amplitude Recovery Parameters	
Analyse:	Common shot,
	Common receiver position
	Common trace
Apply:	Common shot
	Common receiver position
	Common trace

5.19   Tide Statics

Tidal statics were applied using tables of deviation from mean sea level supplied by APACHE. A water velocity of 1500m/s was used to calculate statics, which were applied to the data according to GMT acquisition time. 3 separate tide tables were provided for the 3 separate 3D surveys.

5.20   Binning

The data was binned, output onto a 12.5m inline and 25m crossline grid. It was noted that the Marie survey showed incomplete coverage of some offsets in the middle and eastern half of the survey.

Binning Parameters	
Grid size:	12.5m inline 25m xline
Offset plane definition:	275m to 4250m inc. 75m (54 fold)
	Note this is only applicable for the Marie FTC.
	No definition (open) was used for gather input to PSDM.
Origin:	507906.28043 E,5703630.75292 N
Direction:	0.524degrees
Line interval	*25m*
CDP interval:	*12.5m*
3D Line number at origin:	1 inc. 1 in direction 270.524 degrees
3D CDP number at origin:	1 inc. 1 in direction 0.524 degrees
Coordinate Datum:	WGS84 PROJECTION ZONE: UTM ZONE NO. 55 S

The binning is altered for the separate products: Fast-Track Pre-STM cube and Gathers used for Depth Imaging.

Unbinned Demultiple Gathers (all 3 Surveys)

Survey Marie 3D only

GBA02B, Bream and Marie 3D's

Binning
275m to 4250m inc. 75m
offset plane definition
Rejection of duplicate
offset plane-bin traces.

Binning
No Offset plane definition

No duplicate trace rejection

Fast Track Pre-STM
processing flow
(go to section 5.21)

Gathers used for
Depth Imaging Input
processing flow
(go to section 6)

5.21   Interpolation

Missing bins from each offset plane are interpolated using a dip model derived from the full offset stack.

5.22   Inverse Q (phase only)

Two fundamental properties associated with wave propagation through subsurface materials are: energy dissipation of plane waves with high frequency, and velocity dispersion by which plane waves of high frequency travel faster than ones with low frequency. These effects may be represented mathematically as the earth Q-filter, defined in terms of a specified earth Q model.

In seismic data processing where the earth Q model is often assumed to be frequency independent, inverse Q-filtering attempts to compensate recorded seismic signals for these wave propagation effects.

Inverse Q Parameters	
Type	Phase only Q compensation
Q value	100
Reference Frequency	35Hz
Apply	NMO corrected gathers

5.23   Pre-stack Time Migration

F.S.I's SHIMOGEN program performs Pre-stack 3D Kirchhoff Time migration by the direct 3D Kirchhoff summation method. It is applied to traces in common offset and azimuth order.

The velocity functions derived from analyses of data processed through PSTM are essentially independent of structure and are therefore well suited to direct utilisation in processes such as depth conversion and interpretative studies.

Pre-STM Parameters	
Migration Type:	Curved ray
Aperture:	4000 m
Anti Alias:	Gray's anti-alias pre filtering
Velocity slowing:	100% 2nd pass velocities
Velocity smoothing:	No smoothing
Frequency Limit:	0,120,2000,105,4000,80,6000,60 time(ms),freq(Hz) pairs

5.24   Second and Third Pass Velocities

Initially lines every 1km were migrated using smoothed 1st pass velocities.

2nd pass velocity analysis was then performed on these lines to produce a velocity field on a 1x1 km grid.

The 2nd pass grid was then used to migrate the entire dataset and the final third pass velocities field was infill picked using a 0.5x0.5km grid.

Analysis was performed using the Fugro Seismic Imaging Pty. Ltd. "MGIVA" interactive velocity analysis program. Each velocity analysis comprised a semblance display, a CDP stacked panel repeated 30 times with a suite of velocity functions, and a central CDP gather. The suite of functions were generated using 0%, +/-2%, +/-4%, +/-6%, +/-8%, +/-10%,+/-14% and +18% increments from a central velocity function.

The central function for the 2nd pass analysis was the smoothed 1st pass velocities.

The central function for the 3rd pass analysis was the 2nd pass velocities.

5.25   NMO Correction

Fourth order stacking velocities were used to apply NMO correction using the final picked 0.5km velocity field.

5.26   Residual Radon

Attenuation of multiples was achieved by modelling and subtraction using a least squares, parabolic Radon transform. Normal move out corrections were performed using the third pass velocities, and the CDP gathers transformed into the parabolic Tau-P domain. The segment of the Tau-P domain corresponding to primary reflections is muted, leaving the multiple energy to be transformed back into the T-X domain and subtracted from the original CDP gather. The Hi-Resolution Radon option was invoked, where the resolution of the Radon transform is improved by adding weighting terms to the least squares solution, thus minimising the residual error.

A mild t-x mute was applied immediately before the Radon transform to remove NMO stretch noise from the shallow zone of longer offsets.

Residual Radon Demultiple Parameters	
Survey:	Marie 3D only
Input Data:	107 fold fx interpolated Pre-STM gathers
Preconditioning:	300ms AGC
Reference offset:	5000m
Frequency range:	4-80 Hz
Minimum p:	-500 *(parabolic delta-t, at reference offset)*
Maximum p:	+1000 *(parabolic delta-t, at reference offset)*
No. of p traces:	150
Delta-T cuts:	0,-500,600 400,-300,200 1000,-300,80 4000,-300,80 (time(ms),delta-t cuts -ve to +ve)
Radon Apply:	600ms full off taper to 1000ms full on

5.27   Residual Gain

Inelastic absorption of energy is corrected for by an exponential gain application.

Residual Gain	
Gain:	2dB/sec
Apply:	3500ms

5.28   Mute

A post NMO outer trace mute was applied to remove any coherent noise on the gathers and to reduce NMO stretch.

Outer Mute Parameters			
Offset:	400m	650m	1500m	5000m
Time:	0ms	400ms	1000ms	3600ms
Taper:	60ms			

5.29   Stack

The traces within each bin were summed. The method of fold compensation was 1/root(N) (where N represents the number of traces contributing to the stack, calculated at each sample).

5.30   Inverse Q (Amplitude Only)

Two fundamental properties associated with wave propagation through subsurface materials are: energy dissipation of plane waves with high frequency, and velocity dispersion by which plane waves of high frequency travel faster than ones with low frequency. These effects may be represented mathematically as the earth Q-filter, defined in terms of a specified earth Q model.

In seismic data processing where the earth Q model is often assumed to be frequency independent, inverse Q-filtering attempts to compensate recorded seismic signals for these wave propagation effects.

Inverse Q Parameters	
Type:	Amplitude only Q compensation
Q value:	100
Reference Frequency:	35Hz
Max boost:	8dB
Apply:	Post stack

5.31   Gun and Cable Static

A 10 ms static compensation for gun and cable depths was applied. The static value applied was calculated using average gun and cable depths supplied in the observers reports, converted to a time shift using a water velocity of 1500 m/s.

5.32   Band Pass Filter

Unwanted noise that lay outside the frequency range of the desired reflection data was attenuated by the application of a series of zero phase time variant filters.

| Bandpass Filter Parameters	
Application time (ms):	Frequency trapezoid (Hz):
0	4/6-90/100
1000	4/6-80/90
2000	4/6-70/80
6000	4/6-30/40

5.33   Post Stack Scaling

A dual window, time variant AGC method was used for post-stack scaling. The negative effects normally associated with AGC are avoided by employing two different length windows to determine the amplitude model (using the minimum of the two mean amplitudes determined at each sample). The model is conditioned by a weighted mix with the amplitude model derived from a single window per trace.

Trace equalisation parameters	
Static model:	mean of entire trace
Long AGC window:	1000 ms
Short AGC window:	400 ms
Ratio of static model to AGC:	50:50

6   Gathers Used For Input To PSDM

Following section 5.20 the gathers of all three (GBA02B, Bream and Marie) 3Ds were prepared for input to PSDM.

6.1   Phase Matching

The Marie 3D was used as the base vintage.

Phase matching	
Survey	**Phase rotation and static shift**
Marie	0 deg, 0ms
GBA02B	-5 deg, 0ms
Bream	10 deg, 3ms

6.2   Inverse Q (Phase Only)

Two fundamental properties associated with wave propagation through subsurface materials are: energy dissipation of plane waves with high frequency, and velocity dispersion by which plane waves of high frequency travel faster than ones with low frequency. These effects may be represented mathematically as the earth Q-filter, defined in terms of a specified earth Q model.

In seismic data processing where the earth Q model is often assumed to be frequency independent, inverse Q-filtering attempts to compensate recorded seismic signals for these wave propagation effects.

Inverse Q Parameters	
Type:	Phase only Q compensation
Q value:	100
Reference Frequency:	35Hz
Apply:	NMO corrected gathers

6.3   6.3 Inelastic Gain

Inelastic absorption of energy is corrected for by an exponential gain application.

Residual Gain	
Gain:	2dB/sec
Apply:	3500ms

6.4   Archive Gathers

SEGY format gathers were provided for input to PSDM. 3D Lines ranged from 2900-4773. The entire gather data set was of the order of 2.3 Terabytes large. Stacks of these gathers were used as input to the entire Brute cube.

7   Post Stack Migrated Cube (Brute Cube)

The gathers archived in section 6 were stacked and a post-stack migration was performed to provide a brute time migrated cube

7.1   NMO Correction

Fourth order stacking velocities were used to apply NMO correction using the 1st pass picked 1km velocity field.

7.2   Mute

Outer Mute Parameters						
Offset:	400m	625m	1385m	4606m	4830m	4985m
Time:	0ms	400ms	1000ms	3290ms	3550ms	4000ms
Taper(ms):	60ms					

7.3   Stack

The traces within each bin were summed. The method of fold compensation was varied with the intended use of the resulting stack. The near, far and full angle stacks employed 1/root(N) stack fold compensation. (where N represents the number of traces contributing to the stack, calculated at each sample).

7.4   Post Stack Migration

The post stack volume was migrated (without DMO) to provide a brute migrated cube.
F.S.I's SHIMOGEN program performs Kirchhoff Time migration by the direct 3D Kirchhoff summation method. It is applied to traces in common offset and azimuth order*.
The velocity functions derived from analyses of data processed through PSTM are essentially independent of structure and are therefore well suited to direct utilisation in processes such as depth conversion and interpretative studies.

* in this case 0 offset

Pre-STM Parameters	
Migration Type:	Curved ray
Aperture:	4000 m
Anti Alias:	Gray's anti-alias pre filtering
Velocity slowing:	100% 1st pass velocities
Velocity smoothing:	No smoothing
Frequency Limit:	0,120,2000,105,4000,80,6000,60 time(ms),freq(Hz) pairs

7.5   Gun and Cable Static

A 10 ms static compensation for gun and cable depths was applied. This represented the gun and cable static correction for the base (Marie 3D) dataset.

7.6   Band Pass Filter

Unwanted noise that lay outside the frequency range of the desired reflection data was attenuated by the application of a series of zero phase time variant filters.

Bandpass Filter Parameters	
Application time (ms)	Frequency trapezoid (Hz)
0	4/6-90/100
1000	4/6-80/90
2000	4/6-70/80
6000	4/6-30/40

7.7   Post Stack Scaling

A dual window, time variant AGC method was used for post-stack scaling. The negative effects normally associated with AGC are avoided by employing two different length windows to determine the amplitude model (using the minimum of the two mean amplitudes determined at each sample). The model is conditioned by a weighted mix with the amplitude model derived from a single window per trace.

Trace equalisation parameters	
Static model:	mean of entire trace
Long AGC window:	1000 ms
Short AGC window:	400 ms
Ratio of static model to AGC:	50:50

8 Example Displays
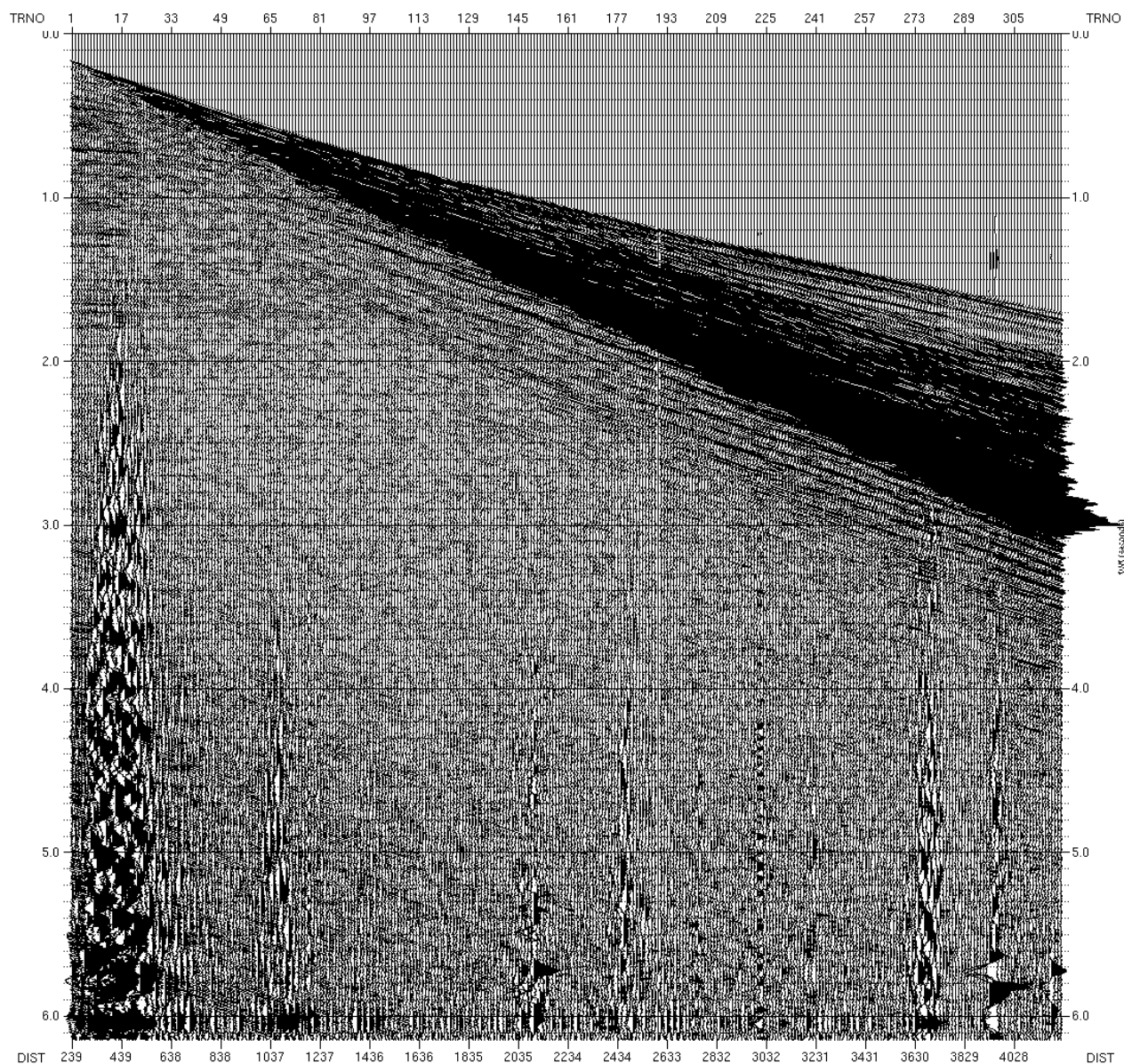
Figure 2. Example shot from Marie 3D. Shot has strong linear noise, swell noise, spiky traces and some cross feed noise @ ~ 6000ms.
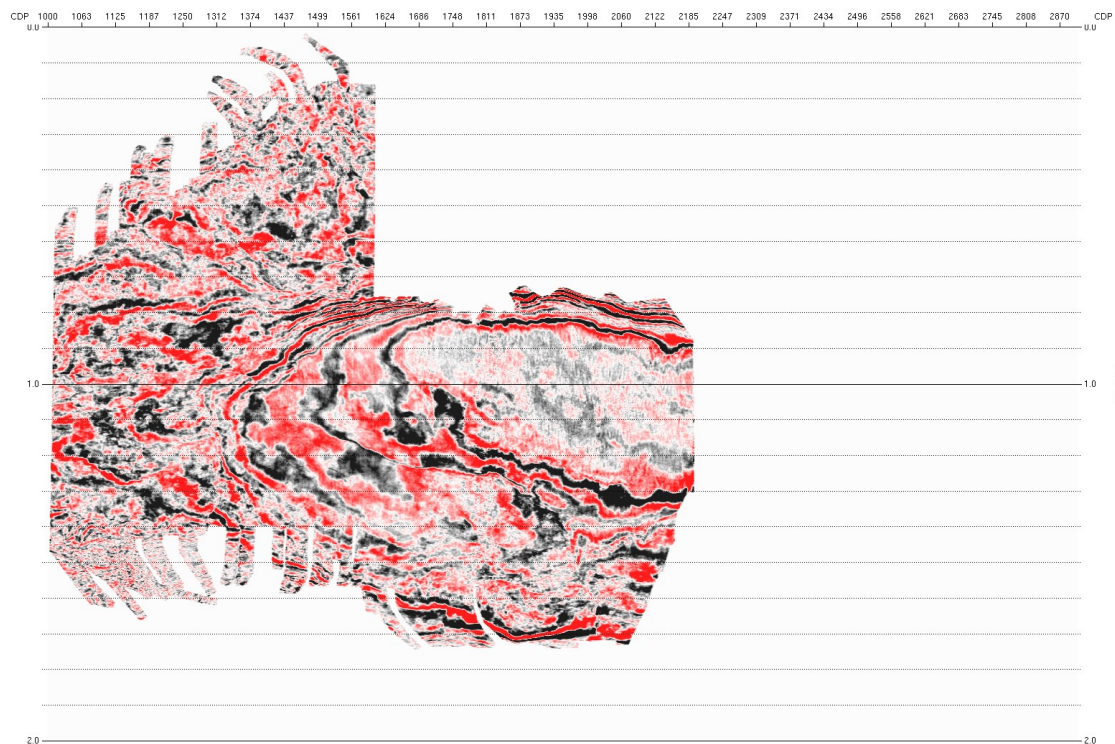
Figure 3. Timeslice: 1700ms of Marie 3D Fast Track Cube (FTC)
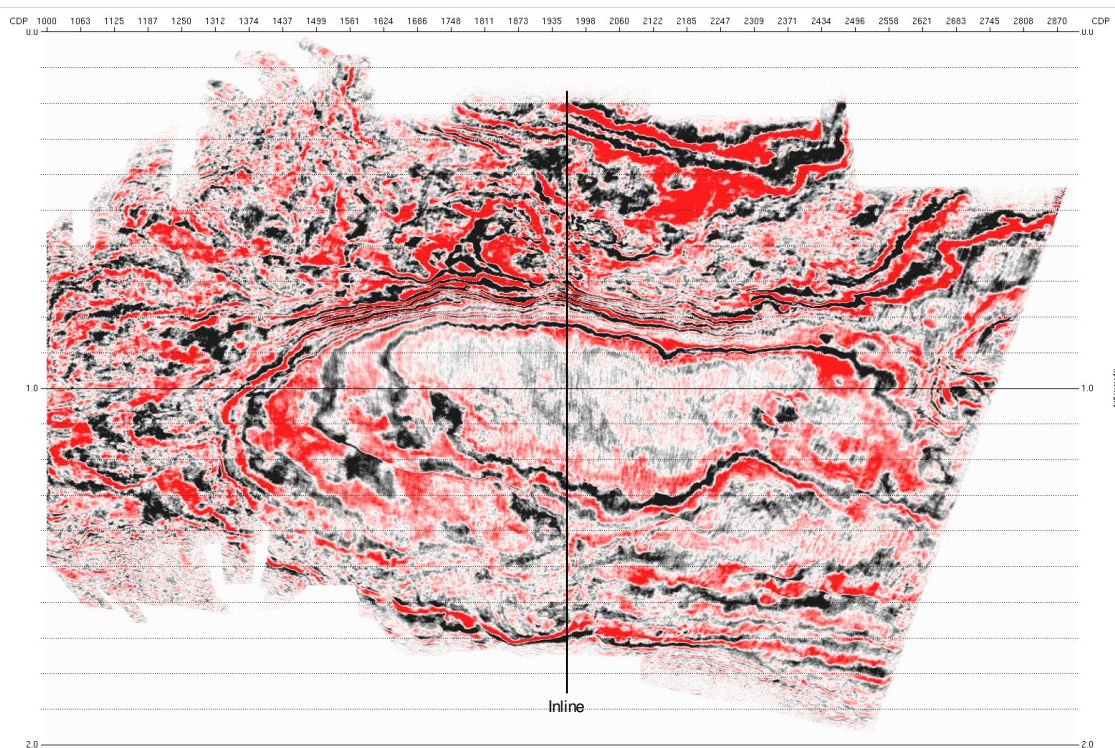
Figure 4. Timeslice: 1700ms of Post Stack Migrated Cube: Marie, GBA02B and Bream 3D surveys
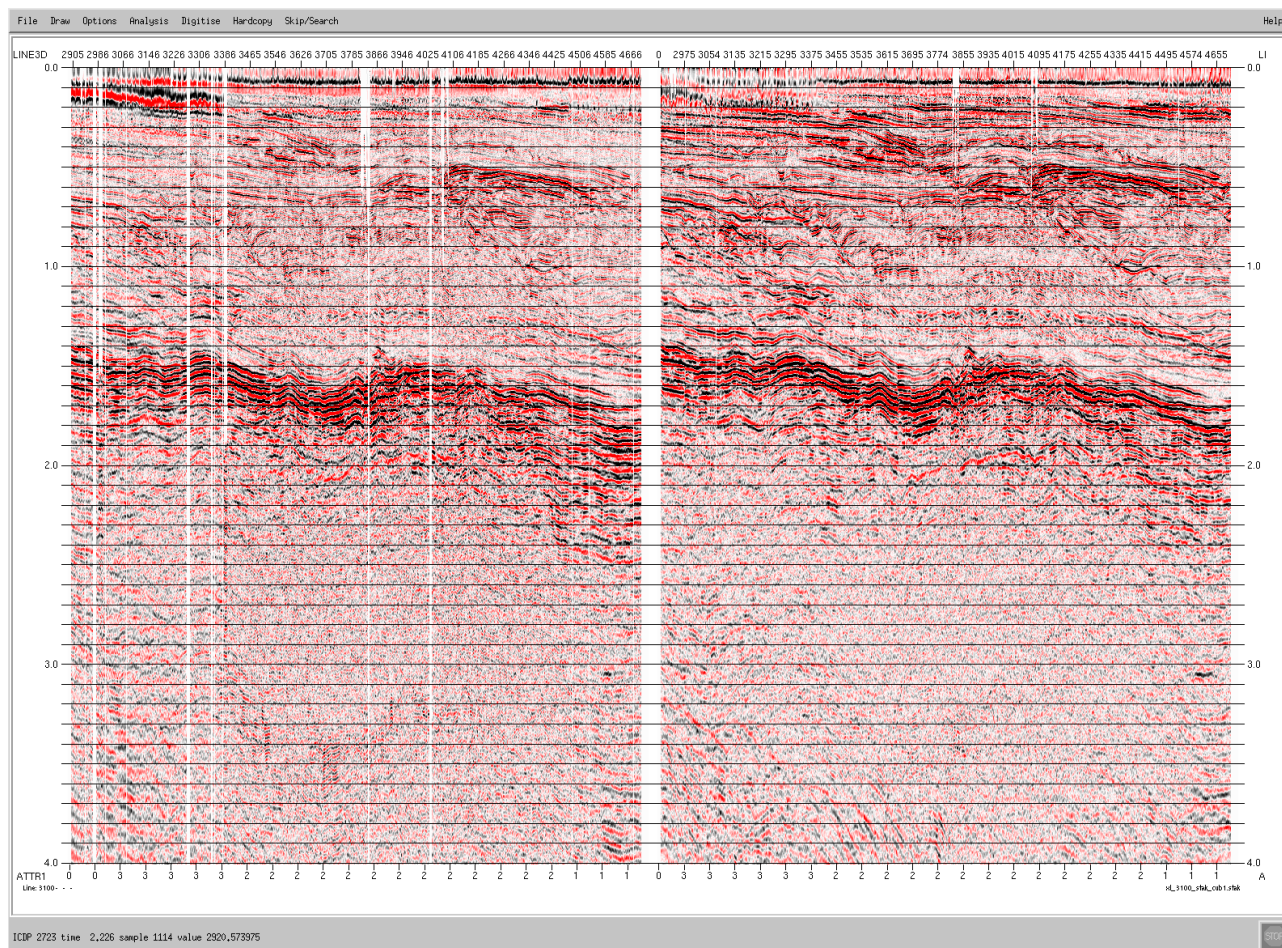
Figure 5. CROSSLINE: Minimally processed cube (left) vs Binned cube (before migration) (right).

This represents the combined effect of Tau-P linear noise removal, SRME, Tau-P deconvolution and Radon de-multiple. No phase only Q compensation is applied. Note bottom annotation describes contributing survey: 1 2 3 are GBA02B, Bream and Marie surveys respectively.
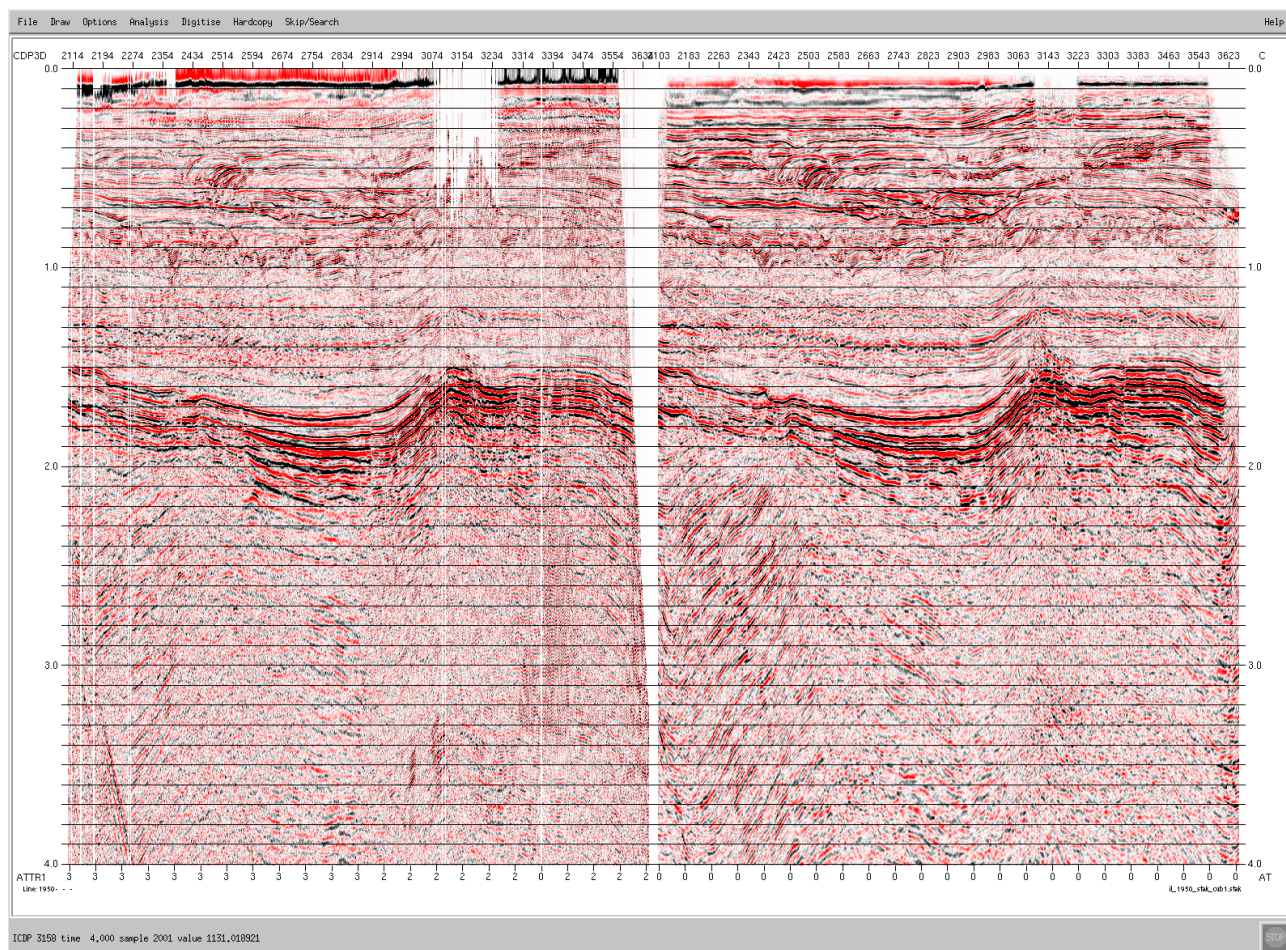
Figure 6. INLINE: Minimally processed cube (left) vs post stack migrated (brute) cube (right).

This display represents all processing completed for gathers output pre PSDM, then Kirchhoff post-stack migrated. Low fold in the shallow section is data from undershooting. A time variant phase shift exists between the 2 sections due to phase only Q compensation applied to the gathers. Note bottom annotation describes contributing surveys: 1 2 3 are GBA02B, Bream and Marie surveys respectively.

9   Polarity Statement

The final desired polarity was SEG standard, where an increase in acoustic impedance is represented by a negative number on tape, and white trough on display.

An acoustic impedance increase is
represented by a trough.
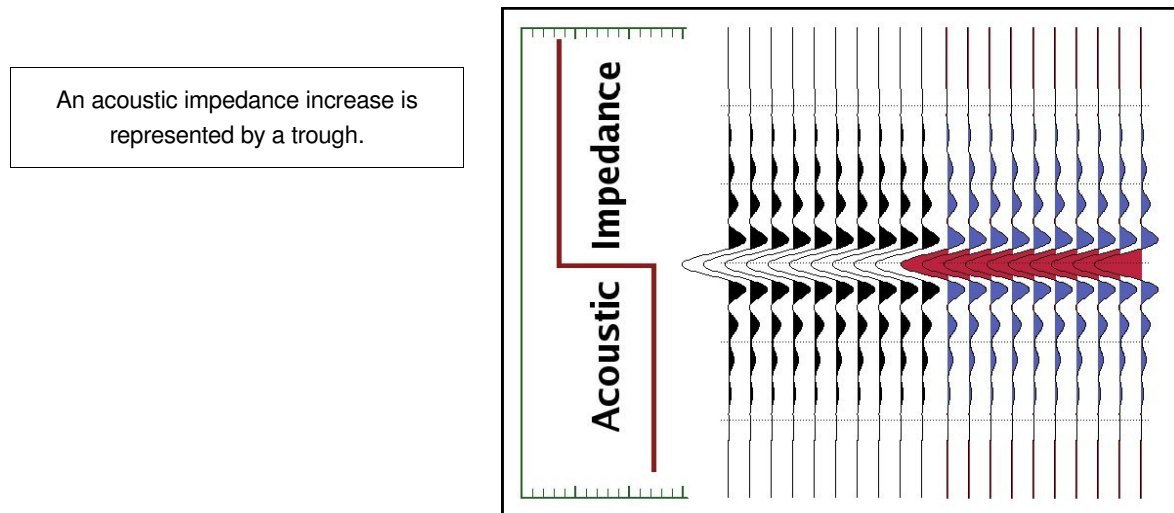
Figure 7. Desired polarity diagram

10 Archive Listing

Gippsland West Deliverables				
Apache Deliverables (RFS)	Item No.		Standard	Media
Pre-Stack				
	1	Raw cmp ordered gathers - no nmo	Yes	LTO
	2	Raw PreSTM cmp ordered gathers - no nmo	Yes	LTO
	3	Raw PreSTM cmp ordered gathers - with nmo	Yes	LTO
	4	Raw PreSDM cmp ordered gathers - no nmo (in twt)	Yes	LTO
	5	Raw PreSDM cmp ordered gathers - with nmo (in twt)	Yes	LTO
Post-Stack				
	6	Raw PreSTM stack data (full angle)	Yes	DLT
	7	Final PreSTM stack data (full angle)	Yes	DLT
	8a	Raw PreSDM stack data (full angle) in twt	Yes	DLT
	8c	Raw PreSDM stack data (full angle) in depth, Calibrated	Yes	DLT
	9a	Final PreSDM stack data (full angle) in twt	Yes	DLT
	9b	Raw PreSDM stack data (3 limited angle) in twt	Yes	DLT
	9c	Final PreSDM stack data (full angle) in depth	Yes	DLT
	9d	Raw PreSDM stack data (3 limited angle) in depth	Yes	DLT
	9e	Final PreSDM stack data (full angle) in depth calibrated to wells	Yes	DLT
	9f	Raw PreSDM stack data (3 limited angle) in depth calibrated to wells	Yes	DLT
Support Data				
	10	Final PreSTM velocity data (ASCII)	Yes	CD
	11a	PreSDM interval velocity model in depth (SEGY)	Yes	DLT
	11b	PreSDM interval velocity model in time (SEGY)	Yes	DLT
	12	PreSDM RMS velocity model in time (SEGY)	Yes	DLT
	13a	PreSDM interval velocity model in time (ASCII)	Yes	CD
	13b	PreSDM RMS velocity model in time (ASCII)	Yes	CD
	14	1D Residual moveout volume (SEGY)	Yes	DLT
	15	Bin centre data (all three surveys)	Yes	CD
	16	Final processing report (3 copies)	Yes	CD
Esso Deliverables (Bream Data Trade) Schedule 5				
	17	Marie 3D post stack time migration (Marie full fold boundary)		DLT
	18	Time processing report		CD
	19	Stacking and migration velocity data (Apache modified Western 3D format)		CD
	20	Bin centre data		CD
Schedule 6				
	21	Marie 3D PreSTM raw and final volume		DLT
	22	Marie 3D raw PreSTM cmp ordered gathers - no nmo		DLT
Bass/Inpex Deliverables (JV Partners) Pre-Stack				
	23	Marie 3D raw cmp ordered gathers - no nmo (Bass copy)		LTO
	24	Marie 3D raw cmp ordered gathers - no nmo (Inpex copy)		LTO
	25	Marie 3D raw PreSTM cmp ordered gathers - no nmo (Bass copy)		LTO
	26	Marie 3D raw PreSTM cmp ordered gathers - no nmo (Inpex copy)		LTO
	27	Marie 3D raw PreSTM cmp ordered gathers - with nmo (Bass copy)		LTO
	28	Marie 3D raw PreSTM cmp ordered gathers - with nmo (Inpex copy)		LTO
	29	Marie 3D raw PreSDM cmp ordered gathers (in time) - no nmo (in twt) (Bass copy)		LTO
	30	Marie 3D raw PreSDM cmp ordered gathers (in time) - no nmo (in twt) (Inpex copy)		LTO
	31	Marie 3D raw PreSDM cmp ordered gathers (in time) - with nmo (in twt) (Bass copy)		LTO
	31a	Marie 3D raw PreSDM cmp ordered gathers (in time) - with nmo (in twt) (Inpex copy)		LTO
Post-Stack				
	32	Marie 3D raw PreSTM stack data (full angle) Bass Inpex boundary		DVD
	33	Marie 3D raw PreSTM stack data (full angle) (Bass Inpex boundary) (copy)		DLT
	34	Marie 3D final PreSTM stack data (full angle) (Bass Inpex boundary)		DVD
	35	Marie 3D final PreSTM stack data (full angle) (Bass Inpex boundary) (copy)		DLT
	36a	Raw Marie 3D PreSDM stack data (full angle) in twt		USB
	36b	Raw Marie 3D PreSDM stack data (full angle) in depth		USB
	36c	Raw Marie 3D PreSDM stack data (full angle) in twt (Inpex copy)		DLT
	36d	Raw Marie 3D PreSDM stack data (full angle) in depth (Inpex copy)		DLT
	37a	Final Marie 3D PreSDM stack data (full angle) in twt		USB
	37b	Raw Marie 3D PreSDM stack data (3 limited angle) in twt		USB
	37c	Final Marie 3D PreSDM stack data (full angle) in twt (Inpex copy)		DLT
	37d	Raw Marie 3D PreSDM stack data (3 limited angle) in twt (Inpex copy)		DLT
	38a	Final Marie 3D PreSDM stack data (full angle) in depth		USB
	38b	Raw Marie 3D PreSDM stack data (3 limited angle) in depth		USB
	38c	Final Marie 3D PreSDM stack data (full angle) in depth (Inpex copy)		DLT
	38d	Raw Marie 3D PreSDM stack data (3 limited angle) in depth (Inpex copy)		DLT
	39a	Final Marie 3D Calibrated PreSDM stack data (full angle) in depth		USB
	39b	Raw Marie 3D Calibrated PreSDM stack data (3 limited angle) in depth		USB
	39c	Final Marie 3D Calibrated PreSDM stack data (full angle) in depth (Inpex copy)		DLT
	39b	Raw Marie 3D Calibrated PreSDM stack data (3 limited angle) in depth (Inpex copy)		DLT
Support Data				
	40a	Final PreSTM velocity data (ASCII)		CD
	40b	Final PreSTM velocity data (ASCII) (Inpex copy)		CD
	41a	PreSDM interval velocity model in depth (SEGY) (Bass copy)		USB
	41b	PreSDM interval velocity model in depth (SEGY) (Inpex copy)		DLT
	42a	PreSDM interval velocity model in time (SEGY) (Bass copy)		USB
	42b	PreSDM interval velocity model in time (SEGY) (Inpex copy)		DLT
	43a	PreSDM RMS velocity model in time (SEGY) (Bass copy)		USB
	43b	PreSDM RMS velocity model in time (SEGY) (Inpex copy)		DLT
	44a	PreSDM interval velocity model in time (ASCII) (Bass copy)		CD
	44b	PreSDM interval velocity model in time (ASCII) (Inpex copy)		CD
	45a	PreSDM RMS velocity model in time (ASCII) (Bass copy)		CD
	45b	PreSDM RMS velocity model in time (ASCII) (Inpex copy)		CD
	46a	1D Residual moveout volume (SEGY) (Bass copy)		USB
	46b	1D Residual moveout volume (SEGY) (Inpex copy)		DLT
	47a	Bin centre data (all three surveys) (Bass copy)		CD
	47b	Bin centre data (all three surveys) (Inpex copy)		CD
	48a	Final processing report (3 copies) (Bass copy)		CD
	48b	Final processing report (3 copies) (Inpex copy)		CD
Field Tapes				
	54	Copy of Marie SEGD field tapes		3590
	55	Copy of Marie SEGD field tapes (Inpex copy)		3590
	56	Marie observers reports		CD
	57	Marie observers reports (Inpex copy)		CD
	58	Marie P1/90 navigation data		3590
	59	Marie P1/90 navigation data (Inpex copy)		3590
For ExxonMobil, SEGY, not TARSEGY	60	Final PreSTM stack data (full angle)		DLT

11   Data Disposition

Data	Date sent	Destination
1 x USB disk containing Seismic-Nav Merged Field data.	28 May 2007	Laurence Hansen Apache Energy Level 3, 256 St Georges Tce PERTH WA 6000
Box 1. 30 x 3590 cartridges containing field data. Tape # 1001-1030 Box 2. 30 x 3590 cartridges containing field data. Tape # 1031-1060 Box 3. 30 x 3590 cartridges containing field data. Tape # 1061-1090 Box 4. 30 x 3590 cartridges containing field data. Tape # 1181-1210 Box 5. 30 x 3590 cartridges containing field data. Tape # 1211-1240 Box 6: 30x 3590E cartridges containing field data. Tape # 1091-1120 Box 7: 30x 3590E cartridges containing field data. Tape # 1121-1150 Box 8: 30x 3590E cartridges containing field data. Tape # 1151-1180 Box 9: 4 x 3590 cartridges containing field data. Tape # 1241-1244 2 x 3590 cartridges containing P1/90 & P2/94 Navigation data 4 x DVD Tape# N0040V-N0043V, Containing P1/90 Navigation Data and Observer's Logs 1 x DVD containing P1/90 Navigation Data. 1 x CD containing Navigation data and reports. tape # N0078C (Copy) 1 x CD containing data migration report & digital tape photographs 1 x 3590 P1/90 Navigation data SEQ010-044 - tape # N0024B 3590 1 x 3590 P1/90 Navigation data SEQ045-093 - tape # N0025B 3590 1 x 3590 P1/90 Navigation data SEQ094-121 - tape # N0026B 3590 1 x 3590 cartridge containing Near Traces Cube. Tape # F0179B 1 x 3590 cartridge containing LMO (First Break QC). Tape # F0180B 2 x 3590 cartridges containing Brute Stacks Tape # F0189B & F0190B 1 x DVD containing Acquisition Reports and Configuration. Tape # F0026C Box 10: 1 x LTO2 cartridge containing field data. Tape # 4007906 8 x LTO Cartridges containing field data. Tape # 4007907-4007914 Box 11: 1 x USB Disk (BREAM3D_USB4) of Seismic-navigation merged field data for 20 sail lines Box 12: 1 x USB Disk (BREAM3D_USB6) containing Seismic-navigation merged field data Box 13: 1 x USB Disk Tape# USB DISK 15, of Seismic-Navigation Merged Field Data for 27 Sail Lines Box 14: 1 x USB DISK (USB DISK 16) of Seismic-navigation merged field data for 20 sail lines Box 15: 1 x USB Disk (USB DISK 17) of Seismic-Navigation Merged Field Data for 21 sail lines Box 16: 1 x USB Disk (USB DISK 23) Containing Seismic-navigation merged field data for 3 sail lines: G06A,-1120P1-89, 1584F2-050, 2384F4-153 1 x USB DISK (USB DISK-19) Containing Seismic-navigation merged field data for 23 sail lines Box 17: 1 x USB Disk (USBDISK21) of Seismic-navigation merged field data for 21 sail lines Box 18: 1 x USB Disk (USBDISK22) of Seismic-navigation merged field data for 27 sail lines 9 x Paper Documents Containing SEGY QC Data	19 Sept 2007	Laurence Hansen Apache Energy Level 3, 256 St Georges Tce PERTH WA 6000

12 Comments

Processing Comments

- The data was characterised by short period multiples; mostly water bottom multiples but also some caused by high impedance shallow events. Strong linear noise also existed in the shot data.

- For the most part the linear noise was removed by Tau-P linear noise removal. Some remnant energy still existed from the the high amplitude low velocity (~1400m/s) mud roll type noise.

- The main tools used to remove the short period multiples were SRME and Tau-P Deconvolution. Radon demultiple was not able to significantly remove them because no significant velocity differential existed between the primaries and their water bottom generated multiples.

- Tau-P Decon. was most effective at attenuating the water bottom multiples. SRME removed short period water bottom generated multiples to a lesser extent. SRME however was of benefit in removing intermediate and longer period multiples: mostly multiples around 500-1000ms caused by high impedance (such as the Latrobe group) events in the shallow which Tau-P deconvolution (280ms operator) was unable to remove.

- Order SRME/Tau-P Decon. proved superior to order Tau-P Decon./SRME. This was evident on longer period multiples being better attenuated.

- The Marie dataset showed low fold in some areas due to incomplete acquisition. The near offsets had complete coverage however the far offsets showed some gaps up to 500m wide. Also the data has above average spiking traces.

- The Marie dataset showed some cross-feed on streamer four. This was attenuated by using FX-Deconvolution to discriminate against non predictable events (noise) on offset planes. The methodology was. See Appendix B

  -Sort into common offset domain
  -FX-decon. (7 trace, 500ms * 100 traces)
  -Subtract FX data from original data to get noise model
  -Sort into common shot and shot stack to get Cross feed noise Model
  -Subtract Cross feed noise Model from original shots.

13   SEGY Trace Header Definition

Apache Energy
SEGY trace headers for shots or gathers with true shot and recv coordinates

header words

start	finish	format	header type
21	24	4 byte Integer	cdp
71	72	2 byte Integer	coordinate scalar (use 1 for coordinates in metres)
73	76	4 Byte IBM REAL	sou_x Real
77	80	4 Byte IBM REAL	sou_y Real
81	84	4 Byte IBM REAL	rec_x Real
85	88	4 Byte IBM REAL	rec_y Real
181	184	4 byte Integer	cdp_x Integer 3D bin centre
185	188	4 byte Integer	cdp_y Integer 3D bin centre
189	192	4 byte Integer	inline number
193	196	4 byte Integer	crossline number
197	200	4 Byte IBM REAL	WD_TWT water depth (twt ms)
201	204	4 Byte IBM REAL	WD_DEPTH water depth (m)
205	208	4 byte Integer	SAIL LINE NUMBER (INTEGER)
209	212	4 byte Integer	NAVIGATON SEQUENCE NUMBER
213	216	4 Byte IBM REAL	OFFSET WEIGHTING (Pre-Stack Data)
217	220	4 byte Integer	3D CDP Number (unique)

SEGY trace headers for 3D PSTM gathers and post-stack volumes
no true source and receiver coordinates available)
header words

start	finish	format	header type
21	24	4 byte Integer	cdp
71	72	2 byte Integer	coordinate scalar (use 1 for coordinates in metres)
73	76	4 Byte IBM REAL	cdp_x Real
77	80	4 Byte IBM REAL	cdp_y Real
81	84	4 Byte IBM REAL	cdp_x Real
85	88	4 Byte IBM REAL	cdp_y Real
181	184	4 byte Integer	cdp_x Integer 3D bin centre
185	188	4 byte Integer	cdp_y Integer 3D bin centre
189	192	4 byte Integer	inline number
193	196	4 byte Integer	crossline number
197	200	4 Byte IBM REAL	WD_TWT water depth (twt ms)
201	204	4 Byte IBM REAL	WD_DEPTH water depth (m)
213	216	4 Byte IBM REAL	OFFSET WEIGHTING (Pre-Stack Data)
217	220	4 byte Integer	3D CDP Number (unique)

Items below are to be defined in EBCDIC header

EBCDIC header also to include Datum (e.g. GDA94 zone 50S)
and 3 corner points for grid definition e.g.:

inline	xline	x	y
1000	2000	100000	2000000
1000	5000	100000	5000000
2500	2000	250000	2000000

14 Modeled Far Field Signature

Marie Survey:

Refer to the Figure 1 in section 5.3.

```
DATA LENGTH     =    1000
DATA TYPE FLAG  =       1
SAMPLE INTERVAL = 0.50000000E+00
ZERO INDEX      =       1
```

```
0.00000000E+00-.11111799E-05-.33040110E-05-.13108629E-03-.38112237E-03
-.22075491E-02-.55686329E-02-.15434542E-01-.31630017E-01-.60835574E-01
-.10265555E+00-.15751778E+00-.22486234E+00-.29328802E+00-.36237395E+00
-.41525126E+00-.45207077E+00-.46478707E+00-.45427188E+00-.42869440E+00
-.38919535E+00-.35235718E+00-.31882402E+00-.29870710E+00-.29176280E+00
-.29468372E+00-.30666721E+00-.31745026E+00-.32637417E+00-.32755348E+00
-.32093084E+00-.30943039E+00-.29343352E+00-.27959189E+00-.26813188E+00
-.26211646E+00-.26124242E+00-.26310086E+00-.26712987E+00-.26933494E+00
-.26950499E+00-.26625532E+00-.25998253E+00-.25220656E+00-.24357048E+00
-.23581462E+00-.22926573E+00-.22390595E+00-.21958539E+00-.21515121E+00
-.21033680E+00-.20462419E+00-.19801371E+00-.19116798E+00-.18428238E+00
-.17807285E+00-.17264836E+00-.16775823E+00-.16345374E+00-.15884721E+00
-.15399499E+00-.14808911E+00-.14049961E+00-.13024731E+00-.11533189E+00
-.94513096E-01-.65828808E-01-.29501446E-010.13537590E-010.60143959E-01
0.10652399E+000.14913912E+000.18547289E+000.21556301E+000.24069463E+00
0.26346076E+000.28562671E+000.30744496E+000.32684284E+000.34167641E+00
0.35838205E+000.40937340E+000.58996809E+000.10962299E+010.22521162E+01
0.44789562E+010.82147951E+010.13736885E+020.21019941E+020.29565151E+02
0.38418999E+020.46281475E+020.51751175E+020.53719563E+020.51572304E+02
0.45511925E+020.36426128E+020.25798412E+020.15332843E+020.65208125E+01
0.40866026E+00-.27981300E+01-.35873270E+01-.31682909E+01-.30540910E+01
-.46919460E+01-.91206665E+01-.16528204E+02-.26320438E+02-.37031910E+02
-.46811981E+02-.53779068E+02-.56497562E+02-.54417763E+02-.47867611E+02
-.38145855E+02-.27029636E+02-.16456198E+02-.80504665E+01-.27349119E+01
-.72296286E+00-.14277918E+01-.38395481E+01-.67696128E+01-.91717424E+01
-.10425240E+02-.10333855E+02-.91519909E+01-.73937311E+01-.56149282E+01
-.42900624E+01-.36423035E+01-.36380556E+01-.40902958E+01-.46467872E+01
-.50575852E+01-.51172256E+01-.47832980E+01-.41811652E+01-.34281716E+01
-.27663660E+01-.22783849E+01-.20377579E+01-.20134859E+01-.20735314E+01
-.21561949E+01-.21131668E+01-.19468840E+01-.16538931E+01-.12903057E+01
-.96577001E+00-.71017307E+00-.60023236E+00-.60107529E+00-.67927837E+00
-.77821243E+00-.81383765E+00-.77113521E+00-.61645859E+00-.38536298E+00
-.11844450E+000.14434521E+000.34918514E+000.49349374E+000.57018387E+00
0.60781664E+000.64064550E+000.69107044E+000.78561080E+000.91751349E+00
0.10766329E+010.12393878E+010.13773503E+010.14779086E+010.15300843E+01
0.15446974E+010.15388601E+010.15334150E+010.15514997E+010.16011403E+01
0.16855340E+010.17923143E+010.19035991E+010.20007753E+010.20653021E+01
0.20913513E+010.20770121E+010.20336430E+010.19740015E+010.19141484E+01
0.18676516E+010.18409370E+010.18385241E+010.18541248E+010.18834673E+01
0.19160503E+010.19449418E+010.19656258E+010.19743640E+010.19757125E+01
0.19714742E+010.19694867E+010.19746655E+010.19903084E+010.20196536E+01
0.20590150E+010.21057801E+010.21529629E+010.21924658E+010.22187347E+01
0.22233148E+010.22037055E+010.21578639E+010.20867851E+010.19979788E+01
0.18966149E+010.17950554E+010.17014287E+010.16238624E+010.15692393E+01
0.15365869E+010.15272380E+010.15344136E+010.15527115E+010.15761997E+01
0.15968037E+010.16133447E+010.16215777E+010.16240317E+010.16235000E+01
0.16225917E+010.16274439E+010.16376479E+010.16549519E+010.16753896E+01
0.16934533E+010.17049272E+010.17023706E+010.16844139E+010.16488712E+01
0.15976022E+010.15351642E+010.14646826E+010.13931029E+010.13238682E+01
0.12614266E+010.12091405E+010.11675565E+010.11392844E+010.11229706E+01
0.11187352E+010.11252168E+010.11399331E+010.11624259E+010.11896913E+01
0.12210586E+010.12545420E+010.12883005E+010.13211421E+010.13500038E+01
0.13729771E+010.13872451E+010.13902664E+010.13806965E+010.13568786E+01
0.13194116E+010.12694924E+010.12091424E+010.11420199E+010.10708739E+01
0.99992043E+000.93231606E+000.87094867E+000.81903940E+000.77789688E+00
0.75013530E+000.73583645E+000.73548955E+000.74788815E+000.77032000E+00
0.79968816E+000.83068591E+000.85916948E+000.87978125E+000.88871258E+00
0.88249987E+000.85931551E+000.81887722E+000.76196176E+000.69089359E+00
0.60823309E+000.51772892E+000.42263785E+000.32679456E+000.23310371E+00
0.14442313E+000.62946014E-01-.93950275E-02-.70301309E-01-.11782651E+00
-.14930262E+00-.16297117E+00-.15662330E+00-.12931621E+00-.80631450E-01
-.11884693E-010.74085511E-010.17326404E+000.28025144E+000.38977438E+00
0.49612606E+000.59499437E+000.68310118E+000.75889856E+000.82265705E+00
0.87478077E+000.91694897E+000.94795096E+000.96833706E+000.97398800E+00
0.96422321E+000.93714654E+000.89251751E+000.83723712E+000.77244830E+00
0.71211630E+000.65812904E+000.62065685E+000.60149407E+000.59794909E+00
0.61105901E+000.62758738E+000.64761376E+000.65920371E+000.66194504E+00
0.65512604E+000.63992357E+000.62518030E+000.61455655E+000.61553943E+00
0.63026279E+000.65732062E+000.69209433E+000.72818184E+000.75564104E+00
0.77216321E+000.77067804E+000.75547320E+000.72879541E+000.69561327E+00
0.66523165E+000.63691491E+000.61820626E+000.60357279E+000.59265161E+00
0.58107978E+000.56282055E+000.53873146E+000.50503051E+000.46612799E+00
0.42450237E+000.38308167E+000.34636733E+000.31317124E+000.28338668E+00
0.25371885E+000.21882968E+000.17679580E+000.12250311E+000.56153864E-01
-.22101235E-01-.11157761E+00-.20773894E+00-.31041089E+00-.41528493E+00
-.52164197E+00-.62903607E+00-.73580045E+00-.84480661E+00-.95441031E+00
-.10669336E+01-.11819969E+01-.12989050E+01-.14182359E+01-.15369439E+01
-.16547922E+01-.17686683E+01-.18764828E+01-.19763585E+01-.20654290E+01
-.21426158E+01-.22060935E+01-.22553079E+01-.22906890E+01-.23130243E+01
-.23242514E+01-.23266783E+01-.23218400E+01-.23119543E+01-.22976289E+01
-.22791319E+01-.22568007E+01-.22285280E+01-.21948879E+01-.21537023E+01
-.21055143E+01-.20505753E+01-.19889613E+01-.19235851E+01-.18544977E+01
-.17852219E+01-.17166196E+01-.16505382E+01-.15886718E+01-.15305908E+01
-.14777261E+01-.14287405E+01-.13839158E+01-.13422415E+01-.13027272E+01
-.12647381E+01-.12271941E+01-.11894724E+01-.11520373E+01-.11147223E+01
-.10802817E+01-.10497878E+01-.10260063E+01-.10109400E+01-.10035872E+01
-.10054616E+01-.10110373E+01-.10198299E+01-.10257193E+01-.10261265E+01
-.10197912E+01-.10044539E+01-.98503733E+00-.96146274E+00-.94007307E+00
-.92263502E+00-.91137636E+00-.90708011E+00-.90605527E+00-.90534353E+00
-.89889383E+00-.88212043E+00-.85209316E+00-.80782378E+00-.75108463E+00
```

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-.68646646E+00-.61780393E+00-.55188727E+00-.49126065E+00-.43880275E+00
-.39377949E+00-.35255027E+00-.31278273E+00-.26843366E+00-.21868616E+00
-.16093855E+00-.97155087E-01-.30607926E-010.35258364E-010.94376020E-01
0.14468990E+000.18324497E+000.21082708E+000.23024212E+000.24375442E+00
0.25714990E+000.27223060E+000.29256266E+000.31860349E+000.34857017E+00
0.38152313E+000.41177130E+000.43768397E+000.45454022E+000.46116441E+00
0.45760033E+000.44423431E+000.42550308E+000.40394667E+000.38497078E+00
0.37174463E+000.36645615E+000.36987254E+000.38001078E+000.39409029E+00
0.40830693E+000.41845870E+000.42217356E+000.41761458E+000.40534166E+00
0.38779306E+000.36730817E+000.34848914E+000.33308825E+000.32390150E+00
0.32101563E+000.32334700E+000.32911861E+000.33386227E+000.33341414E+00
0.32357883E+000.29950622E+000.26074931E+000.20627077E+000.13948190E+00
0.67331128E-01-.60638459E-02-.68791211E-01-.11905241E+00-.14908767E+00
-.15924969E+00-.15260541E+00-.12967539E+00-.10167026E+00-.68329215E-01
-.39297357E-01-.13727430E-010.82576973E-020.28527262E-010.54650702E-01
0.88737845E-010.13711420E+000.19889337E+000.27287391E+000.35248265E+00
0.43166587E+000.50144470E+000.55771732E+000.59621066E+000.61785525E+00
0.62712491E+000.62723392E+000.62764239E+000.62971234E+000.63977975E+00
0.65625662E+000.67781824E+000.70236933E+000.72407568E+000.74306649E+00
0.75564921E+000.76461130E+000.77151787E+000.77900517E+000.79074645E+00
0.80648303E+000.82759833E+000.85104042E+000.87455636E+000.89523464E+00
0.90979940E+000.91828942E+000.91944158E+000.91604459E+000.90939146E+00
0.90209717E+000.89614987E+000.89159369E+000.88920283E+000.88660580E+00
0.88296825E+000.87596762E+000.86430216E+000.84743202E+000.82468402E+00
0.79738837E+000.76627719E+000.73324972E+000.69967914E+000.66661263E+00
0.63488299E+000.60453880E+000.57530195E+000.54665363E+000.51771712E+00
0.48803443E+000.45743245E+000.42604131E+000.39470825E+000.36372209E+00
0.33339137E+000.30409792E+000.27492988E+000.24646780E+000.21802537E+00
0.18975370E+000.16408110E+000.14063717E+000.12502791E+000.11634970E+00
0.11887994E+000.13171139E+000.15409075E+000.18596049E+000.22247976E+00
0.26371941E+000.30530092E+000.34688288E+000.38862023E+000.43070626E+00
0.47642529E+000.52729326E+000.58443320E+000.64918715E+000.71774781E+00
0.78839076E+000.85505283E+000.91236490E+000.95717764E+000.98416865E+00
0.99553800E+000.99061316E+000.97375309E+000.94893730E+000.91679305E+00
0.88235009E+000.84061515E+000.79401737E+000.73777032E+000.67092496E+00
0.59706146E+000.51384938E+000.43317422E+000.35434619E+000.28716984E+00
0.23423485E+000.19348724E+000.16977158E+000.15091826E+000.14031206E+00
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-.10265555E+00 -.15751778E+00 -.22486234E+00 -.29328802E+00 -.36237395E+00
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0.78839076E+00 0.85505283E+00 0.91236490E+00 0.95717764E+00 0.98416865E+00
0.99553800E+00 0.99061316E+00 0.97375309E+00 0.94893730E+00 0.91679305E+00
0.88235009E+00 0.84061515E+00 0.79401737E+00 0.73777032E+00 0.67092496E+00
0.59706146E+00 0.51384938E+00 0.43317422E+00 0.35434619E+00 0.28716984E+00
0.23423485E+00 0.19348724E+00 0.16977158E+00 0.15091826E+00 0.14031206E+00
0.12662105E+00 0.10931184E+00 0.87382644E-01 0.58911894E-01 0.31218555E-01
0.46412735E-02 -.15056871E-01 -.26268627E-01 -.30519949E-01 -.30431880E-01
-.31147683E-01 -.41493859E-01 -.63275233E-01 -.10473655E+00 -.16295592E+00
-.23727401E+00 -.32503238E+00 -.41641170E+00 -.51249093E+00 -.60258657E+00
-.68939161E+00 -.77006847E+00 -.84475762E+00 -.91869956E+00 -.98813862E+00
-.10592502E+01 -.11277308E+01 -.11947036E+01 -.12589431E+01 -.13165313E+01
-.13691667E+01 -.14130007E+01 -.14502046E+01 -.14809470E+01 -.15053035E+01
-.15262039E+01 -.15417334E+01 -.15544702E+01 -.15628166E+01 -.15670627E+01
-.15671253E+01 -.15614717E+01 -.15512117E+01 -.15349816E+01 -.15139563E+01
-.14880522E+01 -.14578688E+01 -.14247645E+01 -.13890090E+01 -.13524778E+01
-.13148124E+01 -.12772943E+01 -.12389886E+01 -.12006563E+01 -.11615433E+01
-.11218677E+01 -.10813575E+01 -.10394648E+01 -.99676013E+00 -.95238864E+00
-.90746468E+00 -.86093664E+00 -.81380630E+00 -.76545477E+00 -.71654463E+00
-.66688895E+00 -.61659557E+00 -.56606275E+00 -.51518881E+00 -.46506539E+00
-.41546321E+00 -.36779803E+00 -.32161558E+00 -.27781495E+00 -.23580641E+00
-.19524460E+00 -.15599021E+00 -.11681323E+00 -.78516163E-01 -.40229205E-01
-.37564840E-02 0.30311635E-01 0.60326543E-01 0.84619127E-01 0.10316106E+00
0.11490642E+00 0.12143137E+00 0.12320618E+00 0.12012748E+00 0.11373225E+00
0.10071801E+00 0.83100088E-01 0.58335111E-01 0.27292283E-01 -.64168046E-02
-.43895584E-01 -.75655982E-01 -.10363853E+00 -.12040455E+00 -.12640959E+00
-.12342443E+00 -.10950189E+00 -.94016172E-01 -.74536100E-01 -.59315510E-01
-.47711618E-01 -.39706841E-01 -.35072088E-01 -.27331248E-01 -.14919317E-01
0.68024853E-02 0.38925916E-01 0.79736017E-01 0.12562472E+00 0.17174850E+00
0.20989478E+00 0.23815432E+00 0.24995811E+00 0.24764821E+00 0.23274864E+00
0.20845707E+00 0.18376297E+00 0.15899788E+00 0.14262487E+00 0.13237898E+00
0.12938499E+00 0.13200025E+00 0.13494880E+00 0.13958687E+00 0.14100376E+00
0.14214285E+00 0.14294155E+00 0.14459249E+00 0.15022594E+00 0.15804100E+00
0.17007279E+00 0.18375336E+00 0.19788758E+00 0.21164310E+00 0.22182564E+00
0.22979453E+00 0.23368160E+00 0.23545077E+00 0.23648952E+00 0.23721793E+00
0.24150555E+00 0.24785081E+00 0.25934669E+00 0.27367163E+00 0.29051942E+00
0.30893937E+00 0.32615763E+00 0.34306666E+00 0.35687682E+00 0.36877880E+00
0.37828726E+00 0.38642660E+00 0.39490116E+00 0.40547487E+00 0.41984701E+00
0.44024950E+00 0.46639898E+00 0.49874434E+00 0.53578204E+00 0.57402349E+00
0.61238754E+00 0.64509857E+00 0.67282784E+00 0.69213599E+00 0.70423722E+00
0.71053141E+00 0.71156871E+00 0.71211982E+00 0.71184087E+00 0.71411949E+00
0.71774179E+00 0.72224534E+00 0.72625965E+00 0.72718328E+00 0.72463697E+00
0.71711951E+00 0.70560855E+00 0.69052428E+00 0.67362624E+00 0.65613729E+00
0.63924032E+00 0.62312549E+00 0.60740221E+00 0.59164673E+00 0.57461500E+00
0.55669481E+00 0.53657341E+00 0.51566905E+00 0.49309203E+00 0.47021830E+00
0.44722235E+00 0.42371362E+00 0.40105408E+00 0.37687105E+00 0.35360631E+00
0.32924232E+00 0.30571046E+00 0.28320974E+00 0.26125988E+00 0.24202538E+00
0.22329116E+00 0.20710777E+00 0.19185598E+00 0.17755617E+00 0.16451463E+00
0.15153024E+00 0.13999833E+00 0.12966751E+00 0.12065657E+00 0.11367284E+00
0.10632539E+00 0.98440036E-01 0.86207308E-01 0.67616120E-01 0.40316716E-01
0.26398317E-02 -.43309197E-01 -.96447743E-01 -.15042700E+00 -.20231599E+00
-.24550420E+00 -.27857178E+00 -.29966369E+00 -.31061870E+00 -.31564033E+00
-.31746003E+00 -.32257122E+00 -.33093640E+00 -.34606928E+00 -.36417425E+00
-.38557538E+00 -.39951217E+00 -.40809894E+00 -.40809783E+00 -.39813700E+00
-.38246408E+00 -.36324552E+00 -.34761855E+00 -.33836964E+00 -.34053370E+00
-.35402891E+00 -.37775567E+00 -.40840837E+00 -.43968761E+00 -.46864924E+00
-.48906773E+00 -.50131083E+00 -.50345612E+00 -.49823526E+00 -.48837677E+00
-.47612929E+00 -.46546423E+00 -.45582190E+00 -.44869530E+00 -.44201842E+00
-.43428412E+00 -.42433721E+00 -.40970147E+00 -.39116138E+00 -.36807522E+00
-.34227839E+00 -.31596917E+00 -.29043052E+00 -.26900366E+00 -.25169358E+00
-.24003805E+00 -.23346065E+00 -.23024480E+00 -.23006052E+00 -.22926603E+00
-.22806835E+00 -.22414726E+00 -.21752648E+00 -.20853050E+00 -.19649626E+00
-.18373291E+00 -.16964301E+00 -.15627421E+00 -.14351641E+00 -.13161395E+00
-.12074219E+00 -.10972795E+00 -.98193377E-01 -.84948793E-01 -.69501504E-01
-.51766790E-01 -.32478333E-01 -.12277541E-01 0.68733958E-02 0.24706282E-01
0.39697979E-01 0.52061420E-01 0.62081676E-01 0.69679745E-01 0.76631255E-01
0.82265295E-01 0.87716013E-01 0.92000253E-01 0.94016485E-01 0.93452618E-01
```

```
0.88778101E-01 0.80821782E-01 0.70595659E-01 0.59294708E-01 0.50624922E-01
0.44898815E-01 0.45120809E-01 0.50466210E-01 0.60157906E-01 0.73032513E-01
0.85118920E-01 0.95959783E-01 0.10226265E+00 0.10478877E+00 0.10410082E+00
0.10197074E+00 0.10214014E+00 0.10639019E+00 0.11770252E+00 0.13556187E+00
0.15907462E+00 0.18443191E+00 0.20806818E+00 0.22538598E+00 0.23376743E+00
0.23220421E+00 0.22134988E+00 0.20529264E+00 0.18670145E+00 0.17118035E+00
0.16054766E+00 0.15685245E+00 0.15958555E+00 0.16561356E+00 0.17306367E+00
0.17699428E+00 0.17643267E+00 0.16946077E+00 0.15739356E+00 0.14297341E+00
0.12915474E+00 0.12045977E+00 0.11884154E+00 0.12643088E+00 0.14193048E+00
0.16373776E+00 0.18775581E+00 0.21070813E+00 0.22842632E+00 0.23851599E+00
0.23969400E+00 0.23141536E+00 0.21633282E+00 0.19493660E+00 0.17205749E+00
0.14857909E+00 0.12767543E+00 0.11127249E+00 0.97589269E-01 0.89678086E-01
```

Bream Survey:

Source signature was supplied in SEGY format

15   SEGY Header

C 1 Fugro Seismic Imaging
C 2 LINE: ILINE3D 1901 - 4090 (inc 1)
C 3   ICDP3D   2000 - 5500 (inc 1)
C 4 SURVEY   : MARIE 3D
C 5 BLOCK : VIC/P42
C 6 DATA TYPE: FINAL PRE-STACK TTIME MIGRATION, FILTERED SCALED
C 7
C 8 POLARITY: SEG NEGATIVE (INCREASE IN ACOUSTIC IMPEDANCE REPRESENTED
C 9   BY A NEGATIVE TROUGH)
C10 CORNER POINTS (covers Sue,GBA02,Bream and Marie)
C11   Easting   Northing   Line Trace
C12   507906.28043 5703630.75292 1480 1500
C13   508477.86780 5766128.13916 1480 6500
C14   591474.39673 5765369.07115 4800 6500
C15   590902.80937 5702871.68490 4800 1500
C16
C17 PROC. SEQUENCE ():
C18 Reformat / Instrument Dephase / Bandpass Filter/ Gain(t^2)
C19 Shot-Trace Edits / Despike / Dewell / Tau-P linear noise removal
C20 SRME (2d) / Tau-P decon. / Remove t^2 gain / Spherical Div. Cor.
C21 Trace Decimation / Radon demultiple / Surface cons. scaling /
C22 Tidal Statics / Binning-Interpolation / Inverse Q (phase only)
C23 Pre-STM / Residual Radon / Inelastic gain comp. / Stack
C24 Inverse Q (amplitude only) / Gun & Cable Static / Filter / Scale
C25
C26
C27 PARTIAL SEGY TRACE HEADER DEFINITION:
C28 DESC   BYTE LOCATION   FORMAT
C29 CDP number   21-24   32 BIT INTEGER
C30 Coordinate scaler   71-72   16 BIT INTEGER
C31 3D Line (Inline) number   181-184   32 BIT INTEGER
C32 3D CDP (Xline) number   185-188   32 BIT INTEGER
C33 Easting of CDP   73-76   32 BIT INTEGER
C34 Northing of CDP   77-80   32 BIT INTEGER
C35
C36 (COORDINATE DATUM: WGS 84 PROJECTION ZONE: 55 S)
C37 GRID ORIGIN: 507906.28043 E, 5703630.75292 N LINE DIRN 0.524 DEG
C38 3D CDP AT ORIGIN : 1500 INC   1 IN DIRECTION OF   0.524 DEG
C39 3D LINE AT ORIGIN : 1480 INC -1 IN DIRECTION OF 270.524 DEG
C40 CDP SPACING : 12.5m LINE SPACING: 25m

16   Appendix A. Testing Log

```
source signature resampled
-------------------------
sig_befresamp.gif
sig_arfresamp_MP.gif
convert to zero phase
--------------------
/com/3d/054/test_GBA02B/dephase.com      ----- convert to zero phase
shots bef/arf dephase
--------------------
dephase_raw.shot
dephase_zero.shot
low cut filter
--------------
lc_filter_bef.shot
lc_filter_arf.shot
deswell
-------
tfdn_bef.shot
tfdn_arf.shot
gathers noth/fk/taup
--------------------
gath1_4ens_noth.stak                -------
gath1_4ens_fk.stak                              ( 4 ensembles)
gath1_4ens_taup.stak
gath1_4ens_tauptxdecon.stak
gath1_4ens_taupdecon.stak
gath1_4ens_srme2d.stak
( qd --nensembles=4 gath1_4ens_noth.stak gath1_4ens_fk.stak  gath1_4ens_taup.stak gath1_4ens_srme2d.stak )
stacks with various linear noise removal schemes
------------------------------------------------
stak1_noth.stak
stak1_fk.stak
stak1_taup.stak
stak1_tauptxdecon.stak
stak1_taupdecon.stak
stak1_srme2d.stak
stak1_srme2dtxdecon.stak
auto_fk.stak
auto_noth.stak
auto_srme2d.stak
auto_srme2dtxdecon.stak
auto_taupdecon.stak
auto_taup.stak
auto_tauptxdecon.stak
migrations noth/fk/taup/taupdecon
---------------------------------
wavmig_noth.stak
wavmig_fk.stak
wavmig_taup.stak
wavmig_taupdecon.stak
14/03/07
--------
Flow up to date: shots
----------------------
1_nodephase.shot
1_dephase.shot                  qd --nensembles=2
1_swellfinal.shot
1_taup.shot
1_taup-srme.shot
1_taup-srme-taupdecon.shot
1_taup-taupdecon.shot
1_taup-taupdecon-srme.shot
Flow up to date: gathers
-----------------------
1_nodephase.gath
1_dephase.gath                  qd --nensembles=2
1_swellfinal.gath
1_taup.gath
1_taup-srme.gath
1_taup-srme-taupdecon.gath
1_taup-taupdecon.gath
1_taup-taupdecon-srme.gath
Flow so far/change of order
---------------------------
1_nodephase.stak
1_dephase.stak                  qd  -p /com/ip/miker/col3d.op
1_swellfinal.stak
1_taup.stak
1_taup-srme.stak
1_taup-taupdecon.stak
1_taup-srme-taupdecon.stak
1_taup-taupdecon-srme.stak
15/03/07
--------
Amplitude spectra at various stages
-----------------------------------
1_dephase.gif
1_swellfinal.gif
1_taup.gif
1_taup-srme.gif
1_taup-srme-taupdecon.gif
1_taup-taupdecon.gif
1_taup-taupdecon-srme.gif
FK spectra at various stages
----------------------------
1_dephase_fk.gif
1_swellfinal_fk.gif
1_taup_fk.gif
```

```
1_taup-srme_fk.gif
1_taup-srme-taupdecon_fk.gif
1_taup-taupdecon_fk.gif
1_taup-taupdecon-srme_fk.gif
Add white noise to the dephase filter
------------------------------------
dephase_white_00.shot
dephase_white_01.shot
dephase_white_02.shot
dephase_white_03.shot
dephase_white_04.shot
dephase_white_05.shot
dephase_white_06.shot
dephase_white_07.shot
dephase_white_08.shot
dephase_white_09.shot
dephase_white_10.shot
dephase_white_12.shot
dephase_white_14.shot
dephase_white_16.shot
dephase_white_18.shot
19/03/07
--------
Should we do srme at all?
-----------------------
1_taup-taupdecon.stak
1_taup-srme-taupdecon.stak
1_taup-taupdecon.gath          qd --nensembles=4 1_taup-taupdecon.gath 1_taup-srme-taupdecon.gath
1_taup-srme-taupdecon.gath
Can we do srme without linear noise attenuation beforehand?
----------------------------------------------------------
1_swellfinal.shot
1_swellfinal_srme.shot
1_swellfinal_srmeshot_taup.shot
1_taup_srme.shot
1_swellfinal.stak
1_swellfinal_srme.stak
1_swellfinal_srmeshot_taup.stak
1_taup_srme.stak
1_swellfinal.gath              qd --nensembles=4
1_swellfinal_srme.gath
1_swellfinal_srmeshot_taup.gath
1_taup_srme.gath
20/03/07
--------
Does srme work on the far cable?
--------------------------------
2_taupshot_cable8.gath         qd --nensembles=4
2_taup_SRMEnewcab.gath
2_taup_SRMExzoff.gath
2_cable8.gath
2_taupshot_cable8.stak          -p /com/ip/miker/col.op
2_taup_SRMEnewcab.stak
2_taup_SRMExzoff.stak
2_cable8.stak
how well does the near offset extapolation work?
------------------------------------------------
nearoff_extrap.shot             qd --nensembles=8 nearoff_extrap.shot
nearoff_extrap_radon.shot       qd --nensembles=8 nearoff_extrap_radon.shot
(using radon method)
What about the issue of doing 2 Tau-P transforms
------------------------------------------------
/com/3d/054/test_GBA02B/twotauptrans.com
Tau-P filtering revisited try different delta-t
-----------------------------------------------
4_taup_delt_04.shot
4_taup_delt_06.shot
4_taup_delt_08.shot
4_taup_delt_10.shot
4_taup_delt_12.shot
Tau-P filtering revisited compare to SUE3D
------------------------------------------
taup_SUE.shot               contract 015(SUE)
taup_oldmike.shot
taup_newmike.shot
Tau-P decon tests, input: taup-srme shots
-----------------------------------------
3_tpdectest_oper040.stak    qd 3_tpdectest_oper*.stak -p /com/ip/miker/colauto.op
3_tpdectest_oper080.stak
3_tpdectest_oper120.stak
3_tpdectest_oper160.stak
3_tpdectest_oper200.stak
3_tpdectest_oper240.stak
3_tpdectest_oper280.stak
3_tpdectest_oper320.stak
3_tpdectest_oper360.stak
3_tpdectest_oper400.stak
Tau-P decon test oper 240ms
---------------------------
3_tpdectest_gap08.stak      qd  3_tpdectest_gap*.stak -p /com/ip/miker/colauto.op
3_tpdectest_gap12.stak
3_tpdectest_gap16.stak
3_tpdectest_gap20.stak
3_tpdectest_gap24.stak
3_tpdectest_gap28.stak
3_tpdectest_gap32.stak
3_tpdectest_gap36.stak
3_tpdectest_gap40.stak
3_tpdectest_gap44.stak
3_tpdectest_gap48.stak
25/03/07
--------
```

```
edits edge effect problem of Tau-P mute
--------------------------------------
4_noedit.shot
4_noextrap.shot
4_extrap_novel.shot
4_extrap_brutevel.shot
4_extrap_1500.shot
check window length paramter for SRME
-------------------------------------
srme_VP421216P001_winlength100.stak          qd srme_VP421216P001_winlength*stak -p /com/ip/miker/col.op
srme_VP421216P001_winlength200.stak
srme_VP421216P001_winlength300.stak
srme_VP421216P001_winlength400.stak
srme_VP421216P001_winlength500.stak
srme_VP421216P001_winlength600.stak
srme_VP421216P001_winlength700.stak
srme_VP421216P001_winlength800.stak
srme_VP421216P001_winlength900.stak
srme_VP421216P001_winlengthnon.stak
Have a look at semblences at various stages
-------------------------------------------
RAW.png
TAUP.png
SRME.png
TAUPDECON.png                 f2 RAW.png TAUP.png SRME.png TAUPDECON.png
30/3/07
-------
Decon tests revisited
---------------------
6_tpdectest_gap20.stak          qd 6*gap*stak -p /com/ip/miker/col.op
6_tpdectest_gap24.stak
6_tpdectest_gap16.stak
6_tpdectest_gap12.stak
6_tpdectest_gap32.stak
6_tpdectest_gap36.stak
6_tpdectest_gap28.stak
6_tpdectest_gap40.stak
Decon tests revisited
---------------------
6_tpdectest_oper200.stak        qd  6*oper*stak -p /com/ip/miker/col.op
6_tpdectest_oper160.stak
6_tpdectest_oper120.stak
6_tpdectest_oper240.stak
6_tpdectest_oper280.stak
6_tpdectest_oper320.stak
6_tpdectest_oper360.stak
6_tpdectest_oper400.stak
6_tpdectest_oper080.stak
6_tpdectest_oper040.stak
Check production flow on 6 vel lines
------------------------------------
/3d/054/*_stak/34_VP421328B032_1_4.stak
/3d/054/*_stak/24_VP421328P022_1_4.stak
/3d/054/*_stak/25_VP421328A023_1_4.stak
/3d/054/*_stak/39_VP421488P037_1_4.stak
/3d/054/*_stak/4_VP421008P002_1_4.stak
/3d/054/*_stak/14_VP421168P012_1_4.stak
Revisit white noise problem
---------------------------
dephase_per1.sho              qd dephase_per*sho
dephase_per2.sho
dephase_per3.sho
dephase_per4.sho
dephase_per5.sho
dephase_per0.sho
dephase_old_per5.shot   old version "not shifted"
dephase_old_per3.shot
dephase_old_per1.shot
17/04/07
--------
Dephase on Marie
----------------
Marie_dephase_raw.shot
Marie_dephase_noshift_1per.shot
Marie_dephase_shift_1per.shot
Marie_dephase_shift_3per.shot
Amplitude spectrum bef/arf dephase
----------------------------------
M_rawshot.gif
M_dephase_noshift_1per.gif
M_dephase_shift_1per.gif
M_dephase_shift_3per.gif
Synthetic Conversion
--------------------
/com/3d/054/test_Marie/dephase.com
TFDN
----
M_bef_tfdn.shot
M_arf_tfdn.shot
Despike
-------
M_bef_despike.shot
M_arf_despike.shot
FK ( 2000m/s costap)
--------------------
M_bef_FK.shot
M_arf_FK.shot
Taup linear noise removal
-------------------------
M_bef_taup.shot
M_arf_taup.shot
23/04/07
```

```
--------
timeslice brute cube
--------------------
ts_600_stak_cub1.gif
xlin of brute cube
/com/3d/054/plots/xlplot.com
stacks: Tau-P FK
----------------------
GAP07A1280P047_nothing.stak
GAP07A1280P047_tfdn_despike.stak
GAP07A1280P047_fk.stak
GAP07A1280P047_taup.stak
2d migs: Tau-P FK
--------------------------
GAP07A1280P047_nothing.wavmig
GAP07A1280P047_taup.wavmig
qd GAP07A1280P047_nothing.wavmig GAP07A1280P047_taup.wavmig GAP07A1280P047_fk.wavmig -p /com/ip/miker/col.op
26/04/07
--------
staks of taup/taupdecon/srme/ combinations
-----------------------------------------
taup_GAP07A1280P047_1_4.stak
taupdecon_GAP07A1280P047_1_4.stak
srme_GAP07A1280P047_1_4.stak
taupdeconsrme_GAP07A1280P047_1_4.stak
srmetaupdecon_GAP07A1280P047_1_4.stak
qd taup_GAP07A1280P047_1_4.stak taupdecon_GAP07A1280P047_1_4.stak srme_GAP07A1280P047_1_4.stak -p /com/ip/miker/col.op
qd taupdeconsrme_GAP07A1280P047_1_4.stak srmetaupdecon_GAP07A1280P047_1_4.stak -p /com/ip/miker/col.op
2d mig of taup/taupdecon/srme/ combinations
-----------------------------------------
taup_GAP07A1280P047_1_4.wavmig
taupdecon_GAP07A1280P047_1_4.wavmig
srme_GAP07A1280P047_1_4.wavmig
taupdeconsrme_GAP07A1280P047_1_4.wavmig
srmetaupdecon_GAP07A1280P047_1_4.wavmig
qd  taup_GAP07A1280P047_1_4.wavmig srmetaupdecon_GAP07A1280P047_1_4.wavmig taupdeconsrme_GAP07A1280P047_1_4.wavmig -p
/com/ip/miker/col.op
decon operator tests
--------------------
opertest_060_GAP07A1280P047_1_4.stak  qd opertest_*GAP07A1280P047_1_4.stak -p /com/ip/miker/col.op
opertest_080_GAP07A1280P047_1_4.stak
opertest_120_GAP07A1280P047_1_4.stak
opertest_140_GAP07A1280P047_1_4.stak
opertest_160_GAP07A1280P047_1_4.stak
opertest_180_GAP07A1280P047_1_4.stak
opertest_200_GAP07A1280P047_1_4.stak
opertest_280_GAP07A1280P047_1_4.stak
opertest_360_GAP07A1280P047_1_4.stak
opertest_400_GAP07A1280P047_1_4.stak
decon gap test
--------------
gaptest_none_GAP07A1280P047_1_4.stak
gaptest_004_GAP07A1280P047_1_4.stak  qd  gaptest_*GAP07A1280P047_1_4.stak -p /com/ip/miker/col.op
gaptest_008_GAP07A1280P047_1_4.stak
gaptest_012_GAP07A1280P047_1_4.stak
gaptest_016_GAP07A1280P047_1_4.stak
gaptest_020_GAP07A1280P047_1_4.stak
gaptest_024_GAP07A1280P047_1_4.stak
gaptest_028_GAP07A1280P047_1_4.stak
gaptest_032_GAP07A1280P047_1_4.stak
gaptest_036_GAP07A1280P047_1_4.stak
gaptest_040_GAP07A1280P047_1_4.stak
gaptest_044_GAP07A1280P047_1_4.stak
Found a solution to the edge effects caused by traces edits and linear noise removal
------------------------------------------------------------------------------
turnshot_oldexoff.shot
turnshot_oldbrutevelexoff.shot
turnshot_newexoff.shot          - shift the data down 1000ms and use 1500m/s
turnshot_noexoff.shot
qd turnshot_oldexoff.shot turnshot_oldbrutevelexoff.shot turnshot_newexoff.shot turnshot_noexoff.shot
03/05/07
--------
Radon gathers (GBA02) various cuts)
-----------------------------------
radgath_cut000.gath              qd radgath_cut*.gath
radgath_cut050.gath
radgath_cut300.gath
radgath_cut250.gath
radgath_cut200.gath
radgath_cut150.gath
radgath_cut100.gath
radgath_cut500.gath
radgath_cut450.gath
radgath_cut400.gath
radgath_cut550.gath
radgath_cut600.gath
Radon stacks (GBA02) various cuts
---------------------------------
rad_cut000.stak
rad_cut050.stak
rad_cut200.stak
rad_cut150.stak
rad_cut100.stak
rad_cut300.stak
rad_cut350.stak
rad_cut250.stak
rad_cut400.stak
rad_cut600.stak
rad_cut550.stak
rad_cut450.stak
rad_cut500.stak
Test resolution of Radon (GBA02)
```

```
--------------------------------
rad_delt05.shot
rad_delt10.shot
rad_delt15.shot
rad_delt20.shot
rad_delt25.shot
rad_delt30.shot
rad_delt35.shot
rad_delt40.shot
Marie Radon tests
----------------
radsemb_000.png
radsemb_025.png
radsemb_050.png
radsemb_075.png
radsemb_100.png
radsemb_125.png
radsemb_150.png
radsemb_175.png
radsemb_200.png
radsemb_225.png
radsemb_250.png
radsemb_275.png
radsemb_300.png
radsemb_400.png
radsemb_500.png
radsemb_600.png
10/05/07
-------
timeslice of brute stack so far
-------------------------------
f2 ts7_1800_stak_cub1.gif
Linear noise removal vs radon
-----------------------------
qd taup0_GAP07A1280P047_1_4.shot taup1_GAP07A1280P047_1_4.shot taup2_GAP07A1280P047_1_4.shot taup3_GAP07A1280P047_1_4.shot
qd rad0_GAP07A1280P047_1_4.shot rad1_GAP07A1280P047_1_4.shot rad2_GAP07A1280P047_1_4.shot rad3_GAP07A1280P047_1_4.shot
notes for Paul
--------------
1800MS TIME slice                                                             -done
2800 cross line                                                               -done
do raw1 shot with SRME                                                                -done
plots (and raw )of order (srme) srme/taupdecon with autocorr -done
raw1 with new interpolation  (already had)          -done
status with edits note after linear noise removal     -deon
old(taup) and new (looser Tau-P mute) tests
-------------------------------------------
taupold_VP421248P005_1_4.stak
taupnew_VP421248P005_1_4.stak
taupold_VP421248P005_1_4.gath
taupnew_VP421248P005_1_4.gath
taupold_VP421248P005_1_4.wavmig
taupnew_VP421248P005_1_4.wavmig
after srme test(looser Tau-P mute)
-------------------------------
srmetest_VP421248P005_1_4.gath
srme_VP421248P005_1_4.gath
srme_VP421248P005_1_4.stak
srmetest_VP421248P005_1_4.stak
check the order and SRME question on a hosts of lines
----------------------------------------------------
run checkprod_Marie.com
check whether SRME-Taupdecon is better than Taupdecon-SRME
---------------------------------------------------------
cd /3d/054/taupdecon_stak/Marie
qd taupdeconsrme_GAP07A1376P020_1_4.st  taupdecon_GAP07A1376P020_1_4.stak -p /com/ip/miker/col.op
qd taupdeconsrme_GAP07A2176P093_1_4.st
qd taupdeconsrme_GAP07A1728J096_1_4.st  taupdecon_GAP07A1728J096_1_4.stak -p /com/ip/miker/col.op
qd taupdeconsrme_GAP07A2112P085_1_4.st
qd taupdeconsrme_GAP07A1792P082_1_4.st
qd taupdeconsrme_GAP07A1024P011_1_4.st  taupdecon_GAP07A1024P011_1_4.stak -p /com/ip/miker/col.op
qd taupdeconsrme_GAP07A1728P074_1_4.st
qd taupdeconsrme_GAP07A2048P077_1_4.st  taupdecon_GAP07A2048P077_1_4.stak -p /com/ip/miker/col.op
qd taupdeconsrme_GAP07A1312P012_1_4.st  taupdecon_GAP07A1312P012_1_4.stak -p /com/ip/miker/col.op
qd taupdeconsrme_GAP07A1376J116_1_4.st  taupdecon_GAP07A1376J116_1_4.stak -p /com/ip/miker/col.op
24/05/07
--------
Tau-P decon vs TX decon on Marie
--------------------------------
qd srme_GAP07A1408P024_1_4.stak taupdecon_GAP07A1408P024_1_4.stak tx_decon_GAP07A1408P024_1_4.stak -p /com/ip/miker/col.op
qd srme_GAP07A1024P011_1_4.stak taupdecon_GAP07A1024P011_1_4.stak tx_decon_GAP07A1024P011_1_4.stak -p /com/ip/miker/col.op
qd srme_GAP07A2048A101_1_4.stak taupdecon_GAP07A2048A101_1_4.stak tx_decon_GAP07A2048A101_1_4.stak -p /com/ip/miker/col.op
qd srme_GAP07A1280P047_1_4.stak taupdecon_GAP07A1280P047_1_4.stak tx_decon_GAP07A1280P047_1_4.stak -p /com/ip/miker/col.op
cut back the Tau-P transform for Tau-P decon (3600->3100 )
---------------------------------------------------------
qd taupdecon_raw_GAP07A2160J120_1_4.shot taupdecon_3600_GAP07A2160J120_1_4.shot taupdecon_3100_GAP07A2160J120_1_4.shot
taupdecon_2600_GAP07A2160J120_1_4.shot
30/05/07
--------
Check the Marie source signature. Westerns suggested that the
0.5ms contructed wavelet was superior to the 2ms contructed wavelet.
I don't see much difference, ie. all the signatures have a non-flat
amplitude spectrum in the low frequencies. So in any case this (as
they also suggest) must be real: ie unique to their 3147cu.ins guns.
-------------------------------------------------------------------
Marie_7m_2ms_1000msshift.sig              -signature used in production
Marie_7m_2ms_1000msshif.sig_0.5_75        -signature new 0.5ms 75% AA filter
Marie_7m_2ms_1000msshif.sig_0.5_90        -signature new 0.5ms 90% AA filter
dephase_prod.shot                         -shot after dephase,lc used in production
dephase_0.5_75.shot                       -shot after dephase: new 0.5ms 75% AA filter
dephase_0.5_90.shot                       -shot after dephase: new 0.5ms 90% AA filter
31/05/07
--------
```

```
spent most of day examining noise problems for Marie.
Scan thru all the insegd staks to check if cross feed noise
is present on stacks. This was found only to be a problem on sequences
10,11,12,13  and was actually a spikey trace on streamers
1 and 6 for these streamers. Reran these sequences.
-----------------------------------------------------------------
gif files of all insegd stacks: /3d/054/gifs/insegdstak_Marie
Scan thru the 1st few shots to determine how widespread the cross-feed
noise problem is. This was found on 6 sequences just by eyeballing it
b's: 25 29 37 53 62 97.
-----------------------------------------------------------------------
gif files: /3d/054/gifs/insegdshots_Marie
Scan thu all the sequences randomly on all cables (excluding cable 4)
to confirm the cross-feed noise presence on other cables.
Conclusion: only cable for has the cross-feed noise present.
-----------------------------------------------------------
05/06/07
--------
Radon tests GBA02B
------------------
radsemb1_0000.png
radsemb1_0050.png
radsemb1_0025.png
radsemb1_0075.png
radsemb1_0100.png
radsemb1_0150.png
radsemb1_0200.png
radsemb1_0250.png
radsemb1_0300.png
radsemb1_0350.png
radsemb1_0400.png
radsemb1_0500.png
radsemb1_0600.png
radsemb1_0700.png
radsemb1_1000.png
radsemb1_0800.png
TMUT,1,
    0,-500,500
  800,-300,360
 1300,-300,200
 2000,-300,200
 5120,-300,160
08/06/07
-------
spent day (and weekend) rerunning cable 4, to fix up cross noise problem)
all up spent 3 days fixing it up.
13/06/07
--------
Insegy job on BREAM
-------------------
raw_scale.gif
raw_dephase_lc_scale.gif    - 1% white noise, gun depth notch not so great.
source sig /com/3d/054/incl_file/Bream_6m_2ms_1000msshift.sig
/com/3d/054/test_Bream/insegy_Bream.com   - com file
02/07/07
---------
offset cubes
------------
animate  /com/3d/054/masks/images/*.jpg
phasematching
-------------
GBA02B to Marie -5,0deg no stat shift. Results in /com/3d/054/phasematch/Marie_GBA02B.com
meeting 5/7/07
--------------
pstm with with/wihout partial stack of duplicate traces : decided not to do
because of azimuth differeces.
description of dip model interp: see manual
Bream displays : see below
Bream shot processing displays: on ftp site
Test the nominal vs actuall offset used for radon
-------------------------------------------------
nom_vs_actual_off.gif
GAP07A1456P030_1_1_r_withtoff.gath      -radon with toff nominal offsets
GAP07A1456P030_1_1_r_notoff.gath        -radon with actuall offsets
Test Marie phase only Q compensation
------------------------------------
qd xl_2800_stak_cub7.stak xl_2800_stak_cub9.stak -p /com/ip/miker/col.op
qd 1120.mstk_noQ 1120.mstk -p /com/ip/miker/col.op
Timeslices of stak_cub7 up to now
---------------------------------
mpl stak_cub7* -p bw.op
Bream Linear noise removal confirmation
---------------------------------------
/com/3d/054/test_Bream/taup_Bream.com   - com file
B_taup_raw.shot               raw shot
B_taup_1750FK.shot            raw shot dspike tfdn fk
B_taup_Taup.shot              raw shot dspike tfdn Tau-P lin.
Test Bream testline through shot sequence
-----------------------------------------
qd insegd_G06A-1280p1-077_1_4.stak taup_G06A-1280p1-077_1_4.stak srme_G06A-1280p1-077_1_4.stak taupdecon_G06A-1280p1-077_1_4.stak -p
/com/ip/miker/col.op
Test Bream testline, reverse the order Taup-SRME-TaupDecon  Taup-TaupDecon-SRME
-------------------------------------------------------------------------------
qd taupdecon_G06A-1280p1-077_1_4.stak taup_taupdecon_srme_G06A-1280p1-077_1_4.stak -p /com/ip/miker/col.op
also qd taup_taupdecon_G06A-1280p1-077_1_4.stak taup_taupdecon_srme_G06A-1280p1-077_1_4.stak -p /com/ip/miker/col.op
Test Gather versions
--------------------
qd --nensembles=3 insegd_G06A-1280p1-077_1_4.gath taup_G06A-1280p1-077_1_4.gath srme_G06A-1280p1-077_1_4.gath taupdecon_G06A-1280p1-
077_1_4.gath
qd --nensembles=3 taupdecon_G06A-1280p1-077_1_4.gath taup_taupdecon_srme_G06A-1280p1-077_1_4.gath
Test Undershoot flow
--------------------
```

```
/3d/054/insegd_stak/Bream/insegd_G06A-1872u1-035_3_1.stak
/3d/054/taup_stak/Bream/taup_G06A-1872u1-035_3_1.stak
/3d/054/srme_stak/Bream/srme_G06A-1872u1-035_3_1.stak
/3d/054/taupdecon_stak/Bream/taupdecon_G06A-1872u1-035_3_1.stak
/3d/054/insegd_stak/Bream/insegd_G06A-1520u2-034_3_5.stak
/3d/054/taup_stak/Bream/taup_G06A-1520u2-034_3_5.stak
/3d/054/srme_stak/Bream/srme_G06A-1520u2-034_3_5.stak
/3d/054/taupdecon_stak/Bream/taupdecon_G06A-1520u2-034_3_5.stak
Have a look at Pre-stm
----------------------
qd /3d/054/plot_data/xl_3800_stak_cub9_interp.stak /3d/054/plot_data/xl_3800_stak_cub10_interp.stak -p /com/ip/miker/col.op
qd /3d/054/plot_data/stak_cub9.1400 /3d/054/plot_data/stak_cub10.1400 -p /com/ip/miker/col.op
Test high res radon various increments
--------------------------------------
higres_intest_05.gath    qd  higres_intest*
higres_intest_10.gath
higres_intest_15.gath
higres_intest_20.gath
higres_intest_none.gath
Test high res radon gather with/without interp
----------------------------------------------
higres_none.gath
higres_with_interp.gath
higres_no_interp.gath
Test various cuts (gather)
--------------------------
qd higres_cut_cut*
Test various cuts (stack)
-------------------------
qd higres_cutstak_*
Test stacks with/without interpoloation
---------------------------------------
qd higres_no_none.stak higres_no_interp.stak higres_with_interp.stak -p /com/ip/miker/col.op
28/08/07
--------
Test Marie post stack cube with/without fxy decon
-------------------------------------------------
qd xl_3000_stak_cub11.stak xl_3000_stak_cub13.stak -p /com/ip/miker/col.op
Look at the "entire" processing flow
------------------------------------
cd /3d/054/plot_data
qd xl_3100_stak_cub1.stak xl_3100_stak_cub2.stak xl_3100_stak_cub3.stak xl_3100_stak_cub4.stak xl_3100_stak_cub5.stak
xl_3100_stak_cub8.stak xl_3100_stak_cub12.stak xl_3100_stak_cub14.stak  -p /com/ip/miker/col.op
Before/after post stack mig of entire cube-
-------------------------------------------
cd /3d/054/plot_data
mpl il_3140_stak_cub15.stak il_3140_stak_cub16.stak
```

17   Appendix B. Cross-feed noise

The Marie dataset showed intermittent cross-feed on streamer four. This was attenuated by using FX Deconvolution to discriminate against non predictable events (noise) on offset planes. The methodology was:

-Sort into common offset domain
-FX-decon. (7 trace, 500ms * 100 traces)
-Subtract FX data from original data to get noise model
-Sort into common shot and shot stack to get Crossfeed noise Model
-Subtract Crossfeed noise Model from original shots.
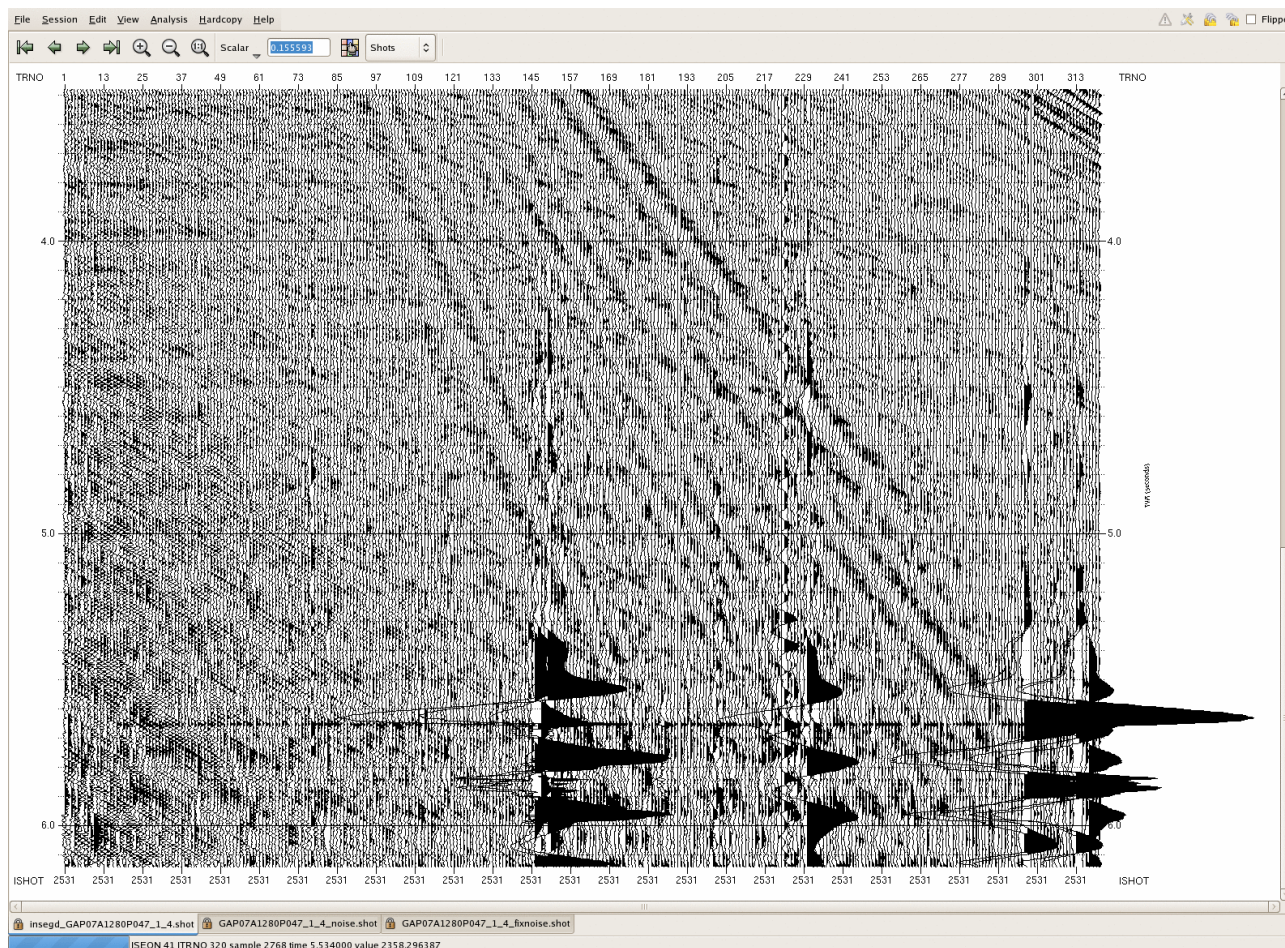
Figure 7. Sequence 047, Cable 4, Showing spikey traces and cross-feed noise @ ~5650ms.
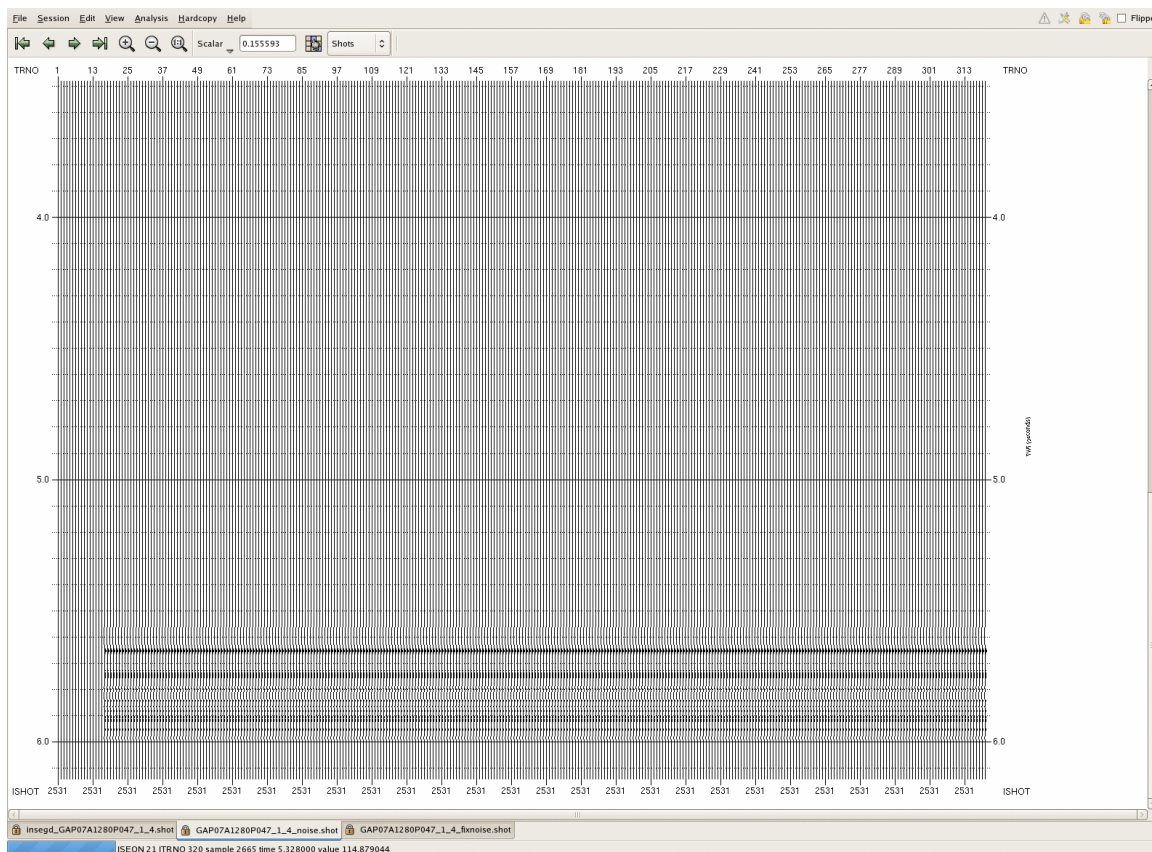
Figure 8. Cross-feed noise model.
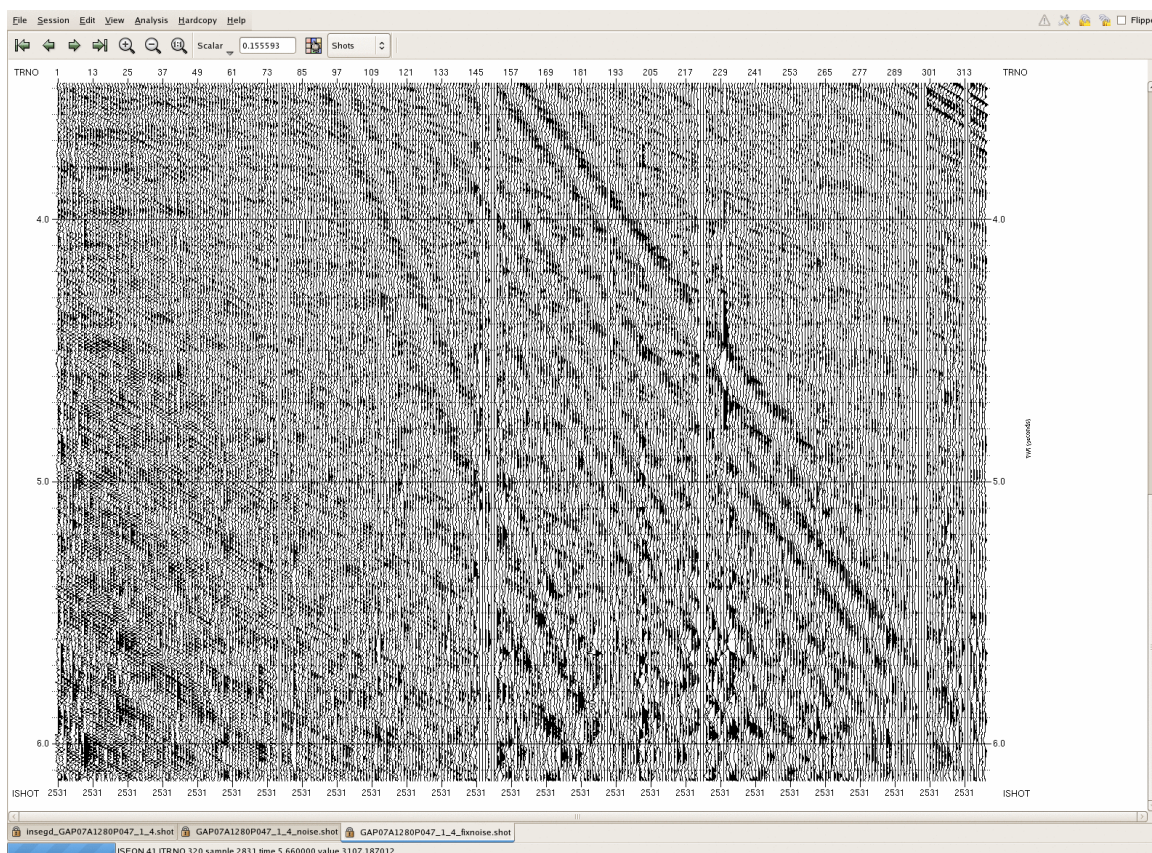
Figure 9. Cross-feed noise removed. Spikes are removed in addition by using despike (5.8).

18 Depth Processing Completed by Oil Hunters

18.1 Introduction

General information

Vic/P42 is located approximately 40 km offshore Victoria and comprises 1876 sq km. Water depths range from 50 to 80 metres. The permit lies adjacent to Kingfish, Australia's largest oil field, as well as a number of other Esso/BHP producing oil and gas fields.

This project covers about 1600 sq km of the permit. The project is a composite of 3 surveys: Marie3D (2007), about 823 sq km, Bream3D (2006) and GBA02B (2002) about 692 sq km. The survey was merged in a shooting angle of 0.52 from the north. The Inline orientation is from the South to the North. Along the merged boundaries, the maximum fold is up 350 traces per CMP. In few locations after merging the surveys empty bins were observed while in other places low fold of 8-10 traces were observed. Figures 1-3 show the project area, input CMPs fold map and Marie boundary.

Input summary

Sample rate: 4 msec
Fold: Varies from 0-360 traces per CMP
Maximum time: 6140 msec
Shooting direction: 0.52 degrees from the North
Inline range: 2900-4778
Xline range: 1658-5460

Output summary

Depth sample rate: 5 meters
Maximum depth: 8000 meters.

The preprocessing was executed by Fugro Seismic Imaging Perth.

The project received high priority from Apache and FSI and all resources were available to accelerate the preprocessing and the PreStack-Depth- Migration (PSDM) thereafter.

Data input

The following inputs were provided for the PSDM project:
- CMP gathers: Two sets of gathers were tested. All traces per bin and uniformed 80 fold traces per bin.
- Velocity: First pass stacking velocity vertical functions.
- Horizon interpretation: Two horizons below the Water Bottom were provided for the initial velocity analysis; BHv and TOL [Base High Velocity & Top LaTrobe]. At the end of the project, 6 horizons were available for velocity update and validation (iteration 4, 5 and 6).
- Well data: 22 wells within the project area. Some of the wells contained Sonic Logs and were used for QC of the initial velocity estimation. A total of 12 wells and 4 tops were used for the final velocity calibration.

The CMP gathers were tested and it was found that using the CMP set with all the traces produced a better image than the 80 fold data set. While the input CMP gathers have variable fold within the survey area; from zero traces per bin or very low fold to the overlapping area with over 350 traces per CMP, the output PSDM CRP gather volume is uniformed offset with 75 meters interval. An amplitude regulation weighting scheme was applied to the output PSDM CRP gathers to compensate for the irregular input fold.

The stacking velocity vertical functions were loaded and correlated. Anomalous points in some VF were edited and few anomalous vertical functions were deleted.

The two horizons that were provided by the client, mapped the High Velocity zone and Top-Latrobe. For accurate water bottom mapping, the observer's-log measurements (in meters) were used and scaled to time.

The Sonic Logs were loaded, QC'd and edited for spikes. A secondary set of logs; interval velocity transformed from Sonic and smoothed to seismic resolution was saved.

Target Oriented PSDM (T.O PSDM)
For the initial velocity volume and each one of the velocity update iterations, a 0.5km grid T.O PSDM was derived (every 20th Inline).
Each line was divided into 3 parts for more efficient usage of the cluster and memory.

Parameters
Travel Time computation: Cartesian Fermat
Aperture along Inline: 4000 m
Aperture along Xline: 4000 m
Anti Alias: Triangulation, medium
Max aperture at 500m

Figures
Figure1: Input CMP gathers: fold map
Figure2: Fold map: maximum fold above 300 traces
Figure3: Marie 3D boundary
Figure4: Stacking velocity vertical function spread
Figure5: Well locations
Figure6: Well Sonic (converted to Interval velocity)
Figure7: WB map
Figure8: BHv map
Figure9: TOL map
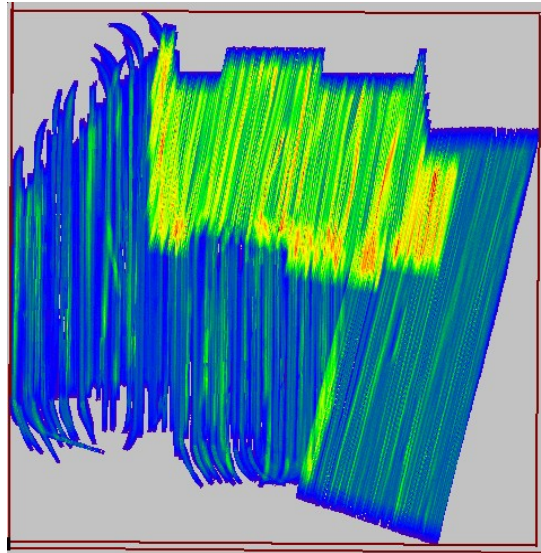
Figure 1. Fold Map
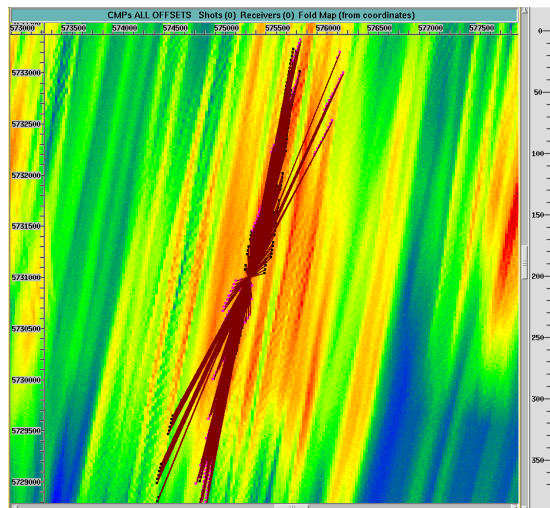
Figure 2. Fold Map: maximum fold above 300 traces
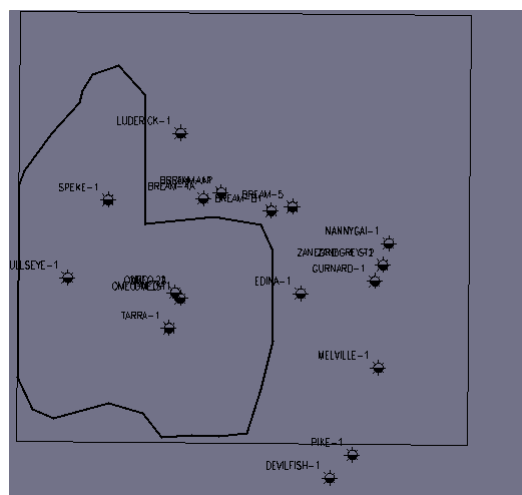
Figure 3. Marie3D boundary
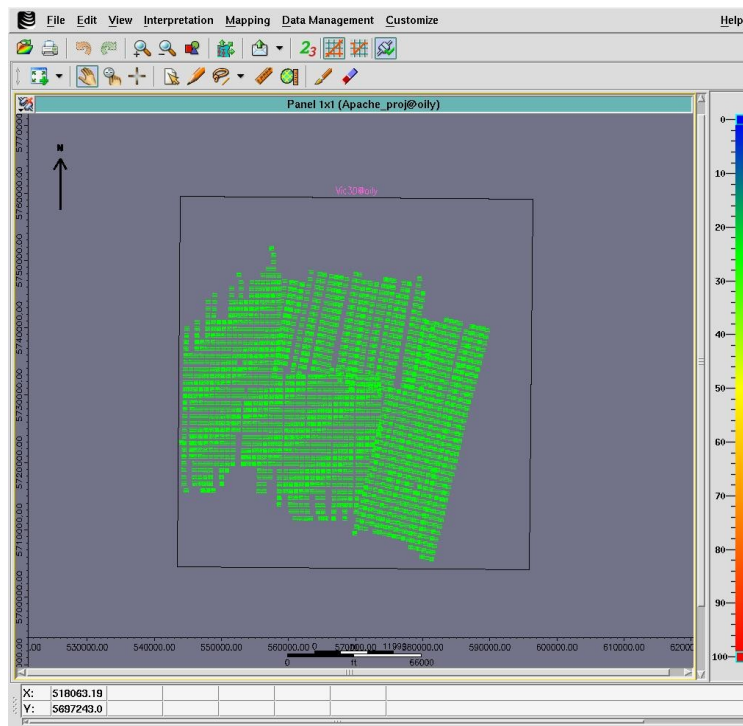
Figure 4. Stacking Velocity Vertical functions spread
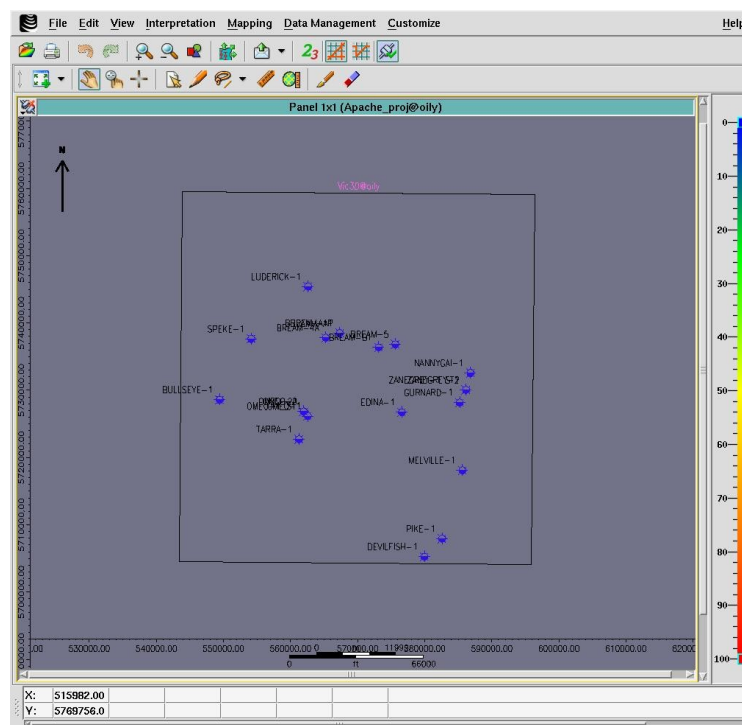
Figure 5. Well locations
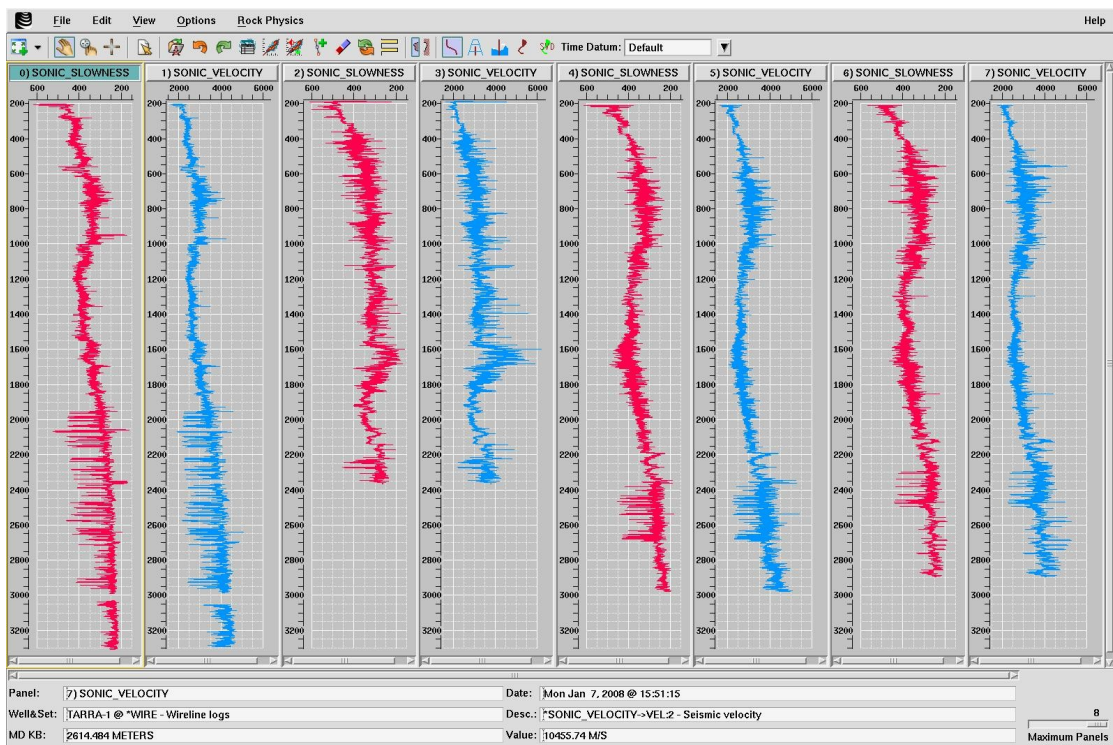
Figure 6. Well Sonics
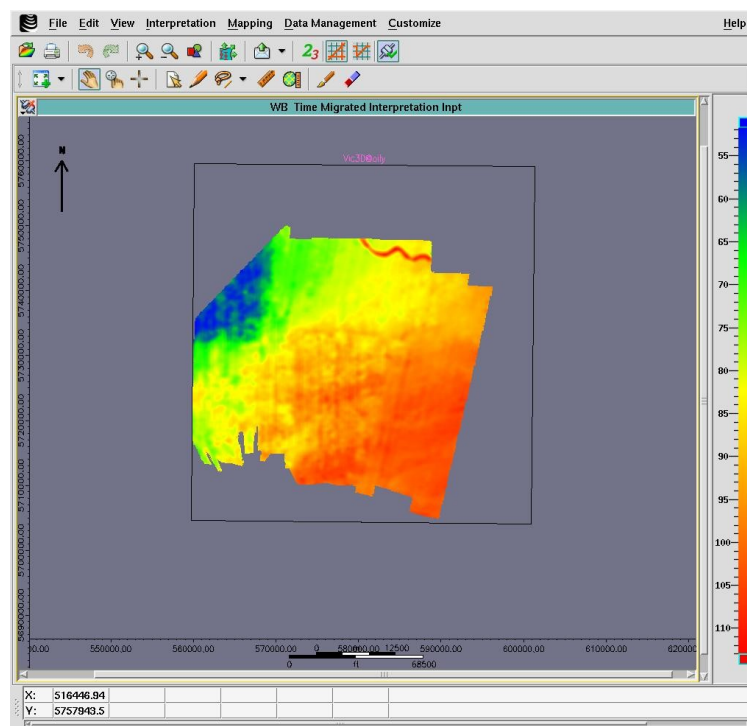
Figure 7. WB Map
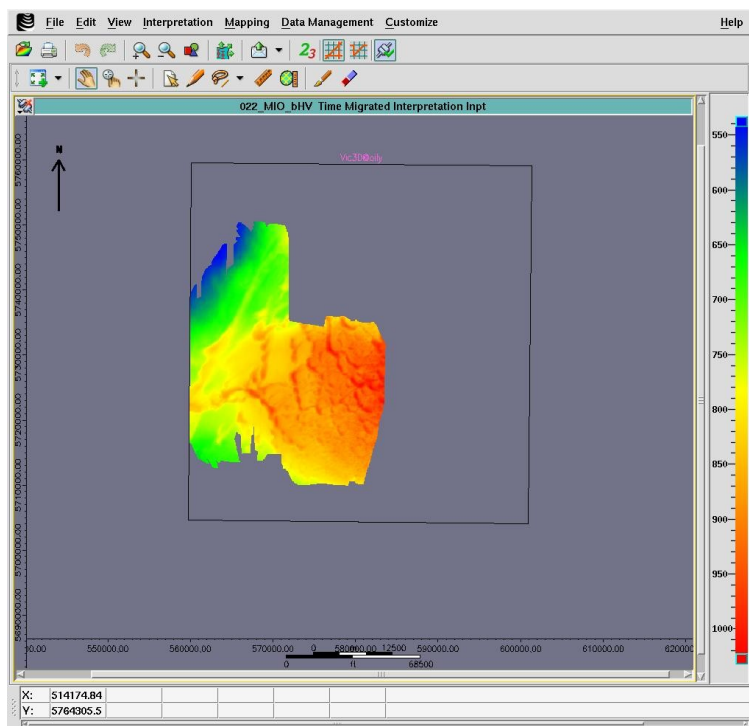
Figure 8. BHv Map
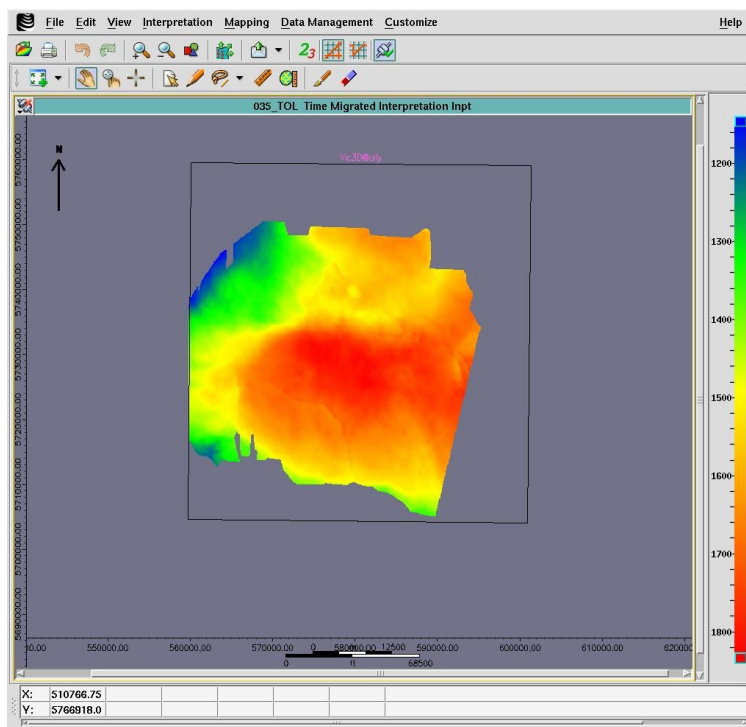
Figure 9. TOL Map

18.2 Phase 1. Initial velocity estimation (IT0)

Introduction

When observing the complex geology and studying the velocity profile below the WB horizon the conclusion is that there are velocity variations within the layer that must be preserved in the interval velocity field. Moreover, in some areas there is an interval velocity inversion within the layer that in traditional layer based velocity estimation cannot be captured.

To ensure accurate initial velocity estimation, it was decided to use extracted lines from the 3D volume in a 1km grid. The initial stage of the velocity analysis commenced with extracting 2D lines from the Marie3D volume. When the preprocessing was completed, additional 2D lines were extracted covering the full project area. See *Figure10.*

The Stacking velocity Vertical Functions (VF) were used for the initial velocity estimation; as input for the Constrained Velocity Inversion (CVI) and to analysis trends (Gradients) and velocity breaks (geophysical boundaries).

The client provided initial interpretation of the main two boundaries below the WB, the high velocity boundary (BHv) and the Top-Latrobe (TOL). Those horizons were used for horizon based velocity estimation.

The client provided 22 well logs that were used for velocity estimation, velocity validation and QC.

Initial velocity estimation – Workflow

The initial velocity estimation was applied to a grid of lines in a 1km interval. Overall the initial velocity estimation was done on 150 extracted lines.

Workflow

1. Stacking velocity vertical functions QC and correlation.
2. Gradient calculations.
3. Coherency Inversion.
4. Log (sonic) analysis.
5. Log based velocity estimation and correlation to structure.
6. Constrained Velocity Inversion (CVI) – Interval velocity estimation.
7. For CVI - Grid based velocity update – two iterations
8. Velocity analysis: QC and conclusions
9. Create initial Interval velocity volume (IT0)
10. T.O PSDM

---

    1.   <u>Stacking velocity vertical functions QC and correlation</u>

The stacking velocity vertical functions were loaded and correlated. Anomalous points in some VF were edited and few anomalous VF were deleted.

    2.   <u>Gradient calculations</u>

The correlated VF were used to calculate gradients for the intervals WB to BHv and BHv to TOL.

    3.   <u>Coherency Inversion</u>

The client provided two layers below the water bottom, BHv and TOL. The events were interpreted along clear velocity breaks and strong seismic reflections. The Gradients were computed using the Stacking velocity VF. *Figure11* shows the Gradient computation for each horizon. To compute the V(0) along each horizon, a ray-trace based velocity analysis (known as Coherency Inversion (CI)) was used. The CI semblances along the events are focused and show high correlation. However, the semblance along BHv shows small oscillations that were amplified when computing the interval velocity along TOL. *Figures 12 and 13* show the CI semblances along horizon BHv and TOL for few lines on the west side of the merged survey.

The CI model building and velocity analysis produced a good image with small residuals along the horizons and in between the horizons. However, the known limitation of the Gradient approach is that it is monotonous continuous velocity within a layer. In case of varying velocity within the layer the gradient approach cannot capture the detailed velocity variations. This project has many channels and faults in the shallow (down to about 1500 meters) that requires a different approach to capture the detailed velocity within each horizon.

4. Log (sonic) analysis
The Sonic logs were loaded, QC'd and edited for spikes. A secondary set of logs; interval velocity transformed from Sonic and smoothed to seismic resolution was saved. See *Figure14*

5. Log based velocity estimation and correlation to structure
Gradients and Vo for the intervals WB to BHv and BHv to TOL were computed for each well. The velocity information was extracted to the grid of lines and compared with the imaging velocity. See *Figure15*

6. CVI
Constrained Interval Velocity Inversion is using the Stacking vertical functions and other information such as trend (from well logs or maps for example), to derive a stable continuous interval velocity volume. This method captures the velocity variation within a layer and produces a log-like velocity profile. Unlike other interval velocity transformation solutions, the CVI derives a stable and consistent velocity volume using a three dimensional statistics balancing for each computed location and a common trend to stabilize the solution. CVI was computed to each line of the grid. The stacking velocity vertical functions were too fast in the shallow and the CVI solution produced significant residual moveout. As a result, two iterations of grid-based tomography were applied. The grid-based tomography corrected the velocity and provided accurate initial velocity volume.
Figures 16, 17 and 18 show some examples of the interval velocity, gathers and semblances after the initial CVI, first pass and second pass of grid-based tomography.
Please note: Though the velocity analysis was mostly done on 2.5D (CMP gather's x,y in actual 3D locations but using 2D ray tracing), the final product was created in a full 3D sense. The Interval velocity vertical functions were correlated, sliced and statistically conditioned to produce a 3D velocity volume as shown in *Figure23*.
In this report, when referring to the CVI solution, it includes the initial CVI velocity estimation and two passes of grid-based tomography.

7. For CVI - Grid based tomography velocity update – two iterations
See 6.

8. Velocity analysis: QC and conclusions
The conclusion of the initial velocity analysis was that the CVI volume has given the best solution. The CVI preserved the information of the complex structures between the WB and TOL. The initial T.O PSDM was

focused with minimal residuals and mapped the complex bedding and channels from the WB to TOL in details. Below TOL the initial velocity field was based on the input VF and the velocity analysis from the CVI. Without a reference horizon below TOL the CVI and CI were seen to show similar trends and validated each other.

The CVI velocity profile has low frequency velocity variation in a continuous trend. The initial analysis of the well data and the geological model that was provided by the client indicated areas with velocity inversion between the WB and TOL. Those areas were well captured by the CVI. See *Figure19.*

The ray-based velocity estimation along BHv and TOL provided an interval velocity model that when converted to average velocity had very small discrepancies to the CVI. The horizon based velocity estimation could not capture the inversions within the layer and derived a lower quality image. When comparing the CVI velocity profile at the well locations to the well data, the CVI showed excellent correlation to wells. See *Figures 20-23*

Those QCs have validated the velocity between the WB and TOL. Below TOL a smoothed velocity profile was used per the result of the CVI and the gradient extracted from the stacking velocity VF correlated to wells.

9-10. Create PSDM volume (IT0) and T.O PSDM

The IT0 interval velocity volume was created and QC'd. This volume was used to run the first T.O PSDM – IT0. This iteration (as well as the velocity update iterations) were at a 500 meters Inline spacing (every 20th Inline) and 12.5 Xline spacing (every Xline). *Figures 24-25* show some examples of IT0 Gathers, semblance and velocity.

 The T.O PSDM gathers were flat down to TOL, the residuals were very small and the image was focused and crisp. Below TOL to the South the gathers were flat with small residuals at the far offsets while in the North significant residuals were noticed. The large residuals to the North were the product of the inaccurate input stacking velocity and the lack of horizon control below TOL.

Figures
Figure10: Extracted 2D lines in 1km grid
Figure11: Gradient calculation from VF
Figure12: CI semblance BHv
Figure13: CI semblance TOL
Figure14: Well velocity at seismic resolution
Figure15: Well gradient calculation
Figure16: CVI Vs.CVI+Tomo1 Vs. CVI+Tomo2 Gather, semblance, section and velocity
Figure17: CVI Vs.CVI+Tomo1 Vs. CVI+Tomo2 Gather, semblance, section and velocity
Figure18: CVI Vs.CVI+Tomo1 Vs. CVI+Tomo2 Gather, semblance, section and velocity
Figure19: CVI Volume cross-section
Figure20: CVI profile at a well location
Figure21: CVI profile at a well location
Figure22: CVI profile at a well location
Figure23: CVI profile at a well location
Figure24: CVI Gather, semblance and section IT0
Figure25: CVI Gather, semblance and section IT0
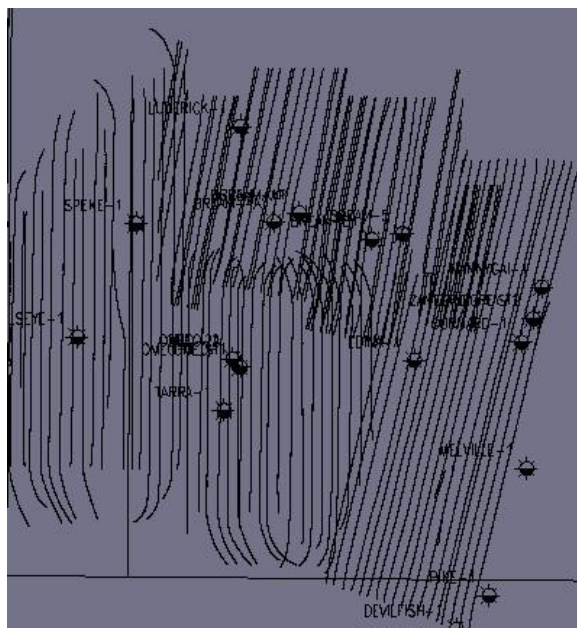
Figure 10. Extracted 2D lines
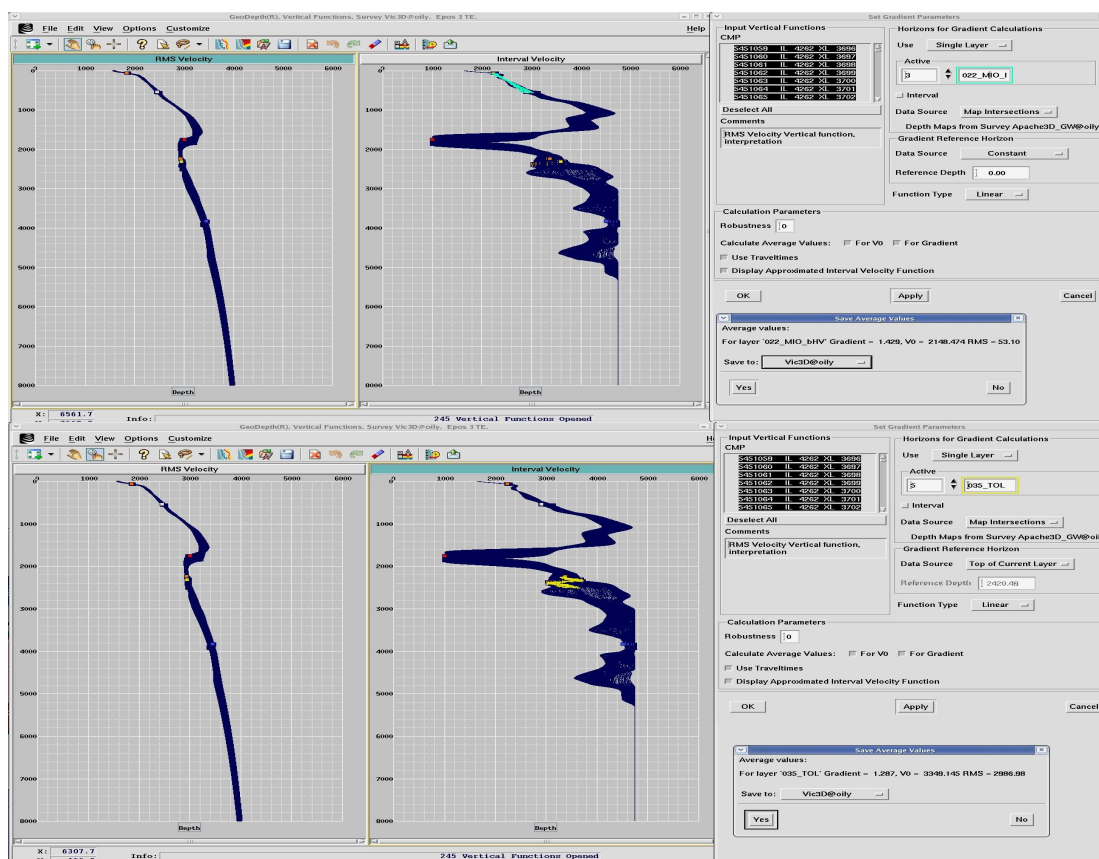
Figure 11. Gradient calculation from VF
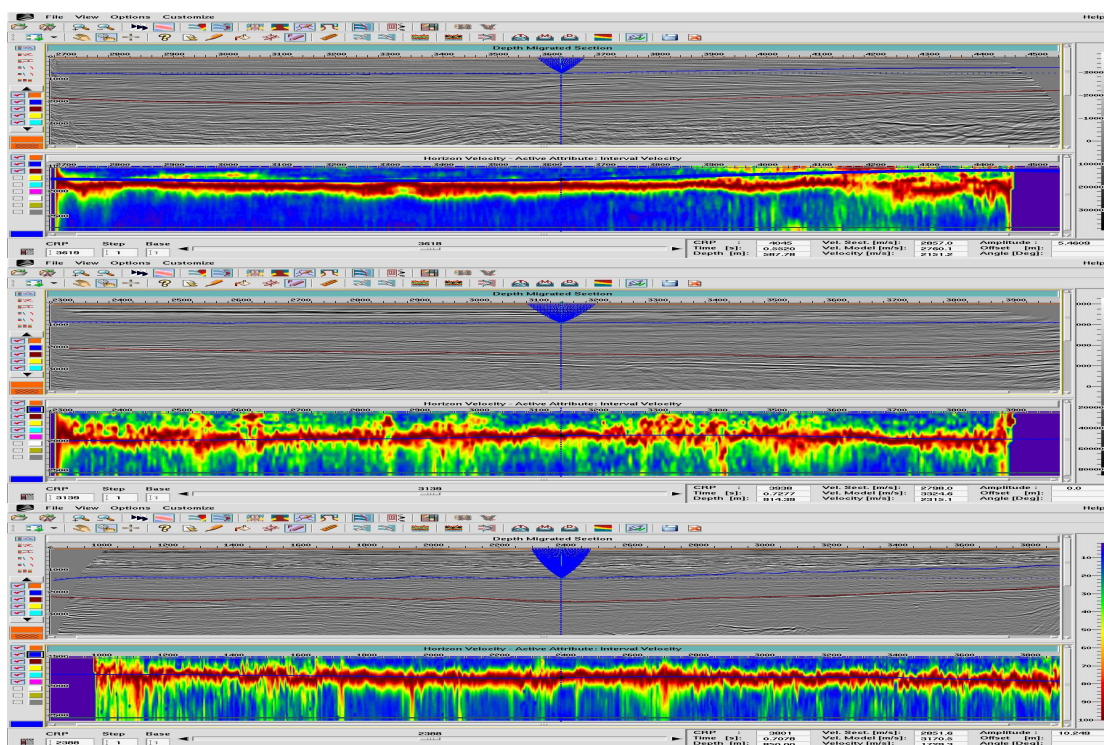
Figure 12. CI horizon BHv
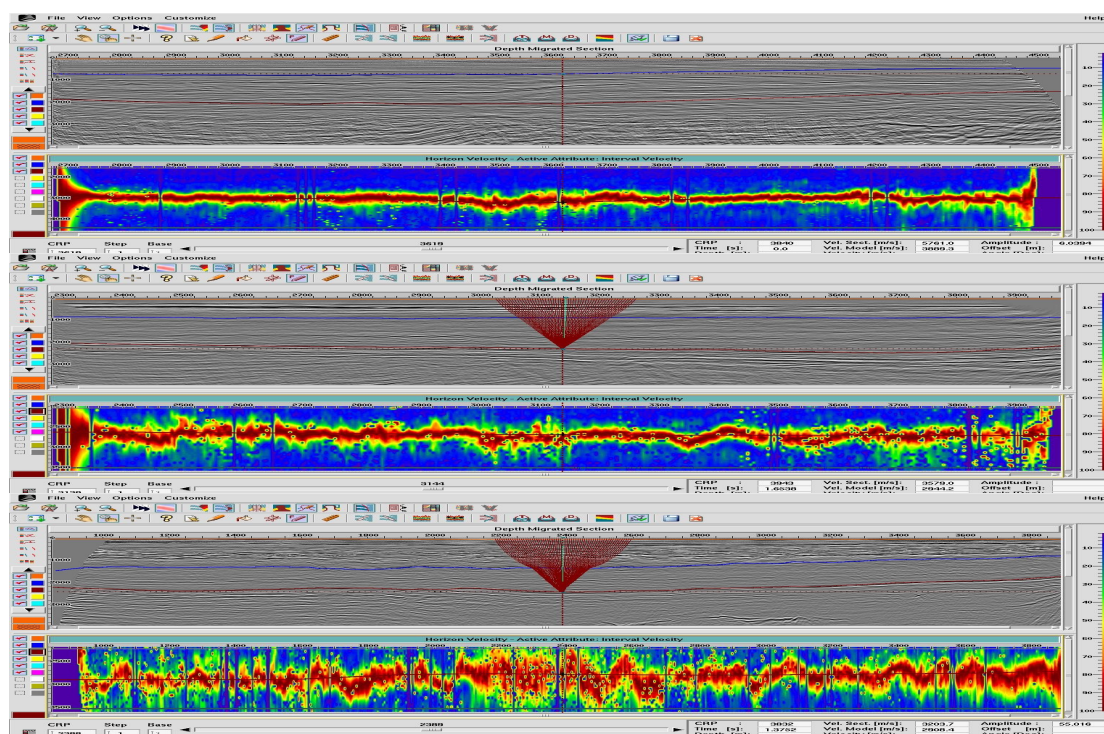
Figure 13. CI horizon TOL
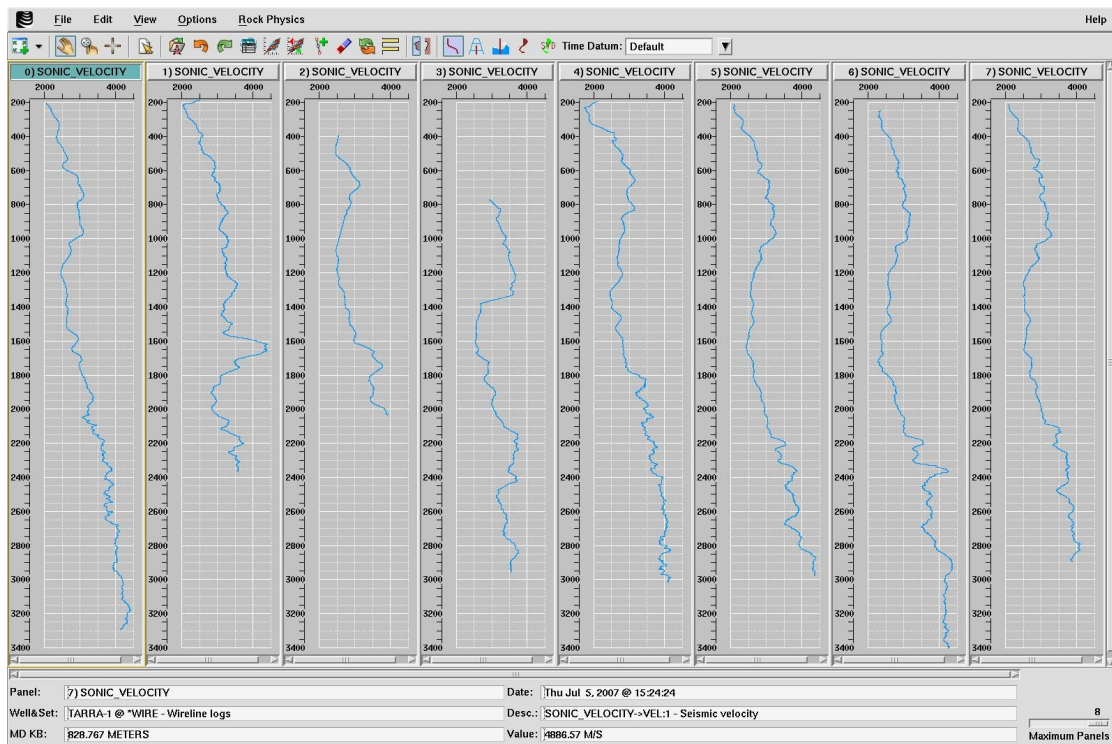
Figure 14. Well sonics in seismic resolution
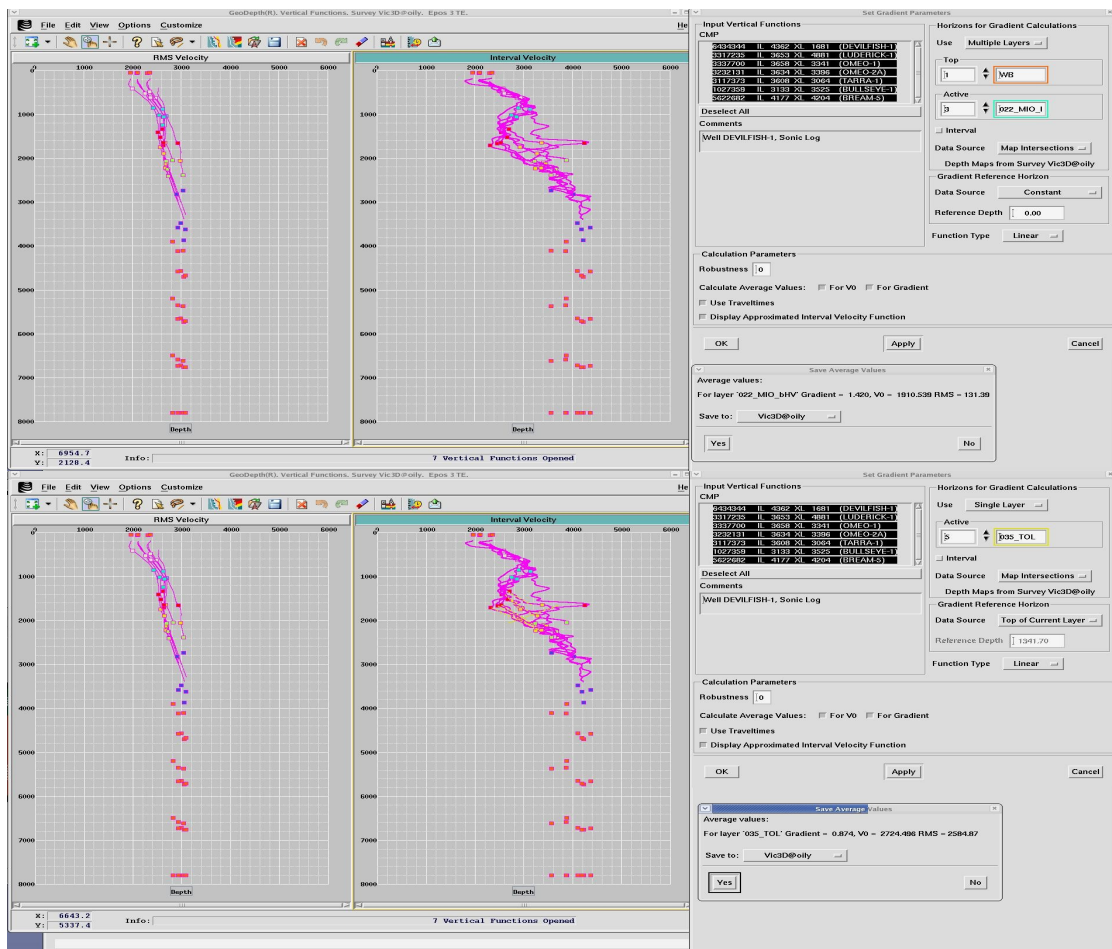
Figure 15. Gradient calculation from wells
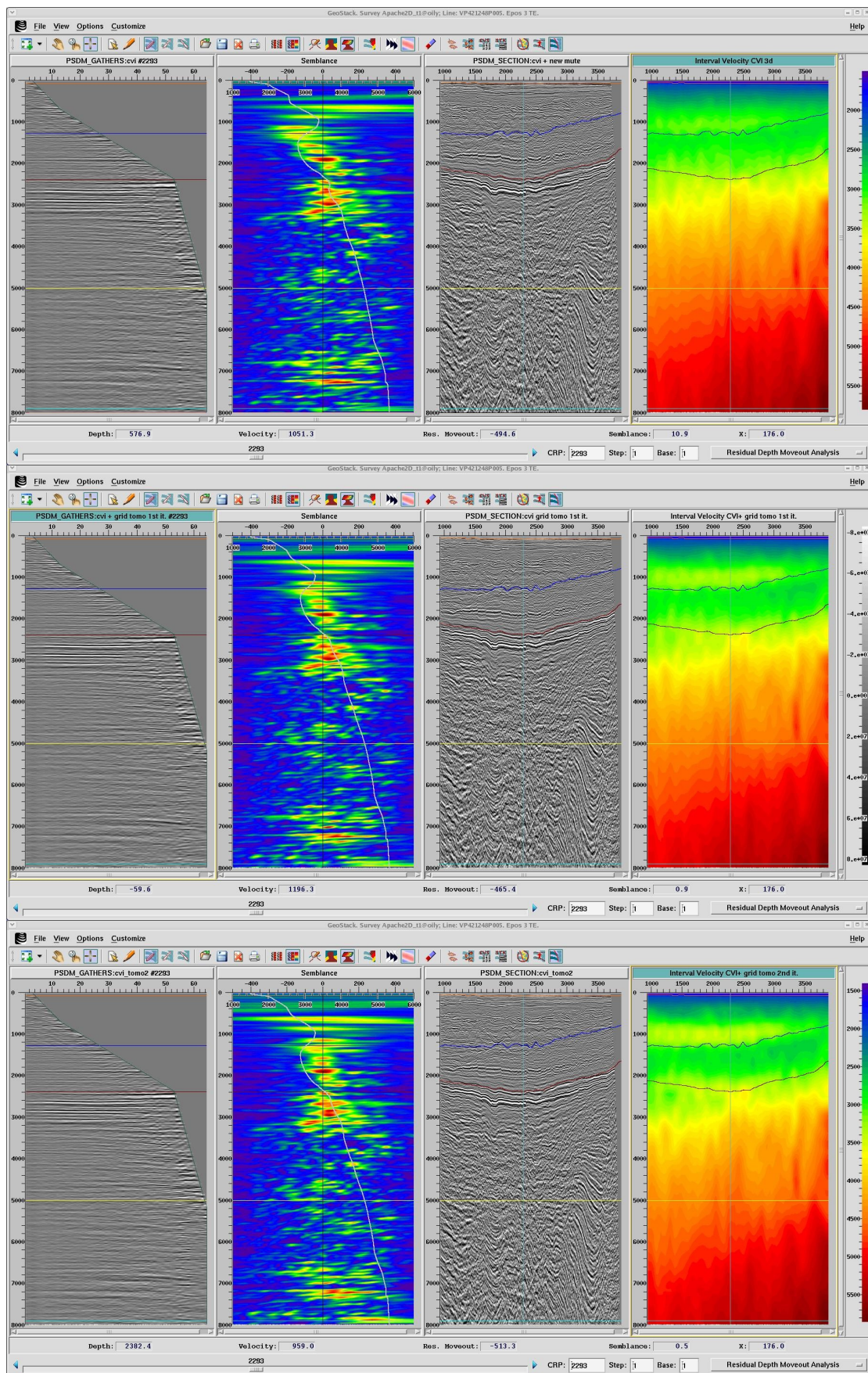
Figures 16 through 18. CVI Vs.CVI+Tomo1 Vs. CVI+Tomo2 Gather,
semblance, section and velocity
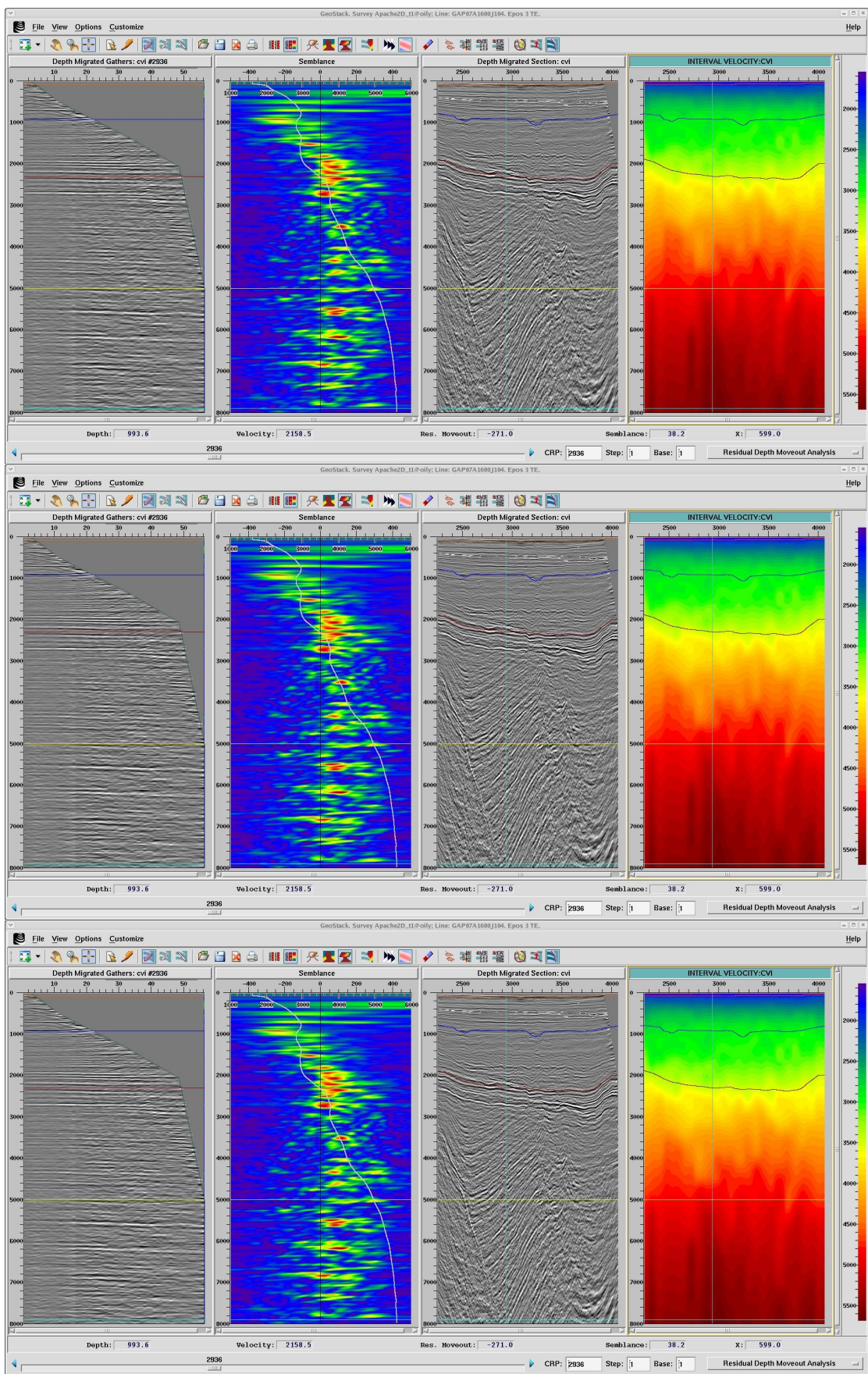
Figure 19. CVI Vs.CVI+Tomo1 Vs. CVI+Tomo2 Gather, semblance, section and velocity
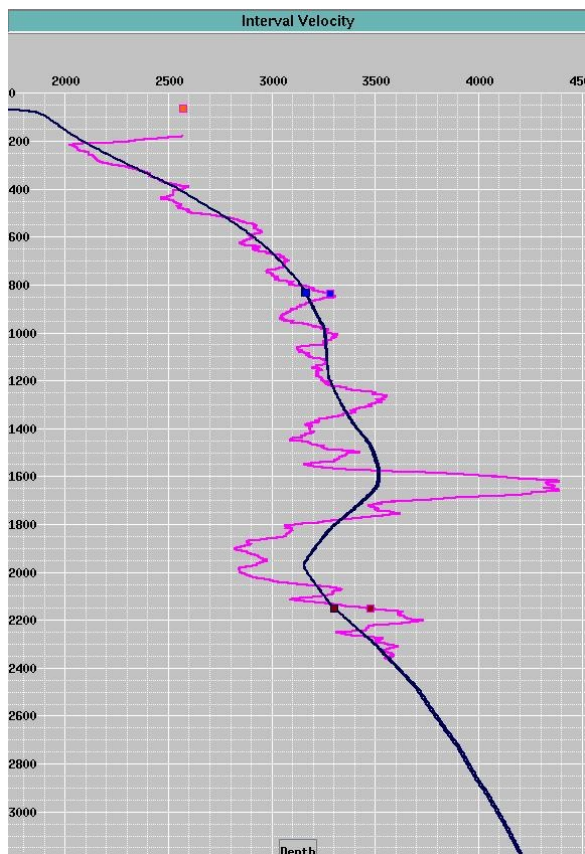
Figure 20. CVI velocity at well Bullseye-1 location
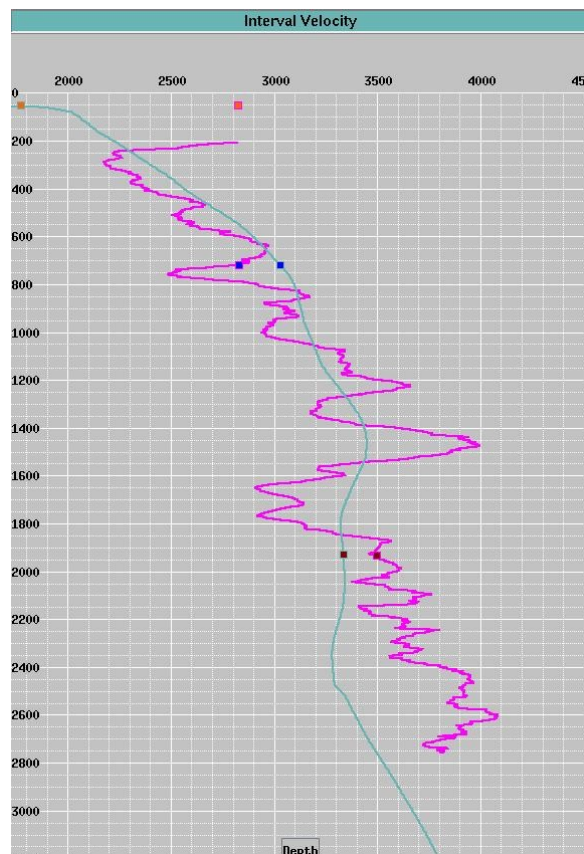
Figure 21. CVI velocity at well Speke-1 location
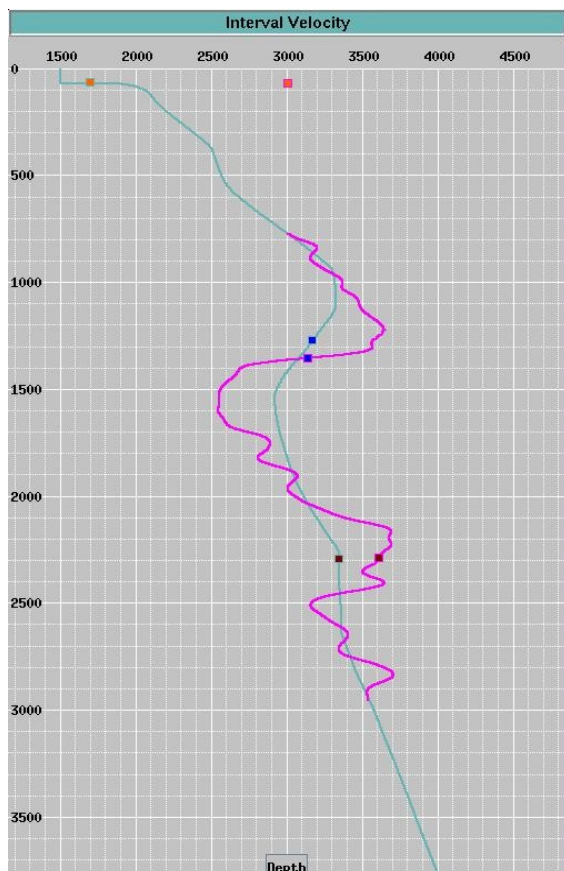
Figure 22. CVI velocity at well Guarnard-1 location
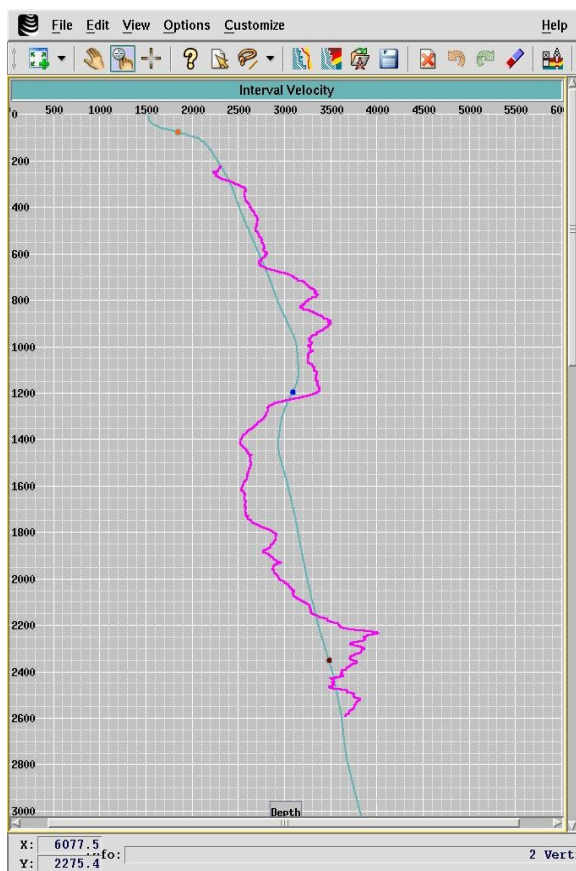
Figure 23. CVI velocity at well Edina-1 location
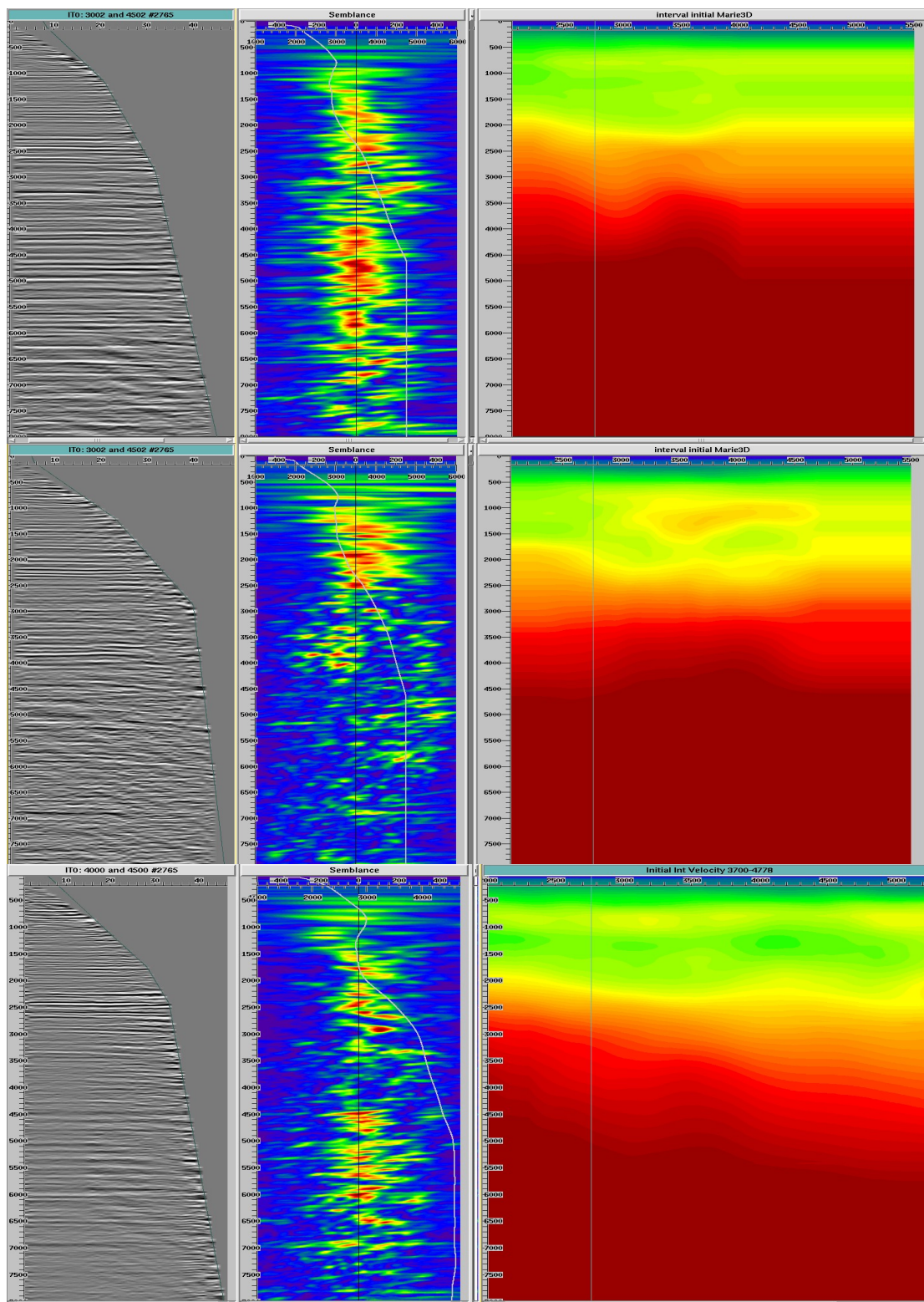
Figure 24. CVI Gather, Semblance and Section IT0
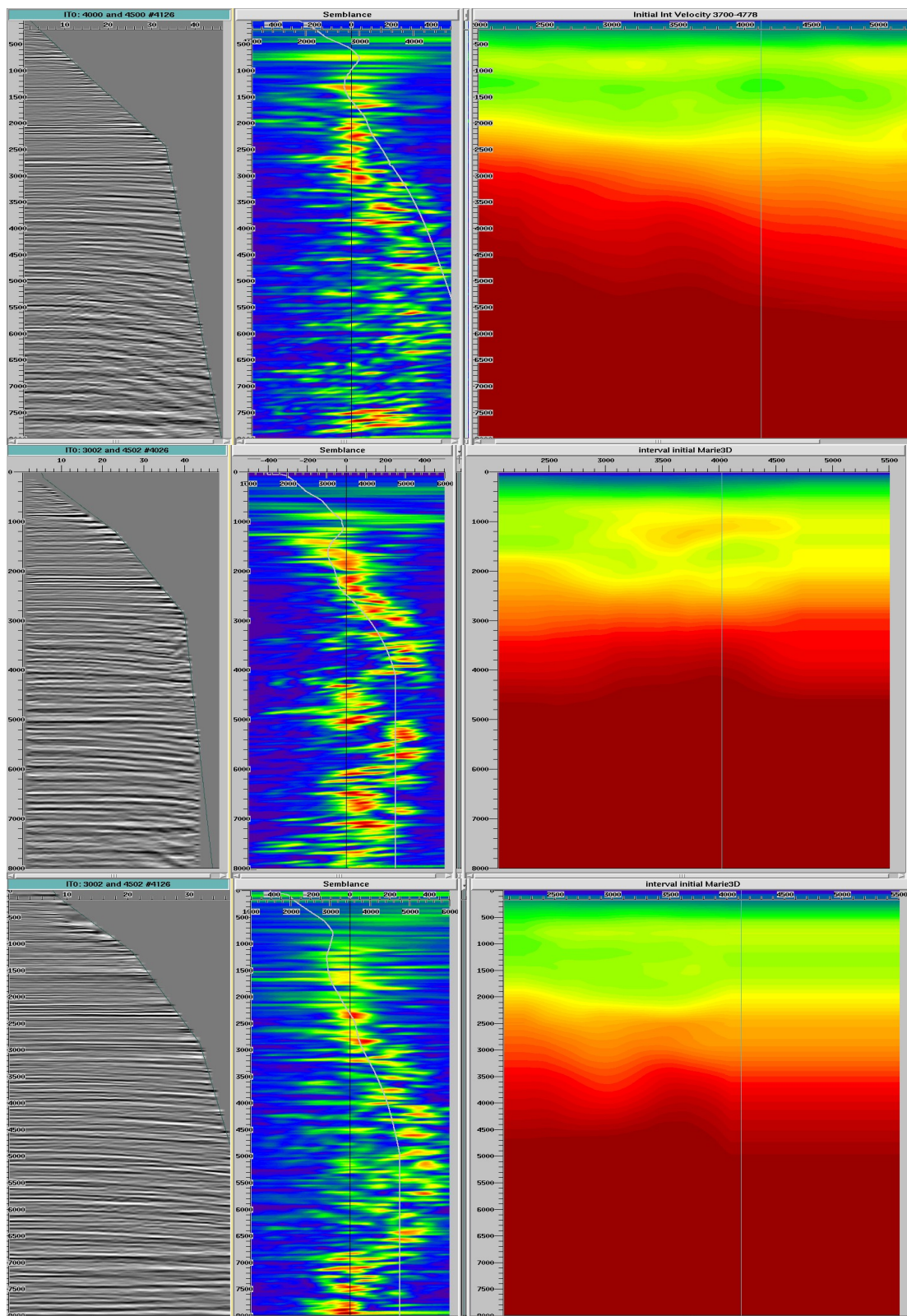
Figure 25. CVI Gather, Semblance and Section IT0

18.3 Phase 2 – velocity update (IT1-IT7)

The T.O PSDM (IT0) showed a very clear image at the shallow part of the data with minimal residual moveout, while the gathers below TOL to the North East showed high residuals with a clear indication of a slow velocity zone. The velocity in that part of the survey was more than 25% slower than in the South. The material in the South is older and high-resolution bedding and faults were sharply imaged. The Northern part contains younger material with different structures and lower data to noise ratio. Some coherent events could be noticed, but the overall residuals were large at this area and the image was not well focused.

The velocity update process is a global solution and limited to a 10-15% velocity changes per iteration. The inputs for the velocity update are the CRP gathers, residual volume and horizons. The residual volume provides the residual error to a referenced offset while each horizon provides a reference location to compute the errors along the ray path. Since only two horizons were provided, phantom horizons parallel to the given horizons were used to compute the ray path errors. The limitation of this method, as was well indicated in advance, is that if the horizons are not following the real earth model the velocity solution will not converge to the geological model. As a result the first two iterations (IT1 and IT2), did not show much improvement in the North West part of the survey, while the velocity in the rest of the survey has converged and the residuals were close to none. The third iteration provided the first model that was within the tomography solution boundary and showed significant improvement in the image. The residuals after that iteration were small enough to apply a global solution without superimposing limitations on the velocity update to stabilize the solution in one hand and direct the solution towards the geological solution in the other. Though three iterations were assumed to be adequate for convergence in the workflow, it was a requirement by the client to continue and apply further iterations to decrease the delays and flatten the CRP gathers. For iterations 4-6 the client provided additional horizons below TOL that were accurately following the earth model. As a result, iterations four and five converged nicely and the final iteration (IT6) has given the best results with minimal residuals throughout the survey. *Figures 26-46* show few examples of IT1 to IT6 along several inlines and crosslines. Note the significant changes in the velocity profile beyond CMP 3800 when comparing IT0 velocity and IT6, see *Figure 47 and 48*.

To summarize: The input stacking velocity VF didn't capture the velocity changes between the Southern and the Northern parts of the area as can be seen in IT0 velocity volume. IT3 shows the beginning of the trend and IT6 completes the velocity solution by decreasing the velocity in that area by an average of 27%. The velocity volumes were QC'd to ensure the velocity trend is correct and not a product of multiples that might have not been attenuated in the preprocessing stage. The geological model from the client (as provided for iteration 4-6) and the geophysical result (flat CRP gathers throughout the volume) validated the final global update velocity solution.

Apache QC'd the velocity volume further and requested changes in the model where the velocity model was not entirely following the geological model. IT7 was not a global update but a local velocity manipulation that, when completed, finalized the production velocity volume.

The main changes the client requested in the velocity volume were:
- The high velocity in the shallow had few "bleeding" locations to the slow velocity zones below. The client requested the removal of the "bleedings."
- The extrapolation of the velocity beyond the survey boundaries introduced high velocity trends towards the edges. The client requested a continuous velocity extrapolation towards the edges.
- Below TOL a high velocity stripe in the Northern part of the volume was apparent. The client

requested the removal of the fast velocity stripe.

Figures

Figure26. Gather, semblance and section IT1
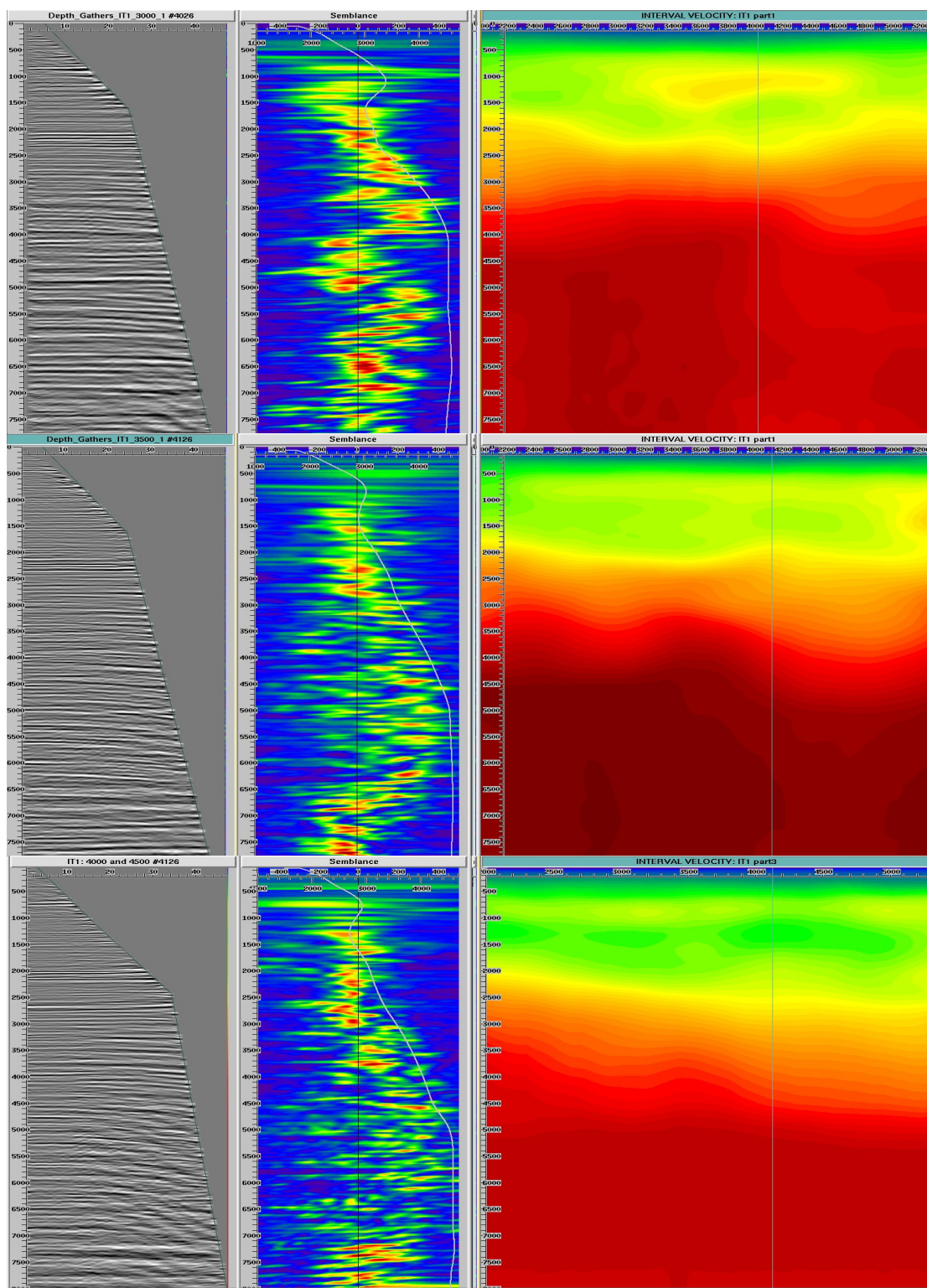
Figure27. Gather, semblance and section IT1
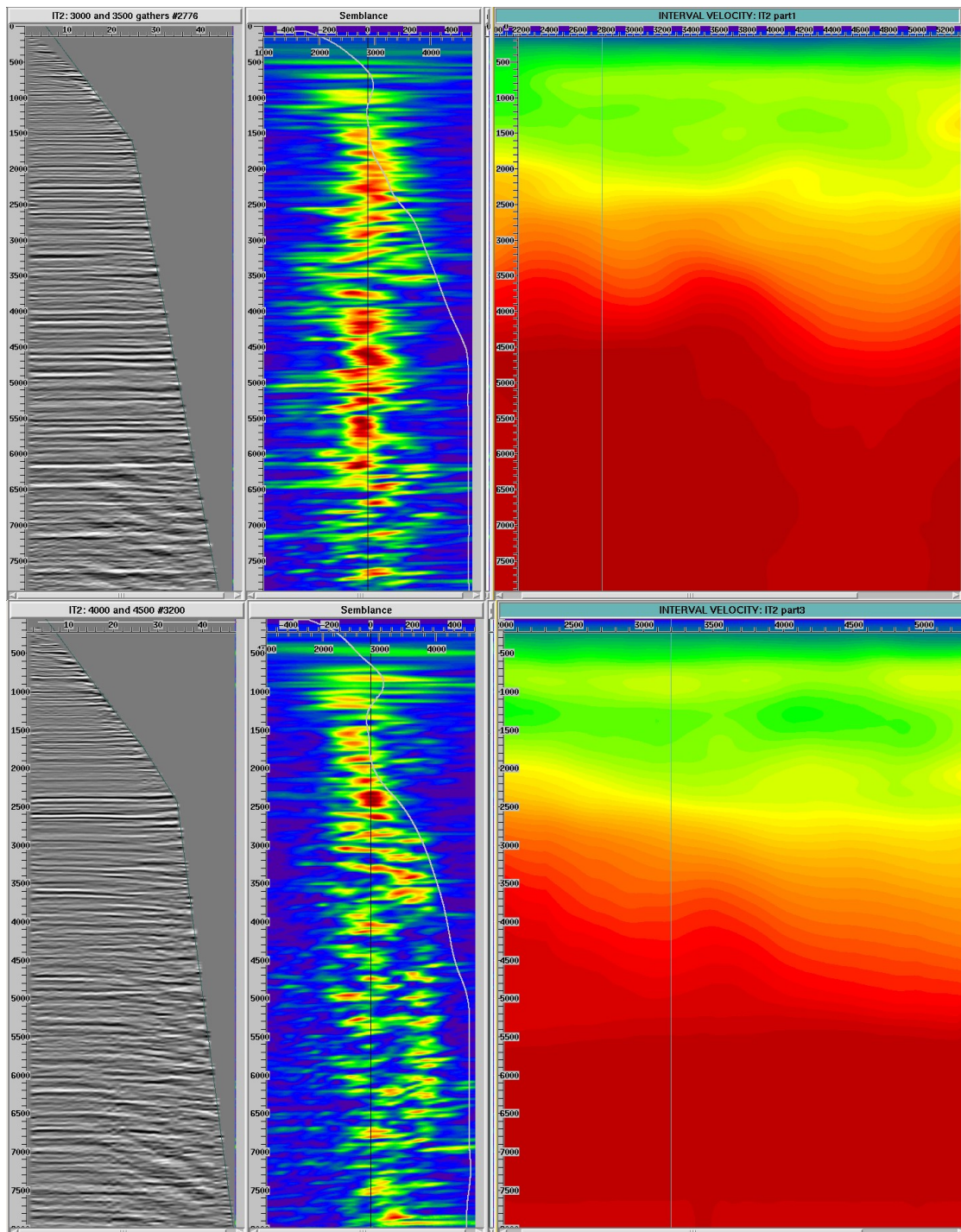
Figure 28. Gather, semblance and section IT2
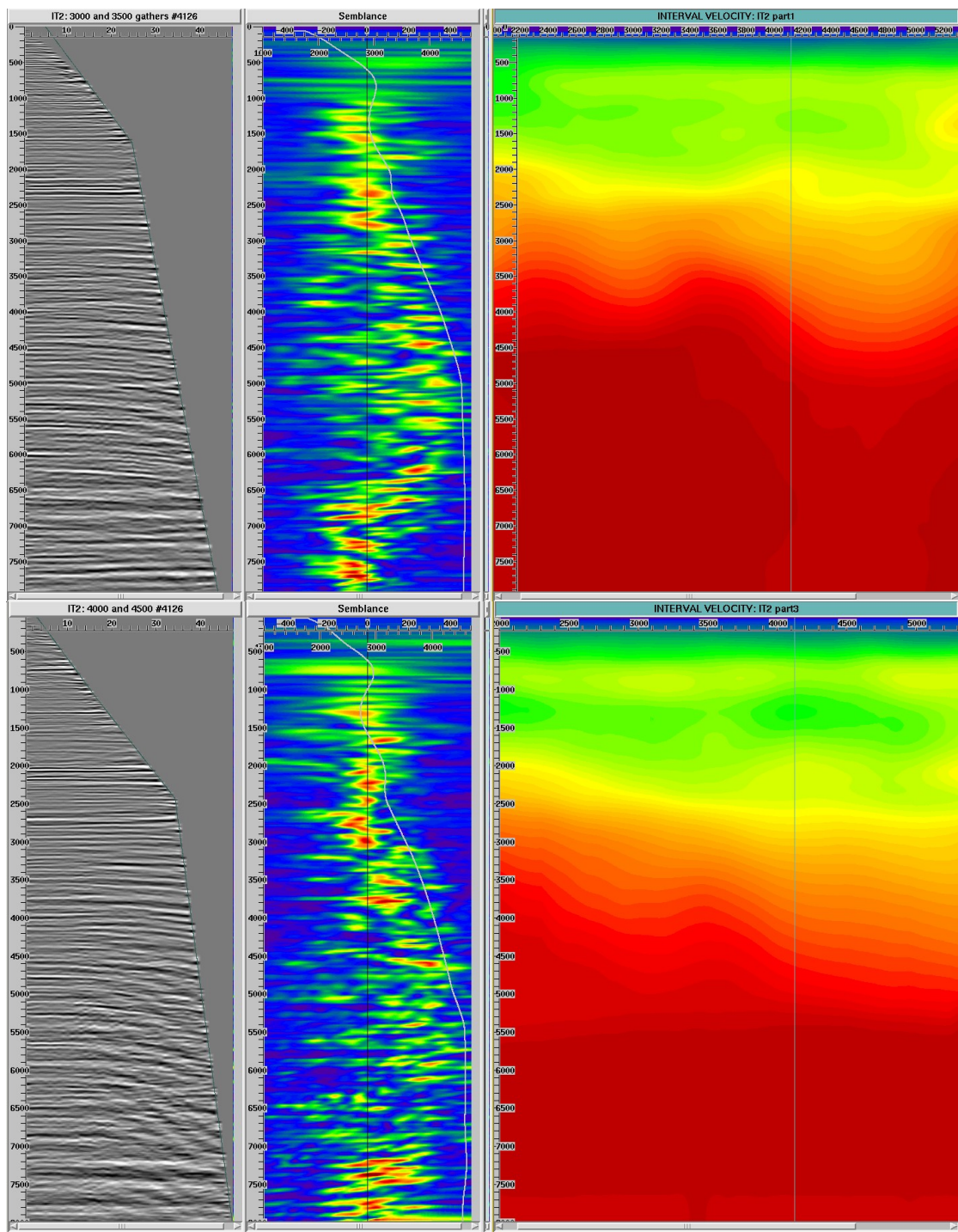
Figure 29. Gather, semblance and section IT2
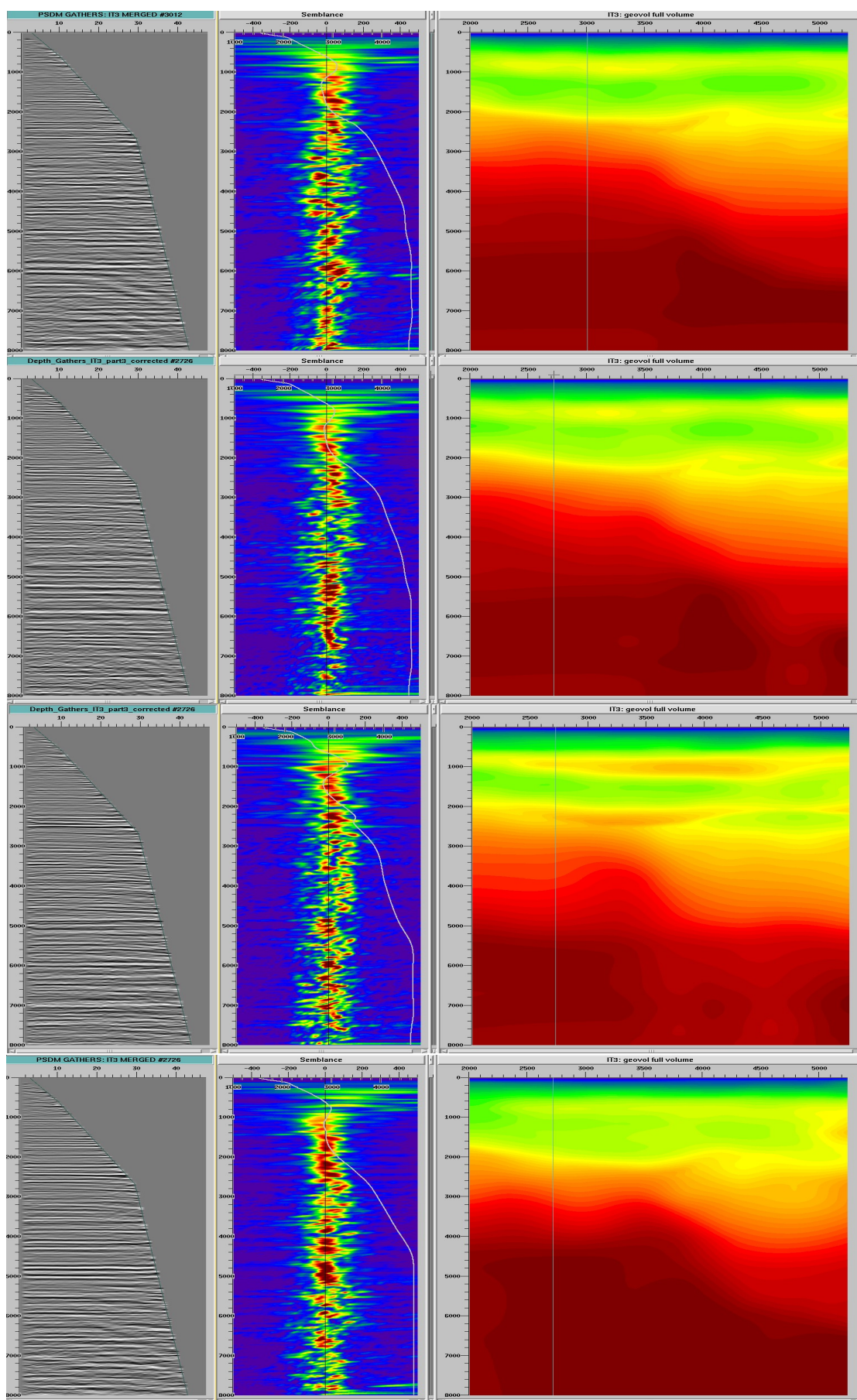
Figure 30. Gather, semblance and section IT3
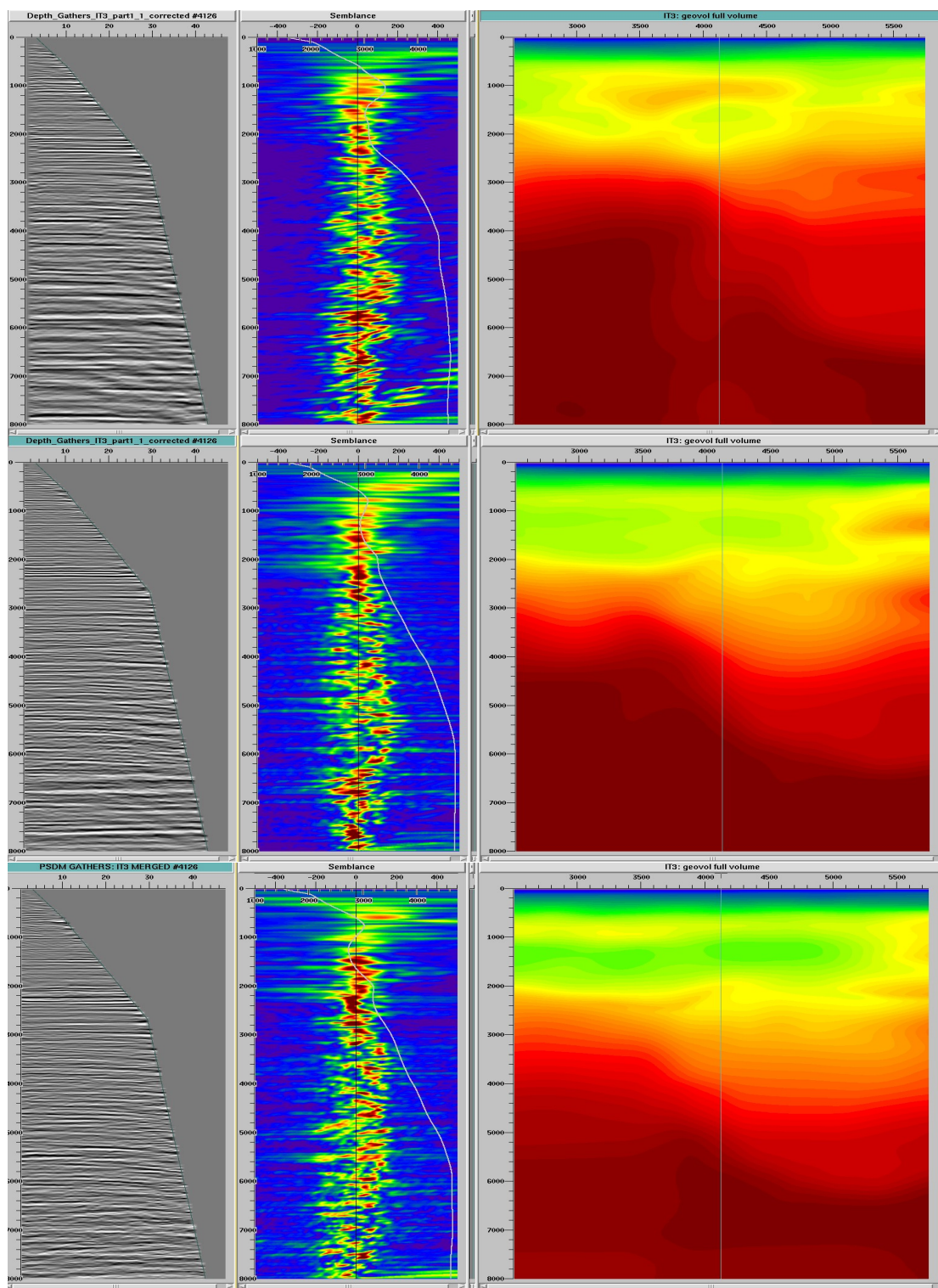
Figure 31. Gather, semblance and section IT3
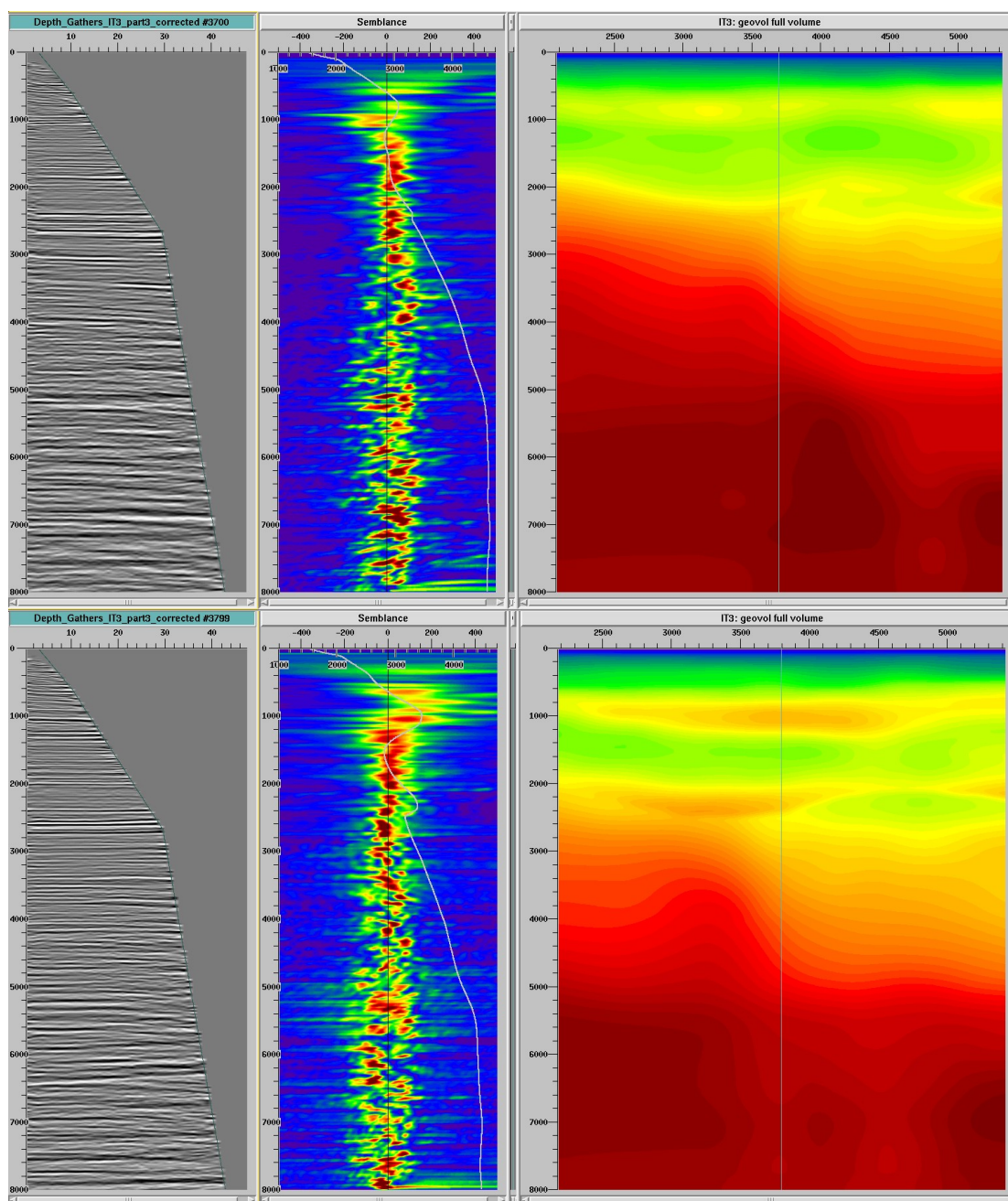
Figure 32. Gather, semblance and section IT3
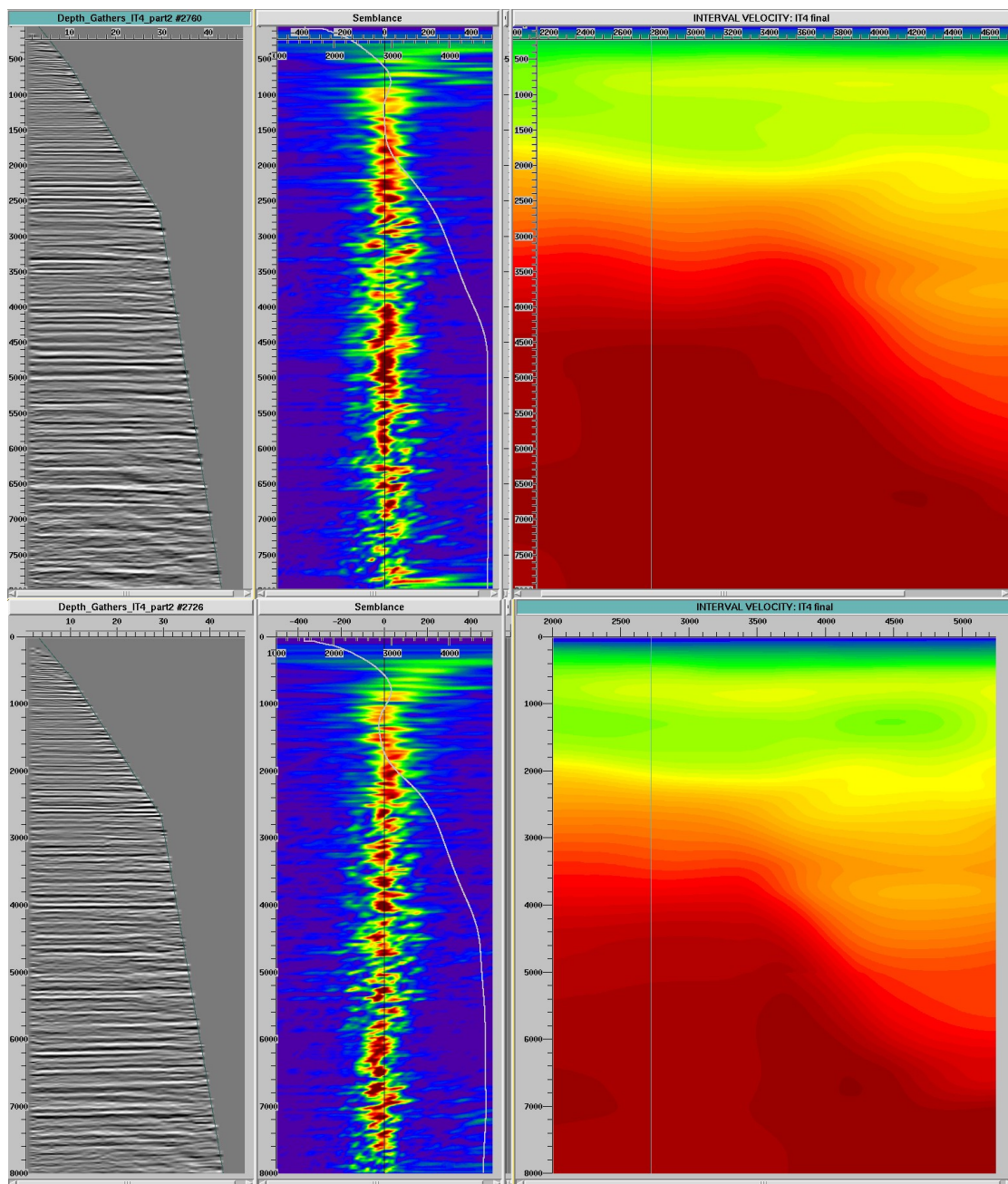
Figure 33. Gather, semblance and section IT4
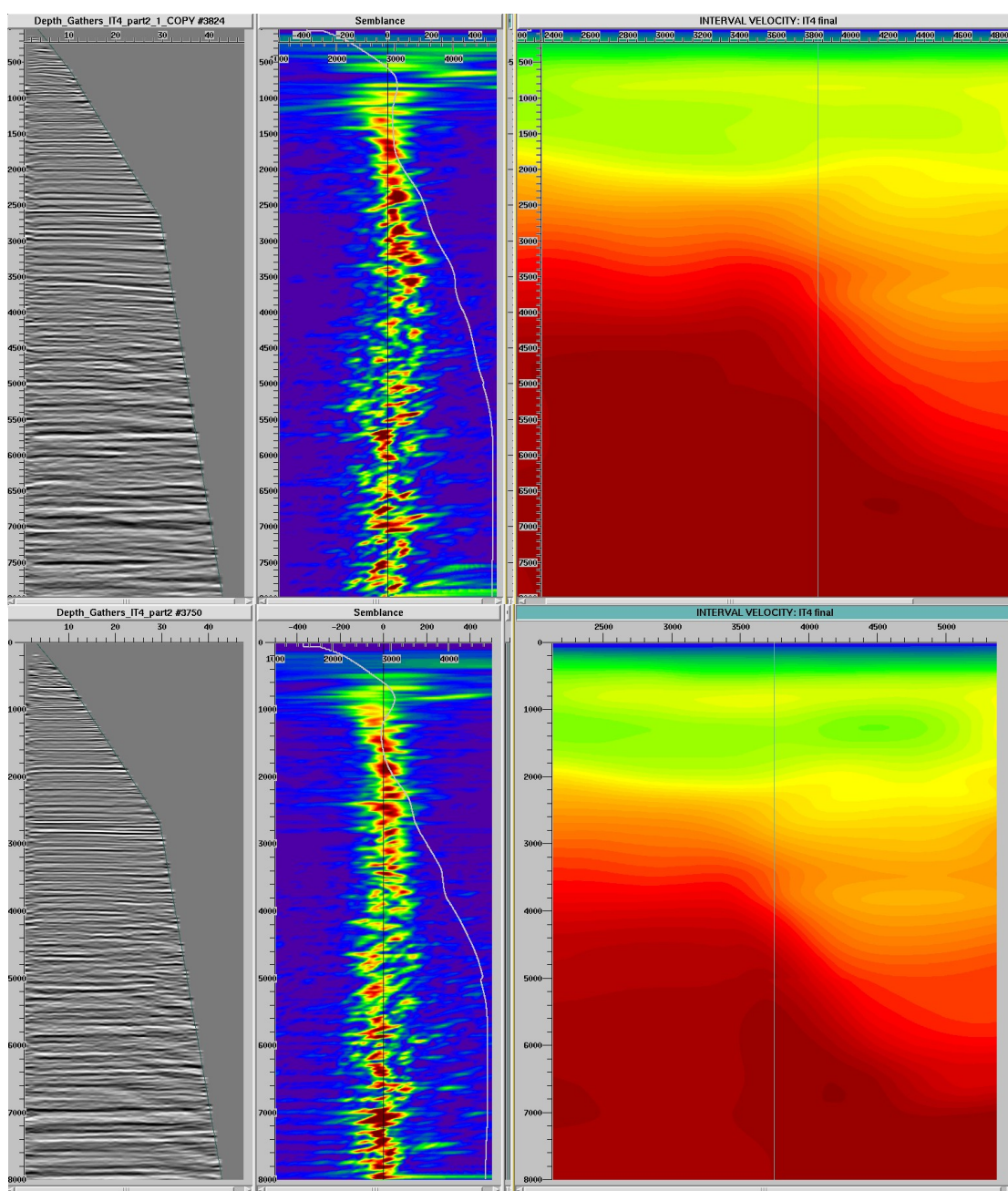
Figure 34. Gather, semblance and section IT4
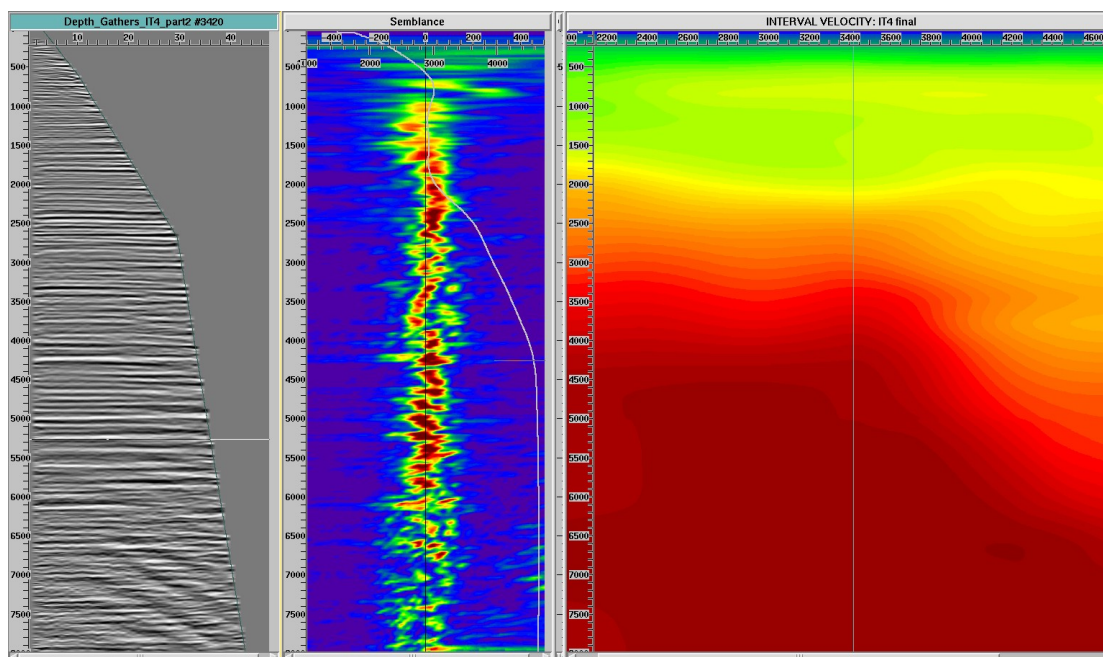
Figure 35. Gather, semblance and section IT4
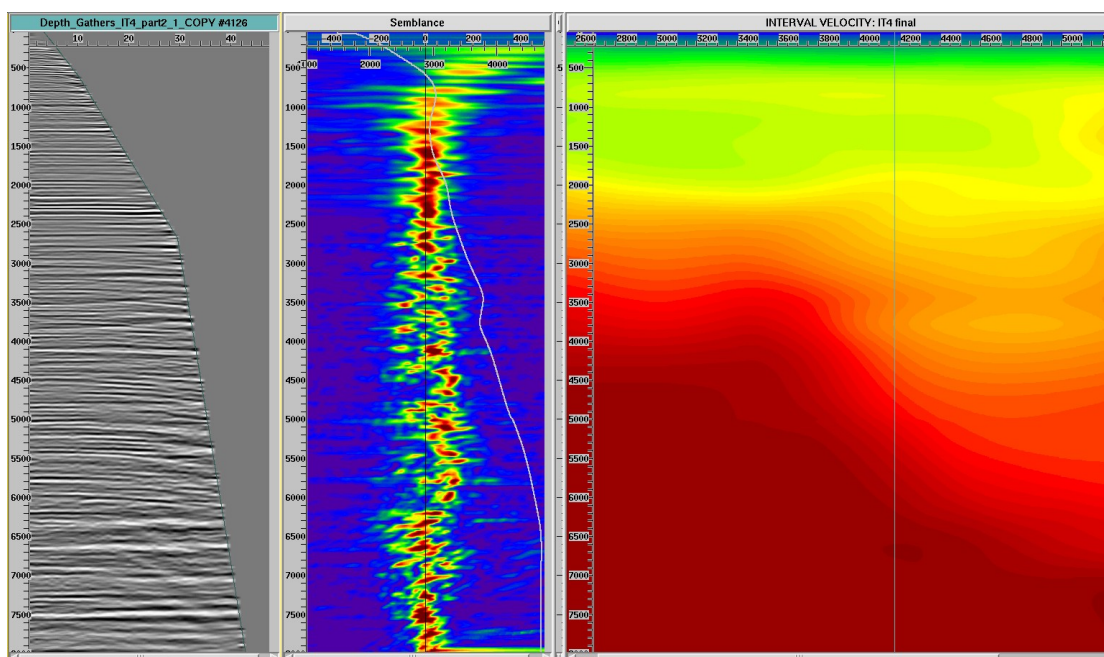
Figure 36. Gather, semblance and section IT4
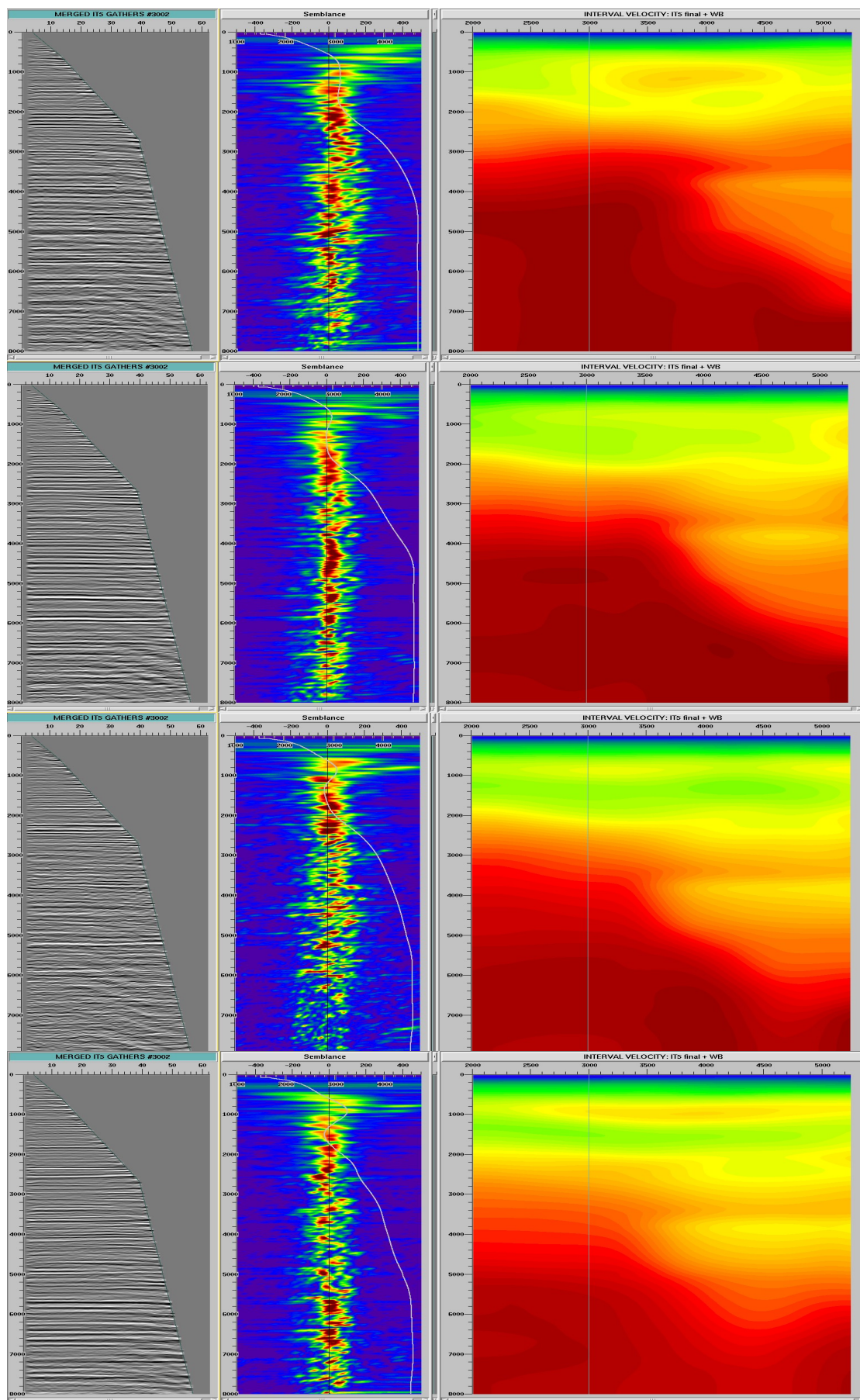
Figure 37. Gather, semblance and section IT5
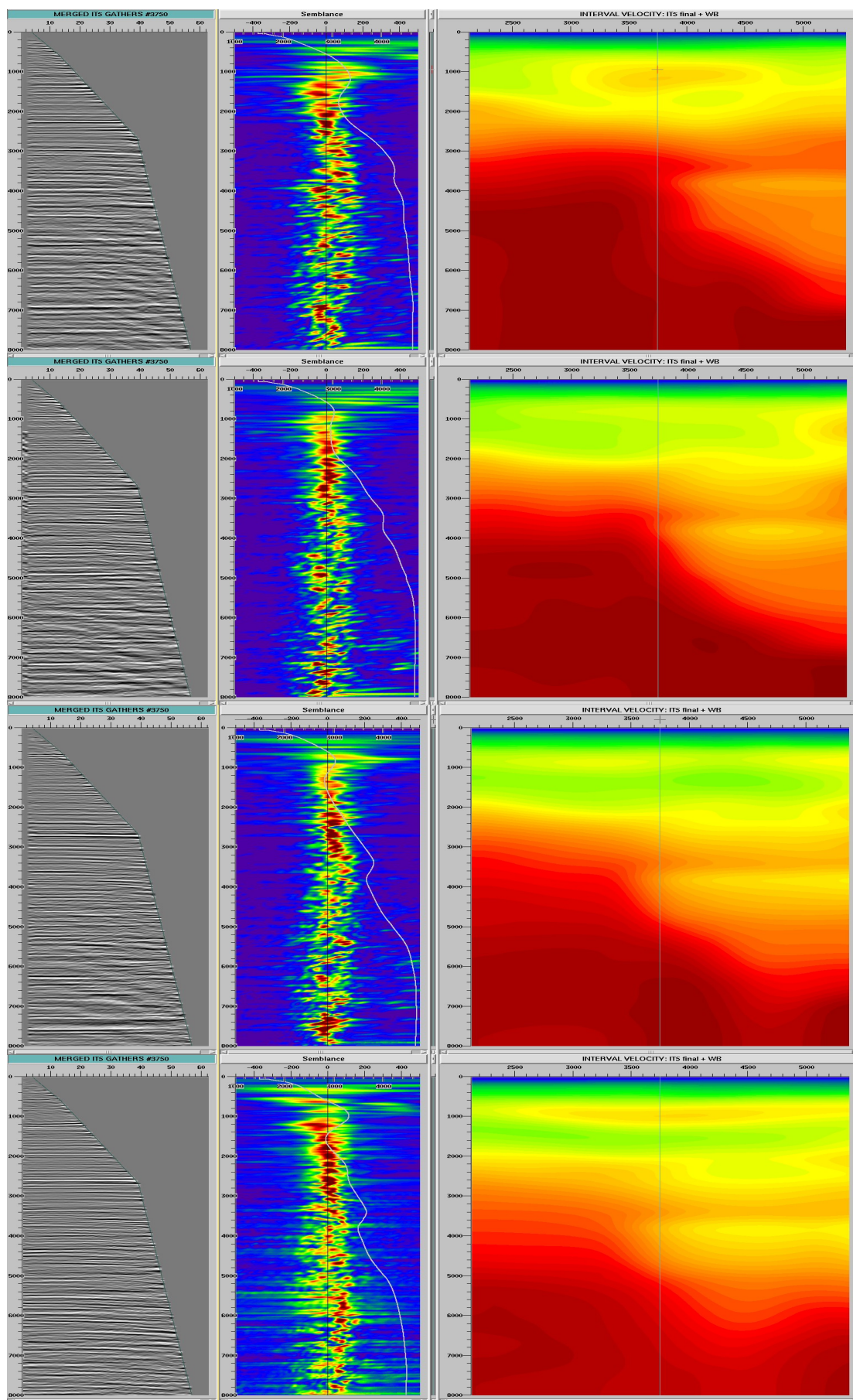
Figure 38. Gather, semblance and section IT5
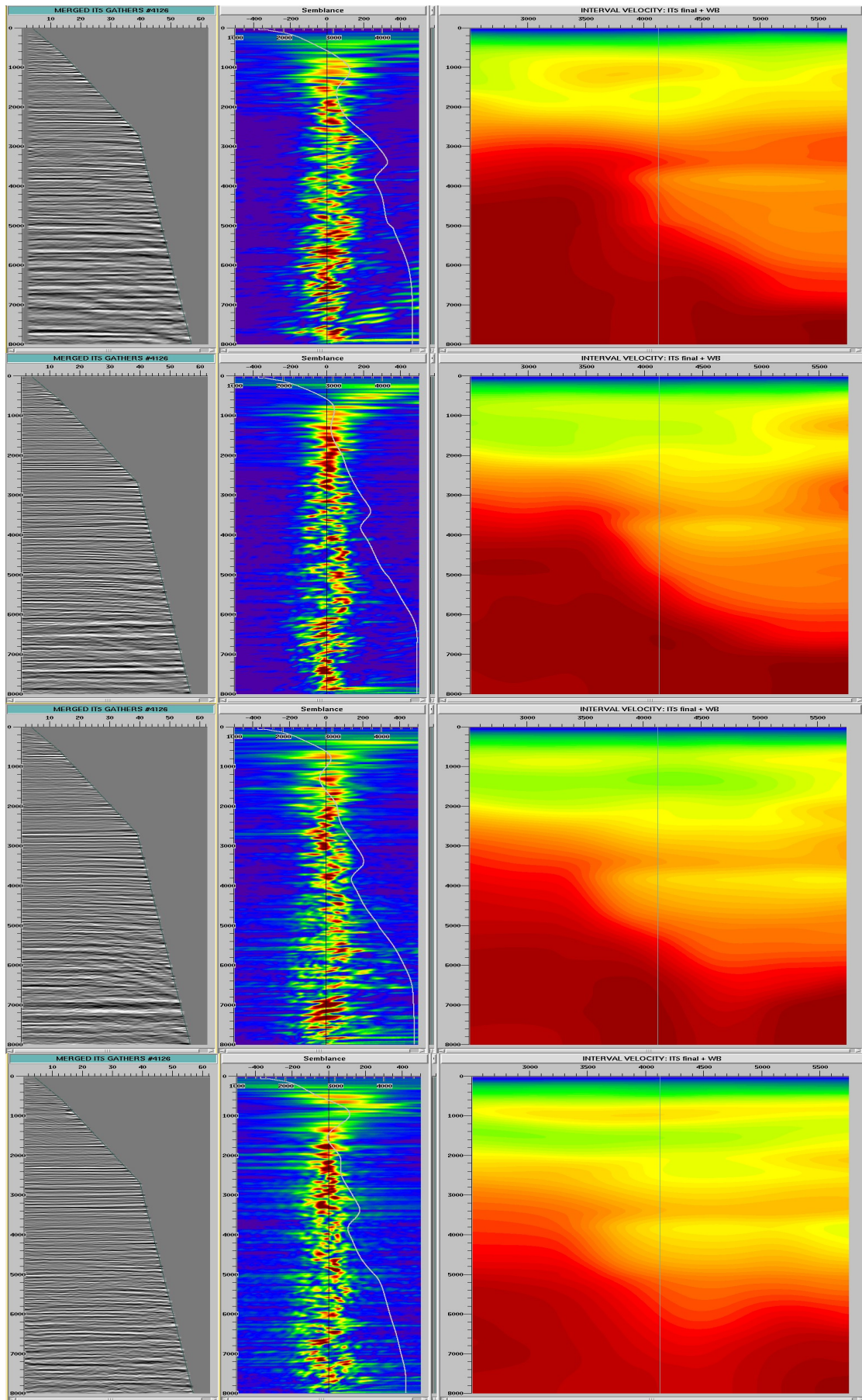
Figure 39. Gather, semblance and section IT5
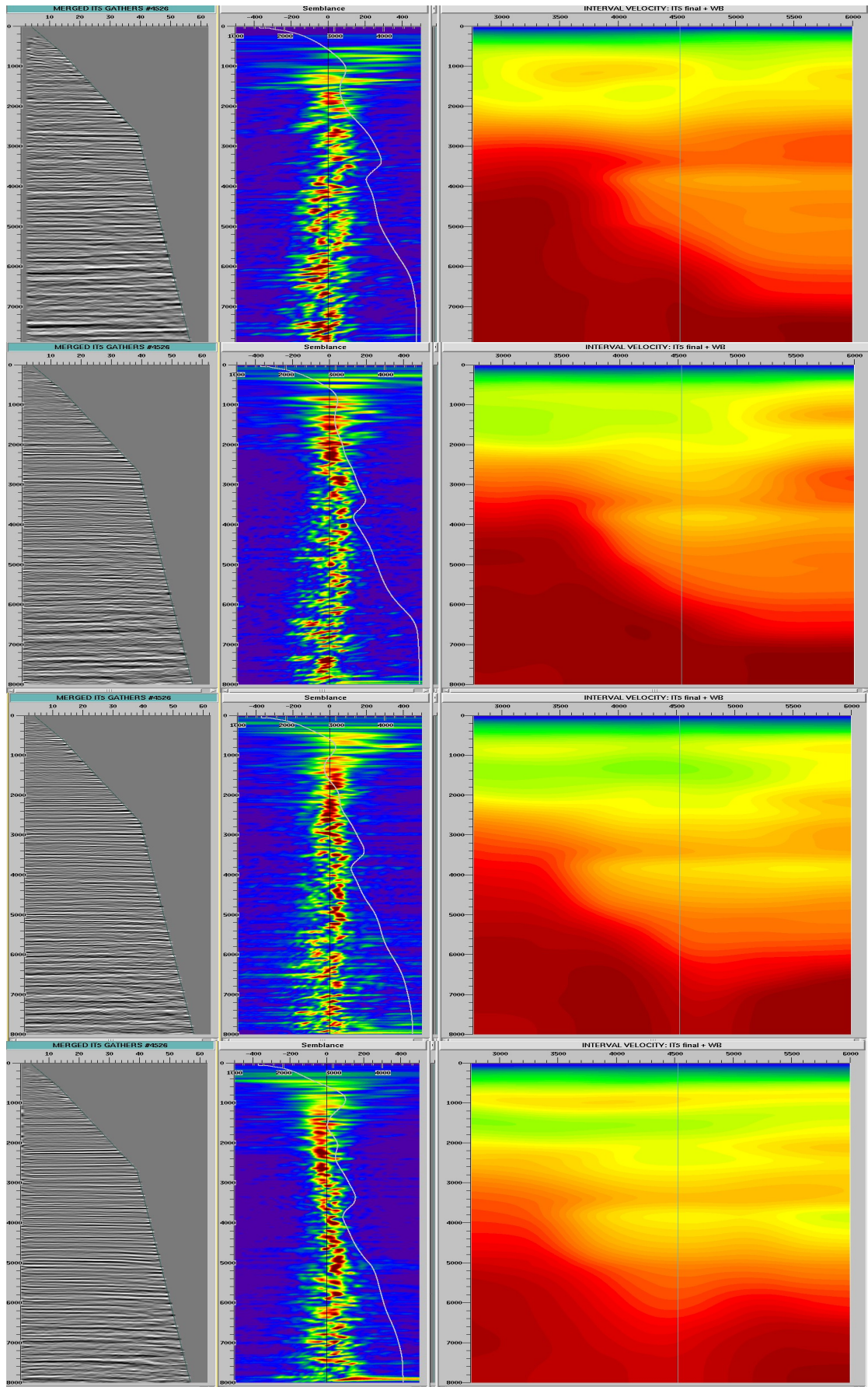
Figure 40. Gather, semblance and section IT5
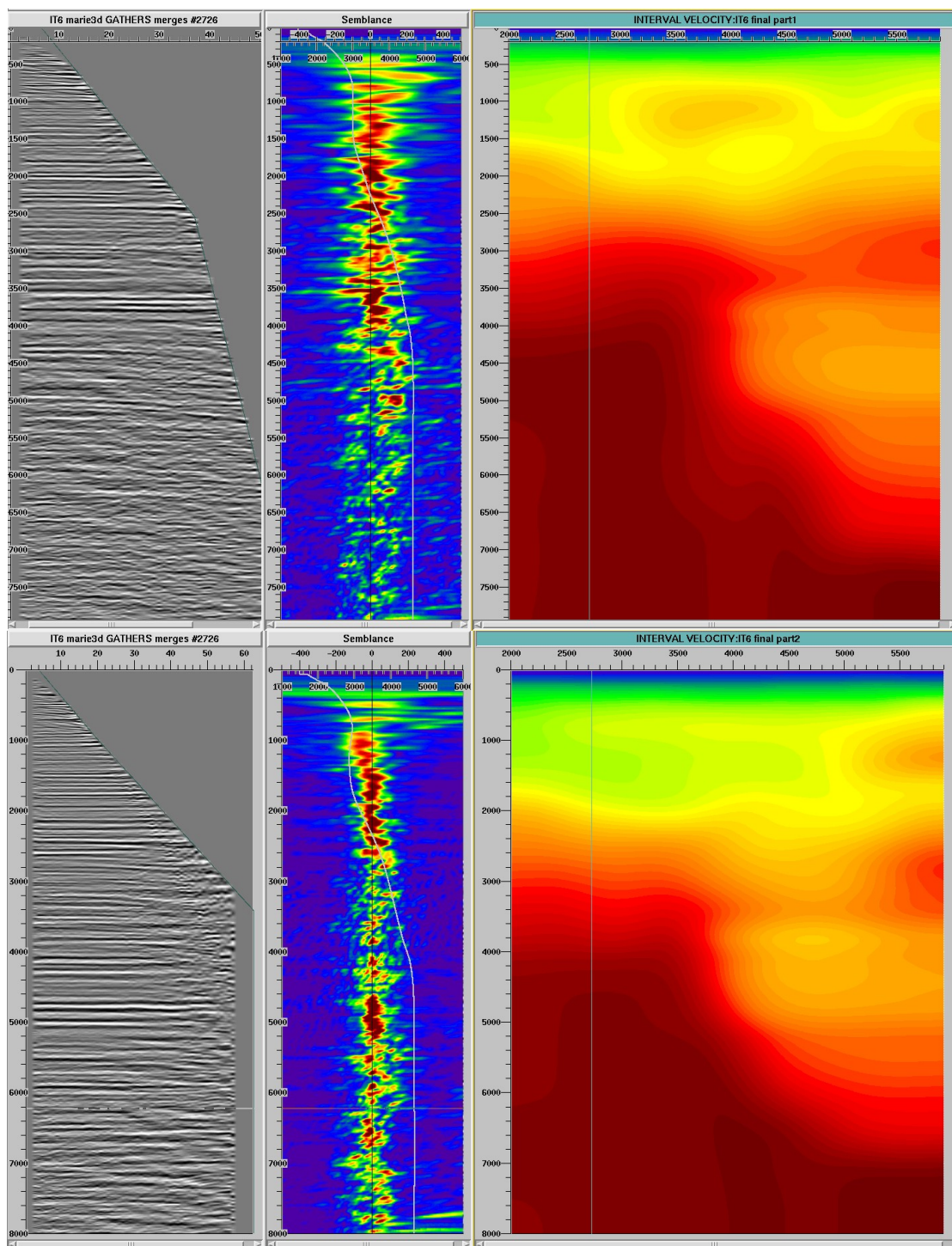
Figure 41. Gather, semblance and section IT6
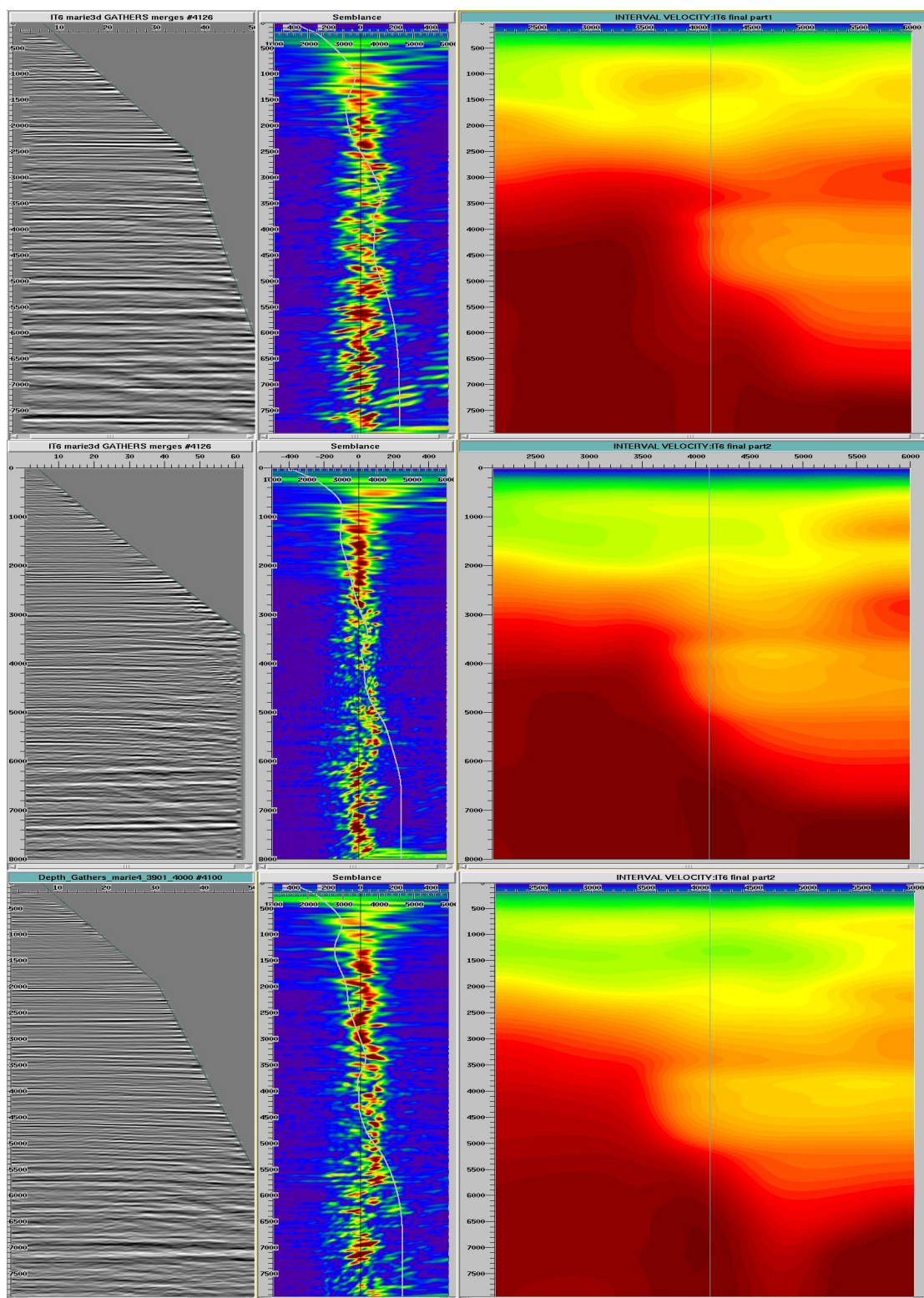
Figure 42. Gather, semblance and section IT6
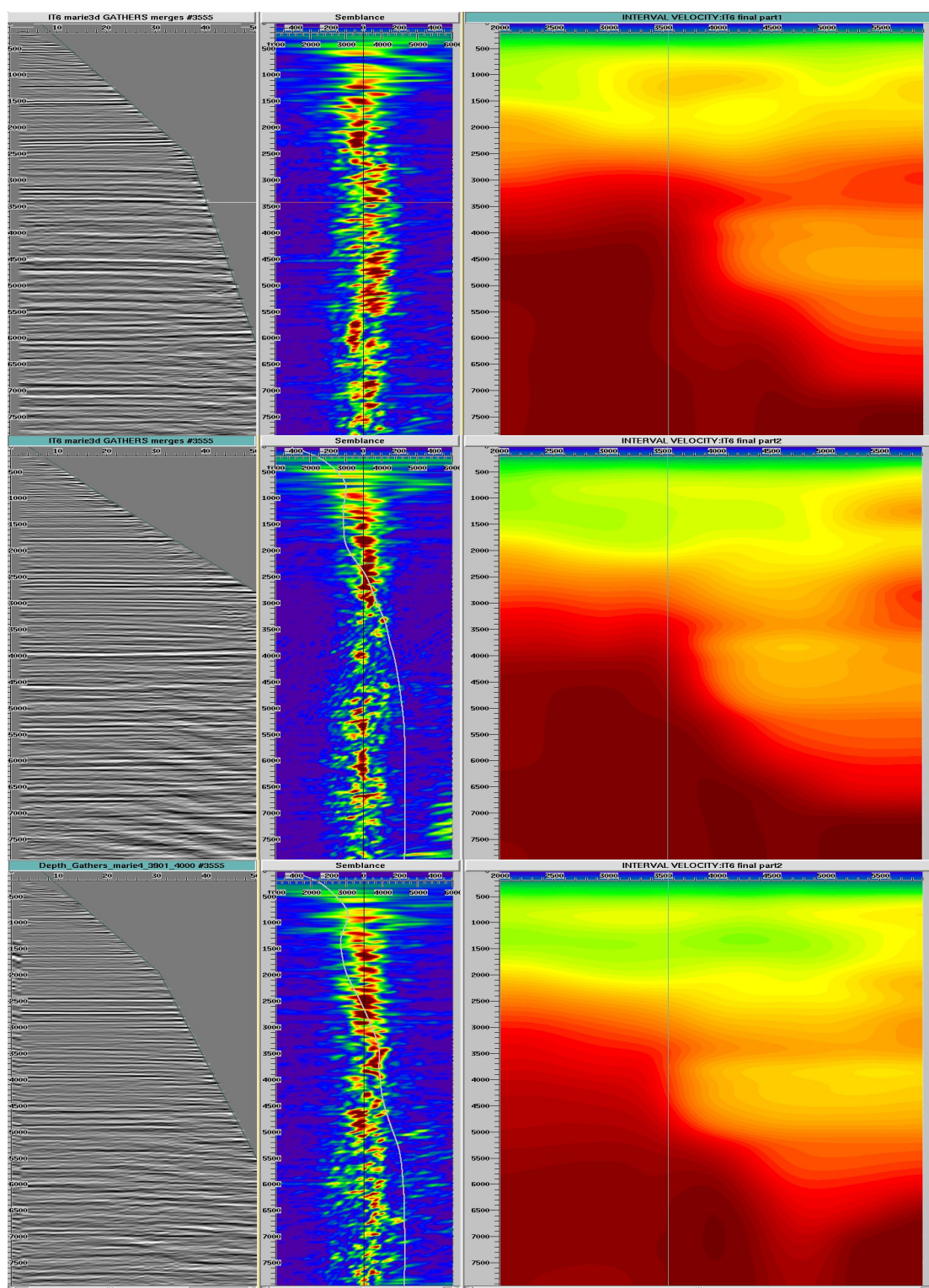
Figure 43. Gather, semblance and section IT6
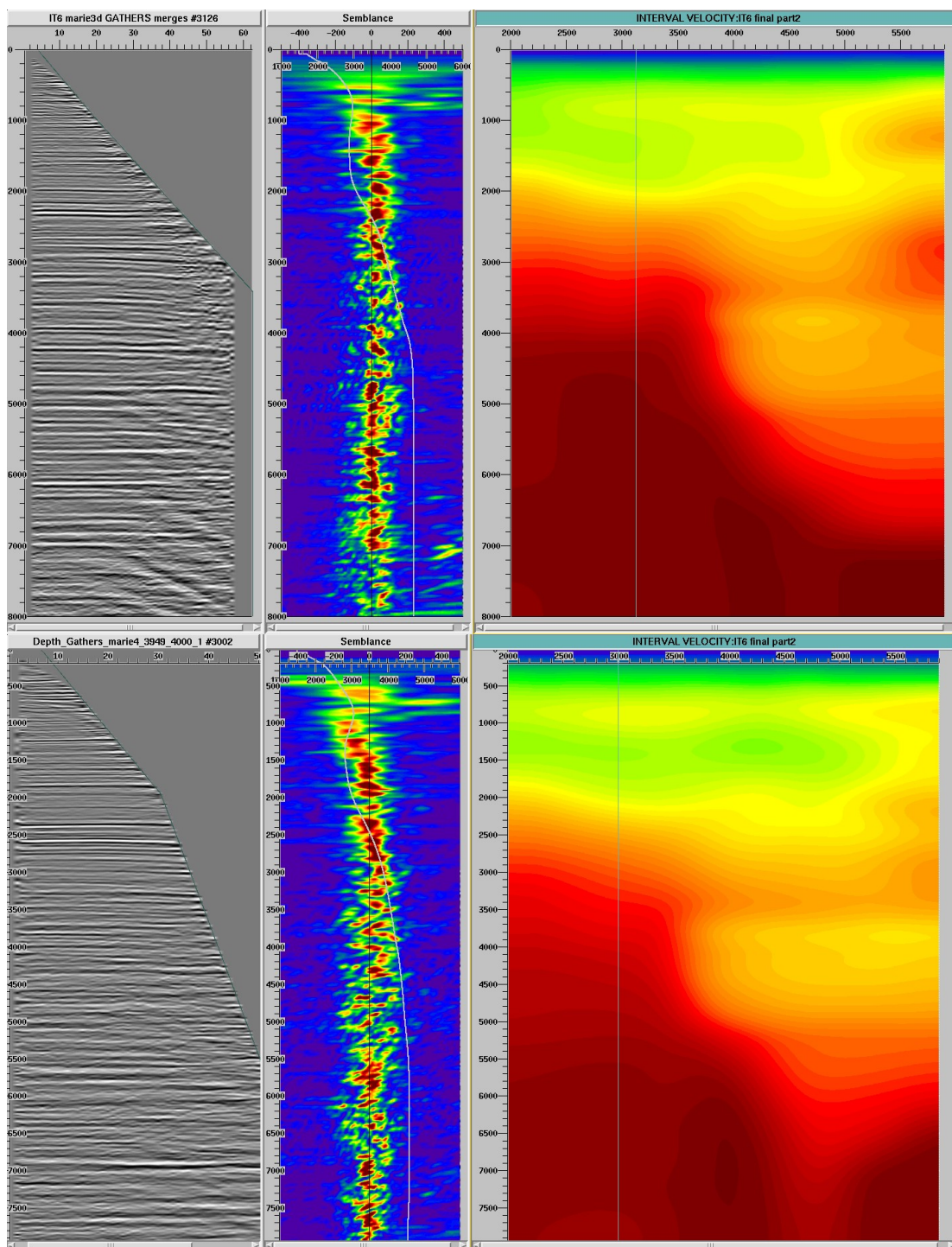
Figure 44. Gather, semblance and section IT6
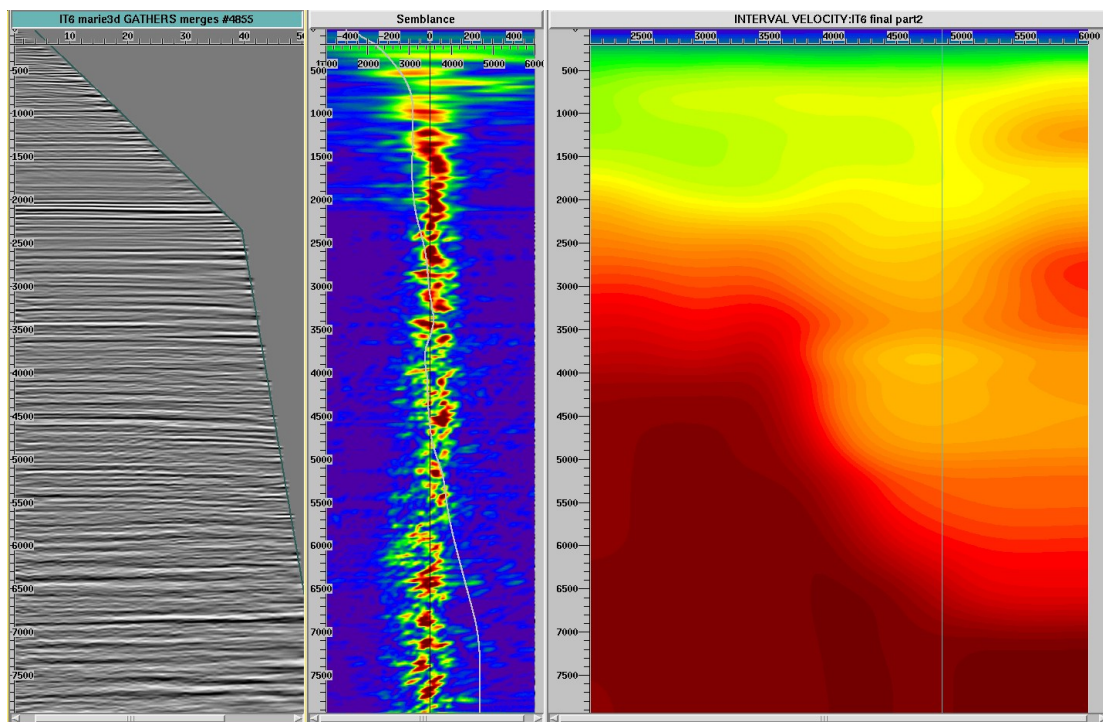
Figure 45. Gather, semblance and section IT6
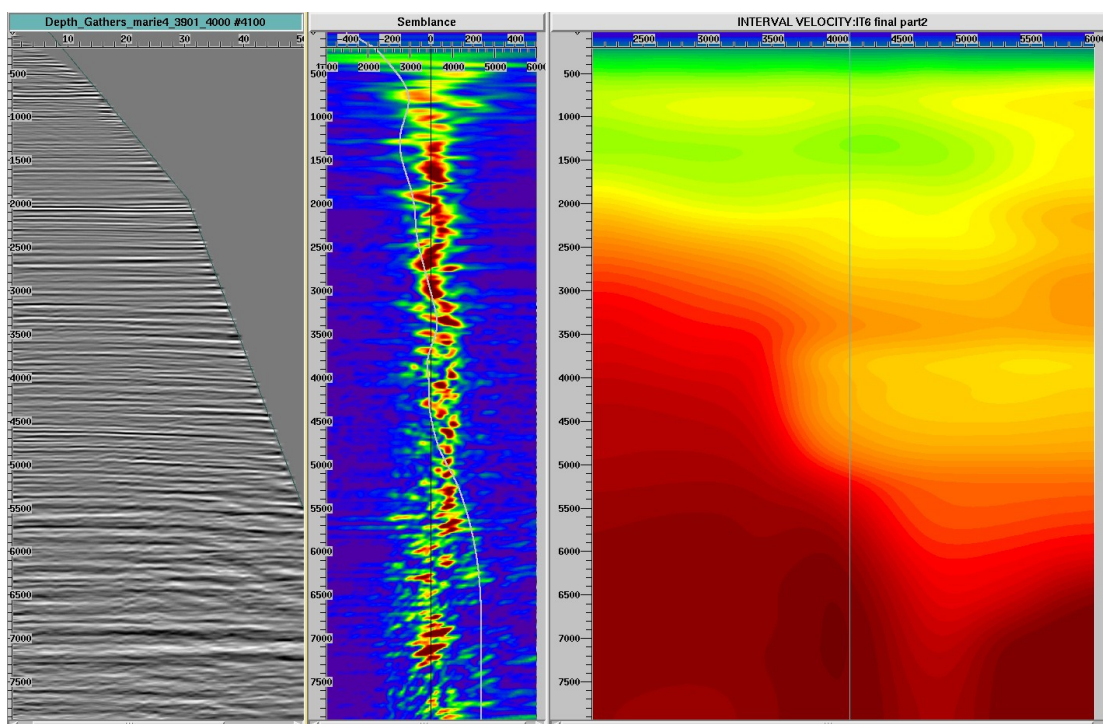
Figure 46. Gather, semblance and section IT6
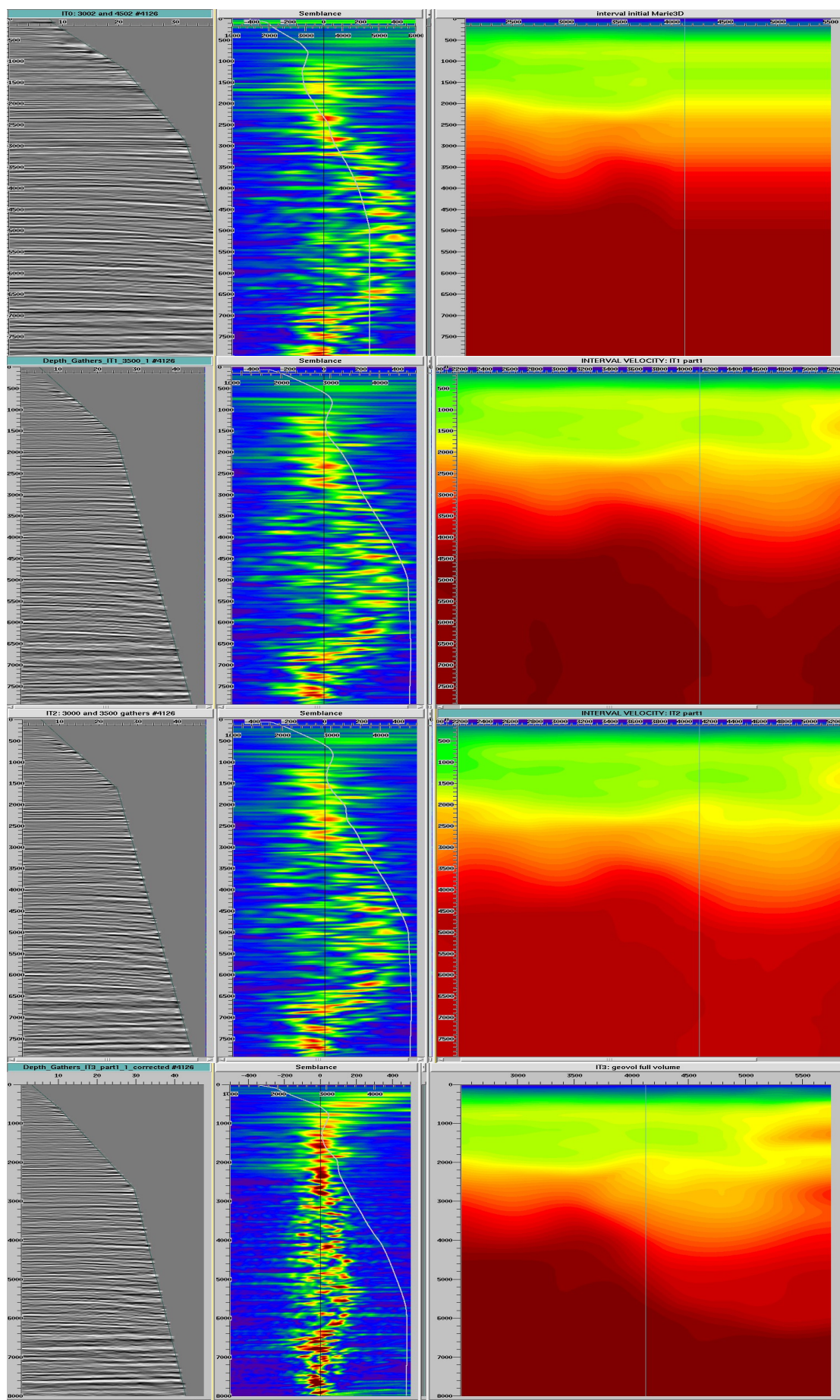
Figure 47. Initial velocity IT0 to IT3 global update
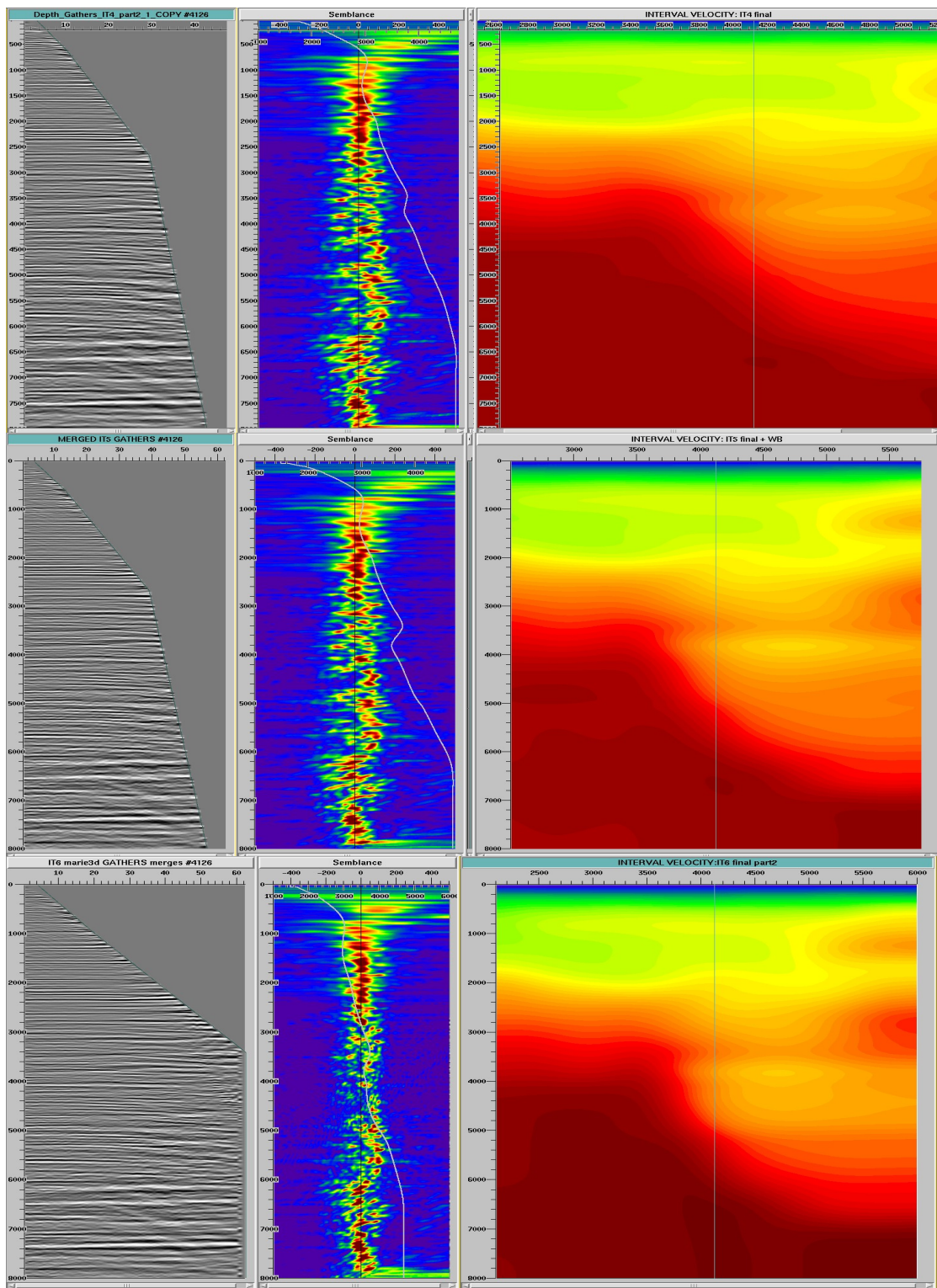
Figure 48. IT4 to IT6 global update

Production PSDM

Similar parameters were used in the production migration and throughout the iteration process.

Travel Time computation: Cartesian Fermat

Aperture along Inline: 4000 m

Aperture along Xline: 4000 m

Anti Alias: Triangulation, medium

Max aperture at 500m

Output parameters were as follows:

Depth sample: 5 meters

Offset range: 100 – 4700 meters

Offset interval: 75 meters

Inline range: 2900 – 4778

Xline range: 1660 – 5500 (cut to project boundaries)

CMP gathers input: Gathers contain all offsets

Velocity input: IT7 - final velocity volume

Figures

Figure 49: Gathers, semblance and section production migration

Figure 50: Gathers, semblance and section production migration

Figure 51: Gathers, semblance and section production migration

Figure 52: Gathers, semblance and section production migration

Figure 53: Gathers, semblance and section production migration

Figure 54: Gathers, semblance and section production migration

Figure 49. Gathers, semblance and section production migration
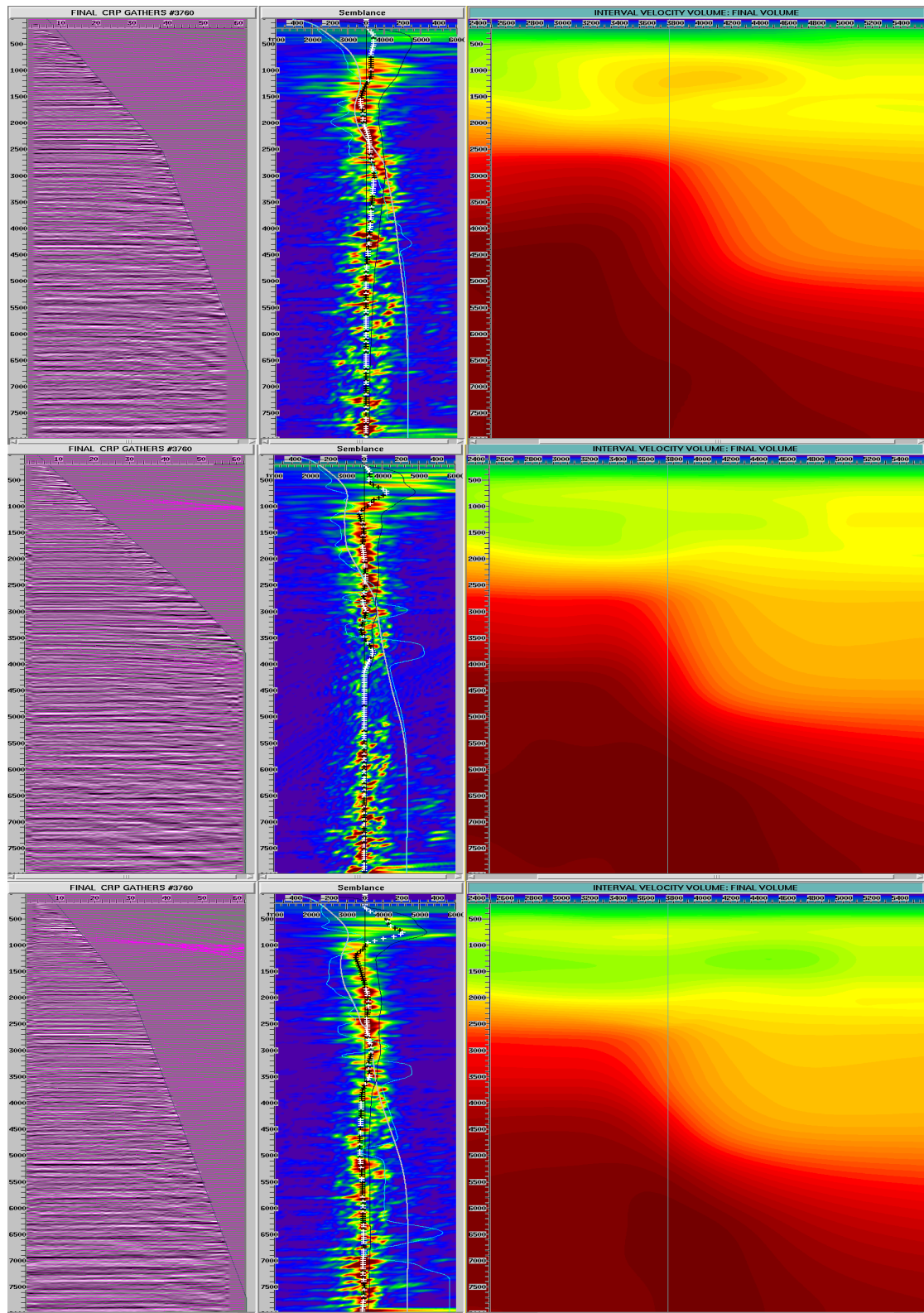
Figure 50. Gathers, semblance and section production migration
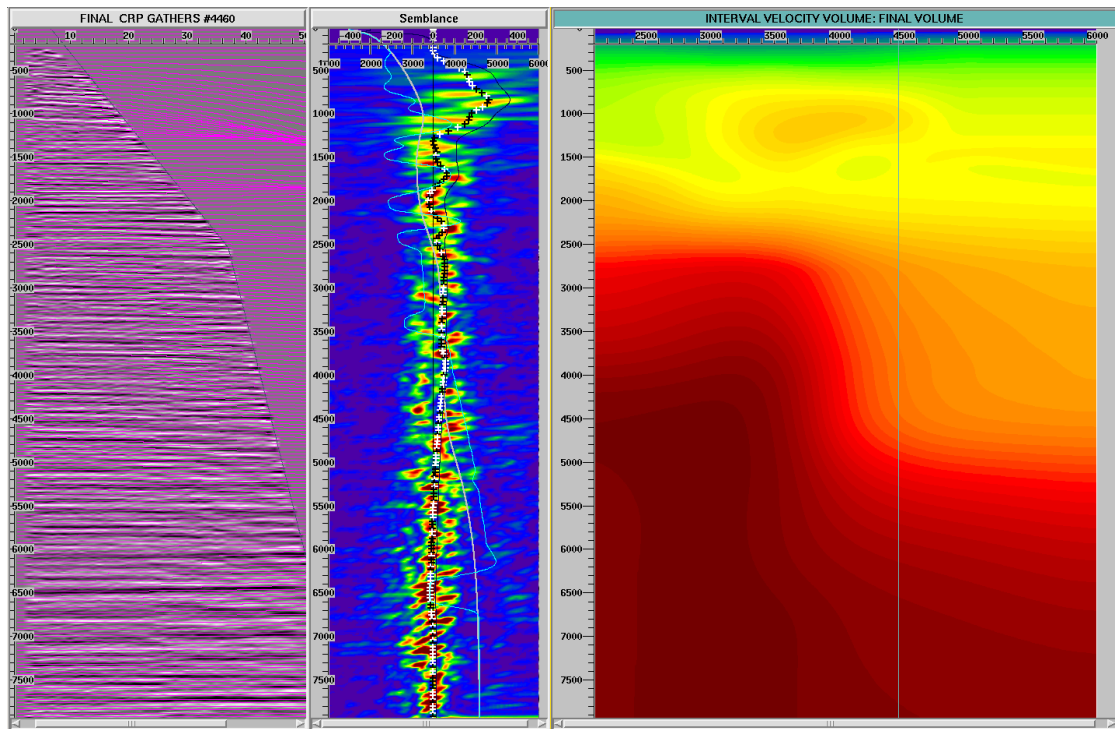
Figure 51. Gathers, semblance and section production migration
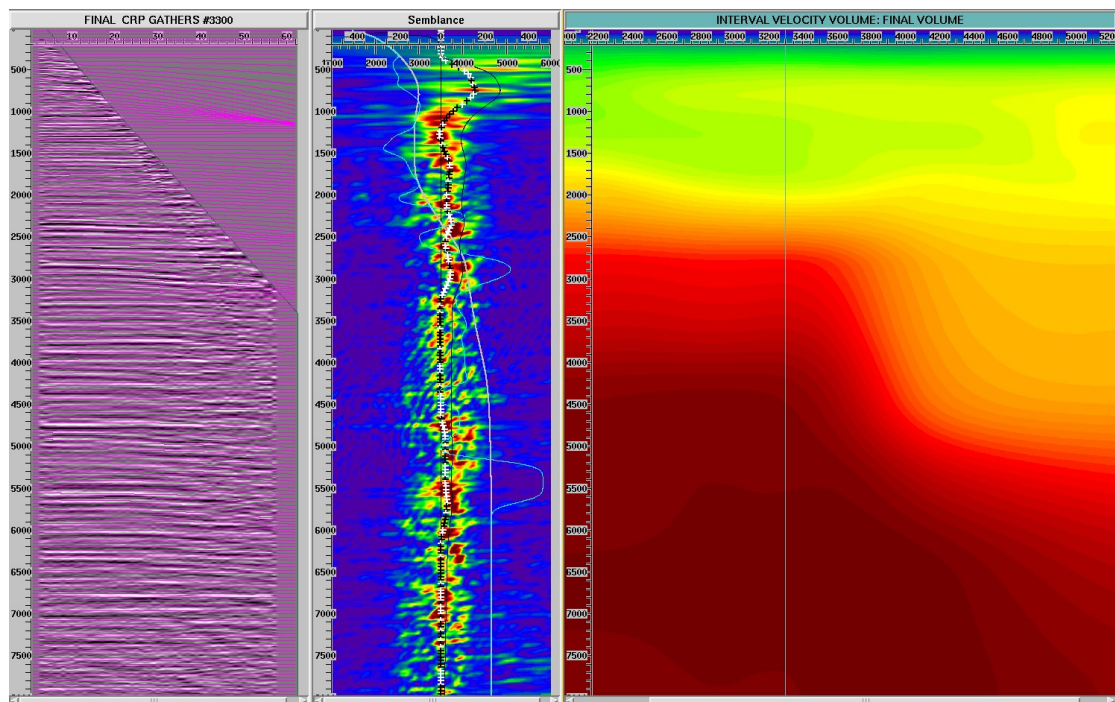
Figure 52. Gathers, semblance and section production migration
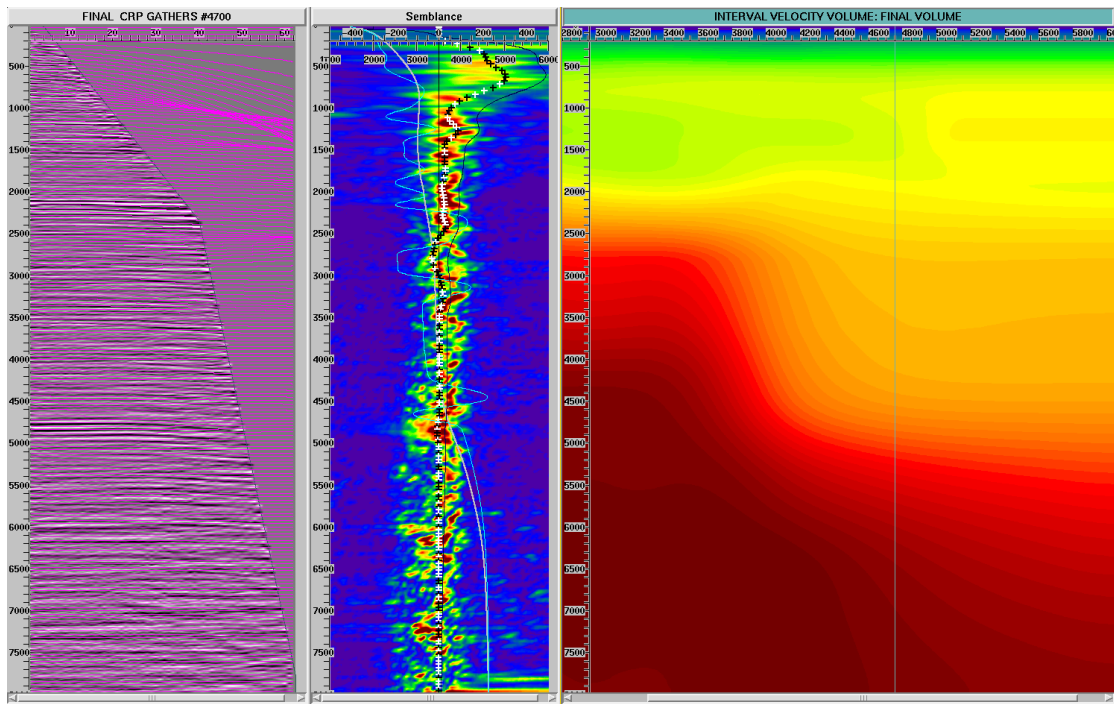
Figure 53. Gathers, semblance and section production migration
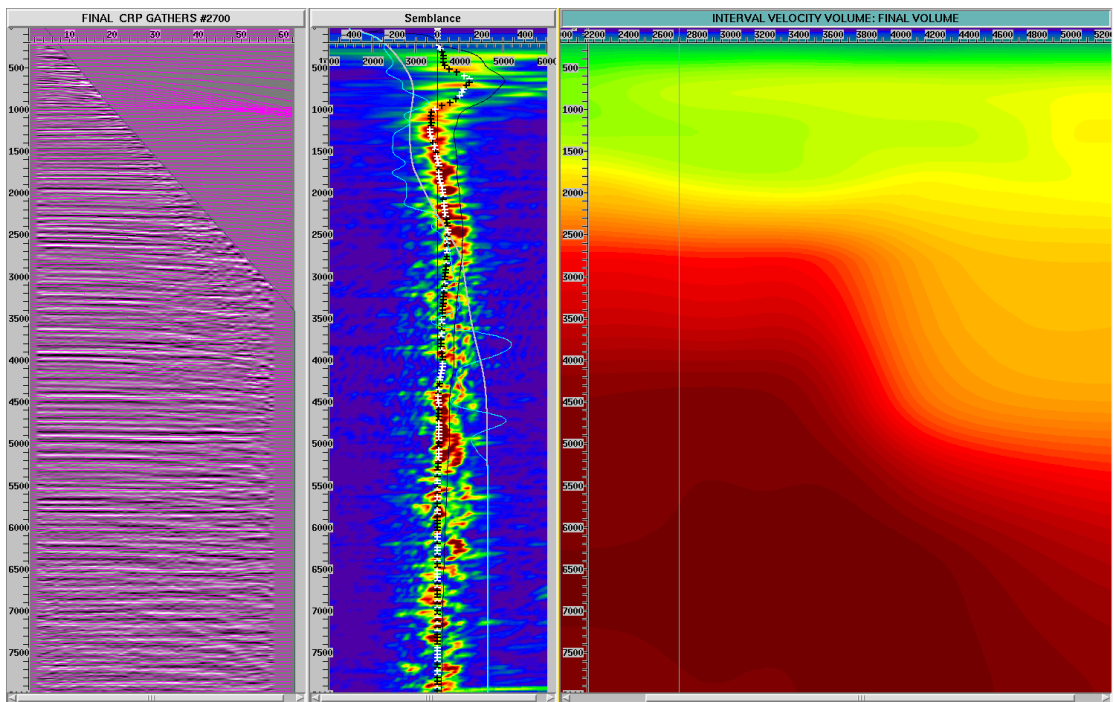
Figure 54. Gathers, semblance and section production migration

18.4 1D velocity update and post stack processing

Though the final velocity volume derived flat gathers in most areas, small residuals could be picked to improve the imaging.

To derive the best image the following workflow was applied:
- 1D vertical residual picking on 500x500 meters grid,
- Create residual volume and QC,
- Gather flattening,
- Scale gathers to time,
- Post stack processing,
- Create a scaled to time volume,
- Scale seismic volume back to depth,

The residual vertical functions were picked on a 500x500 grid. The VF were QC'd, sliced in a 40m interval (vertically), edited and conditioned.

The residual volume showed very small residuals, most of them positive, that validated the velocity model and resembled less than 1% velocity variation.

The residual volume was used to flatten the gathers. Please note that in some areas the input cable length was much smaller than the migration output. While the output maximum offset for the whole area was 4700 metres Marie's input gathers had a much smaller cable. The additional offsets in those areas must be treated with caution.

The final interval velocity volume, IT7, was used to scale the flat CRP gathers to time.

After a few tests on a sample line, the post stack processing sequence was agreed and applied to the scaled to time gathers. The output was a scaled to time seismic volume that is clean of multiples, crisp, focused and with a better signal to noise ratio. *Figures 55-58* show some examples of the final seismic volume scaled to time.

The final interval velocity volume, IT7, was used to scale the volume to depth. *Figures 59-66* show some examples of the final seismic depth volume

Figures
Figure55: Final Scale to Time PSDM cross-section
Figure56: Final Scale to Time PSDM cross-section
Figure57: Final Scale to Time PSDM cross-section
Figure58: Final Scale to Time PSDM cross-section
Figure59: Final PSDM cross-section
Figure60: Final PSDM cross-section
Figure61: Final PSDM cross-section
Figure62: Final PSDM cross-section
Figure63: Final PSDM cross-section
Figure64: Final PSDM cross-section, cross-line direction
Figure65: Final PSDM cross-section, cross-line direction
Figure66: Final PSDM cross-section, cross-line direction
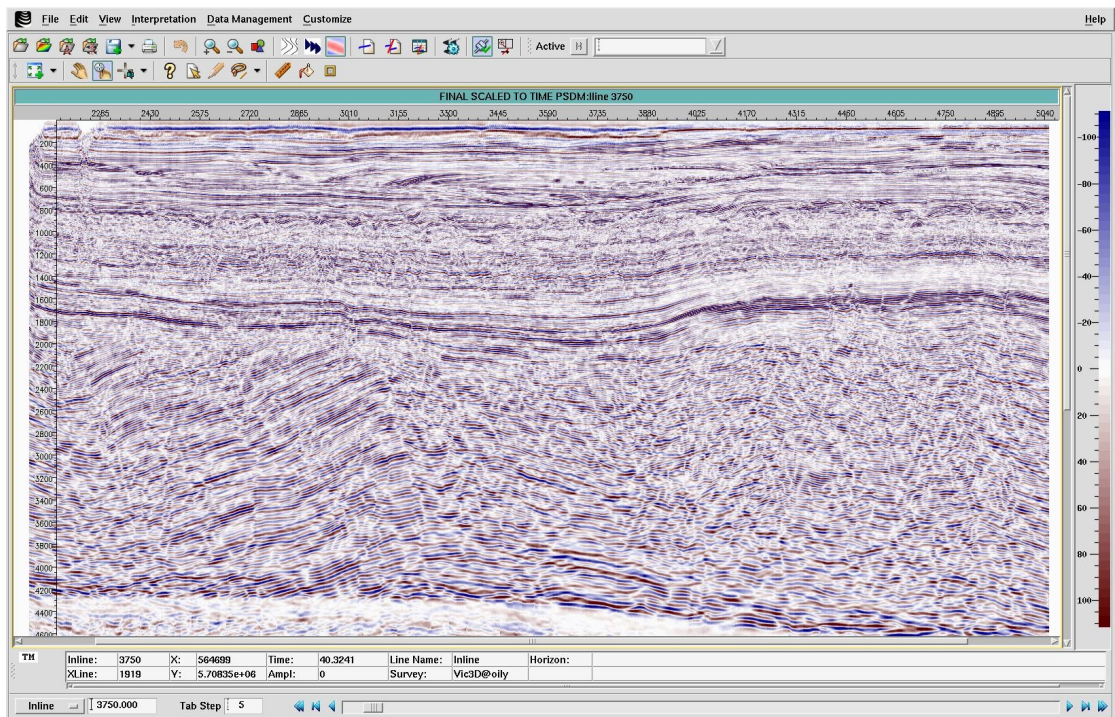
Figure55. Final Scale to Time PSDM cross-section
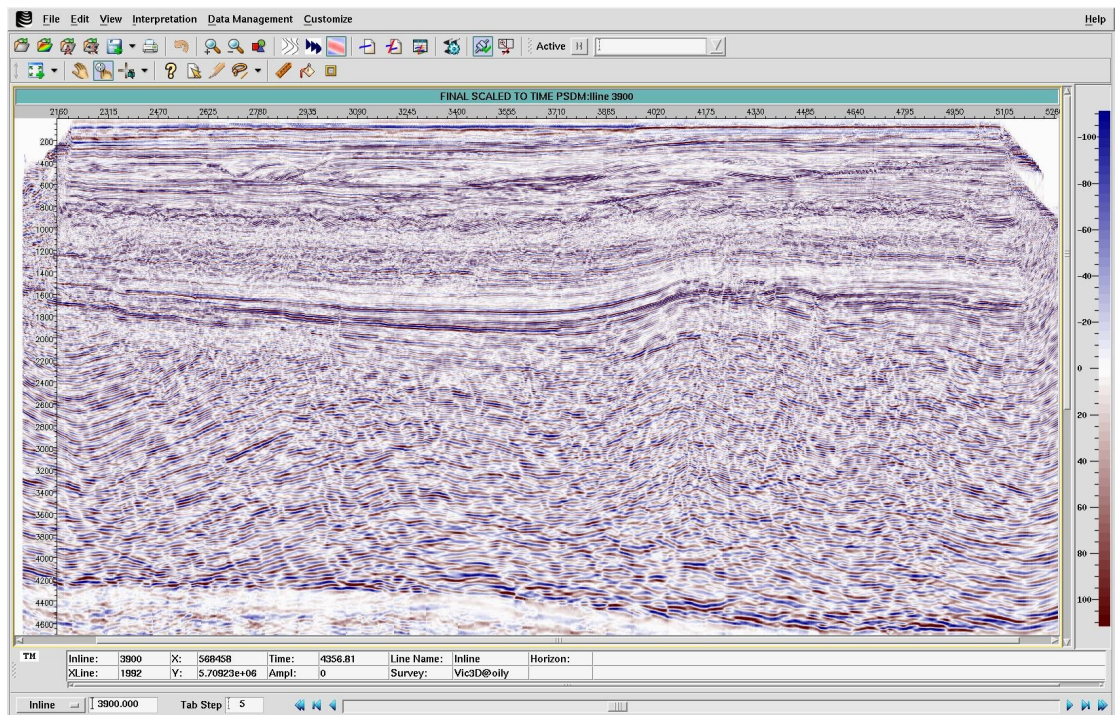
Figure56. Final Scale to Time PSDM cross-section
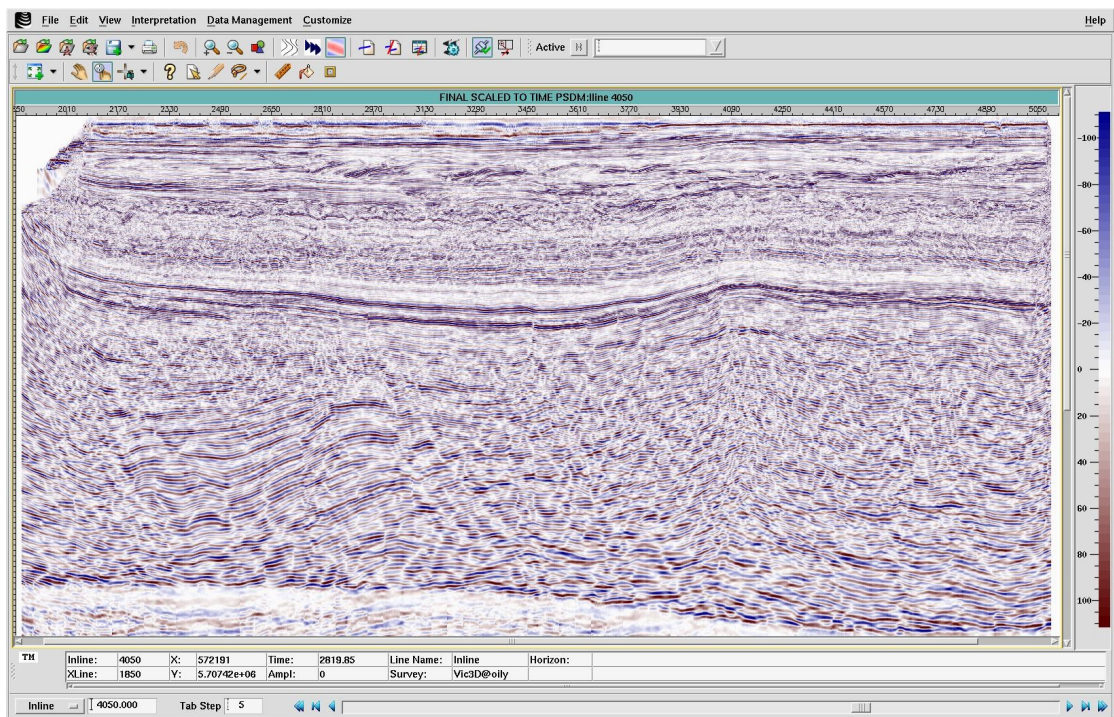
Figure57. Final Scale to Time PSDM cross-section
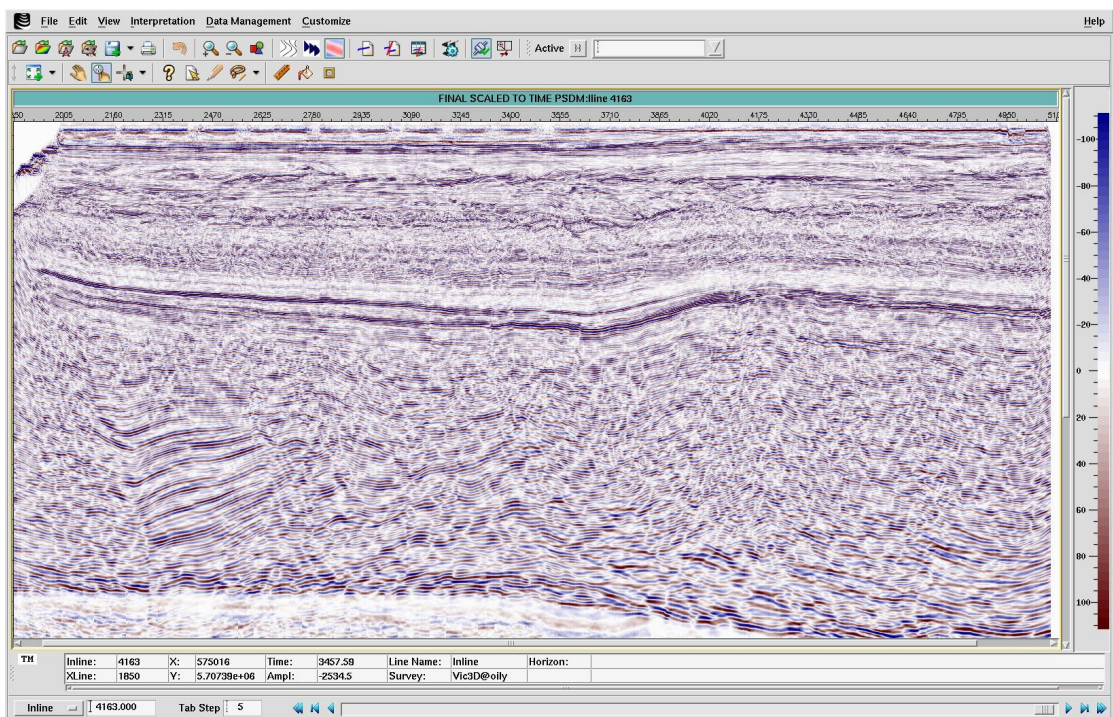
Figure58. Final Scale to Time PSDM cross-section
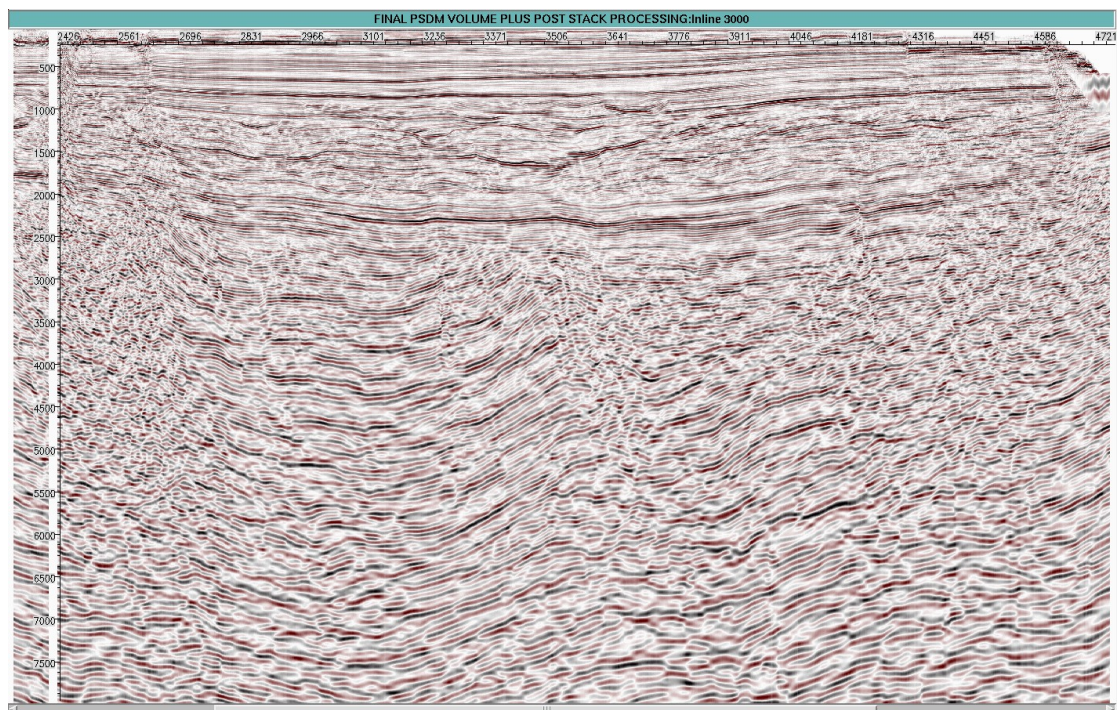
Figure 59. Final PSDM cross-section
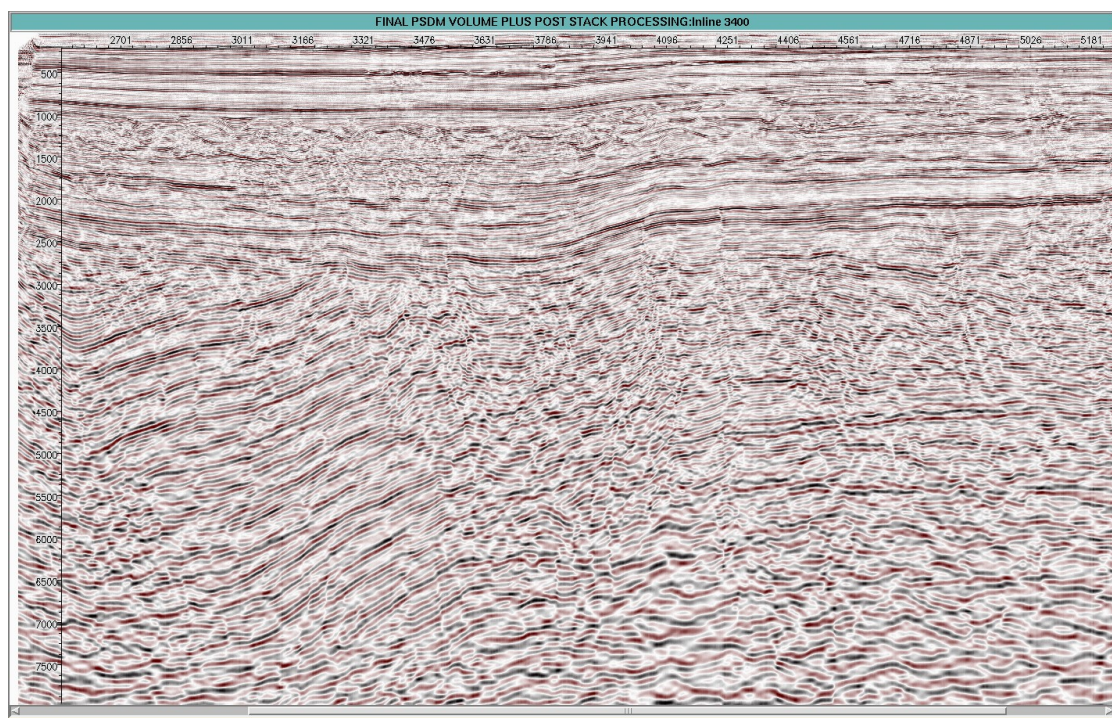
Figure 60. Final PSDM cross-section
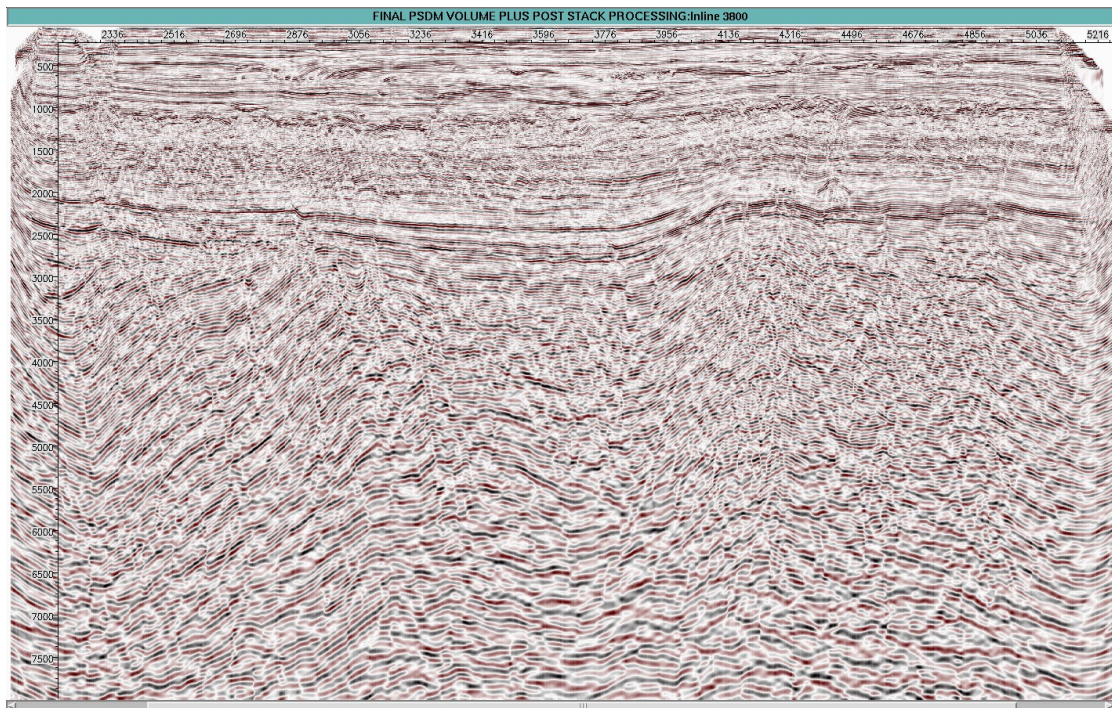
Figure 61. Final PSDM cross-section
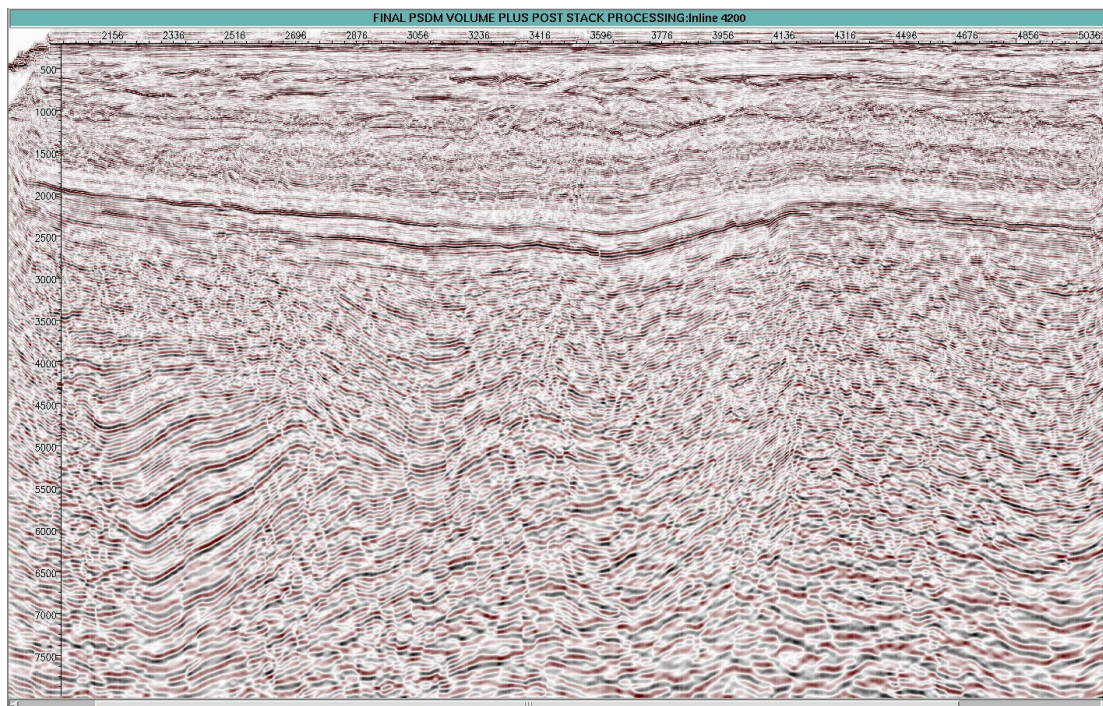
Figure 62. Final PSDM cross-section
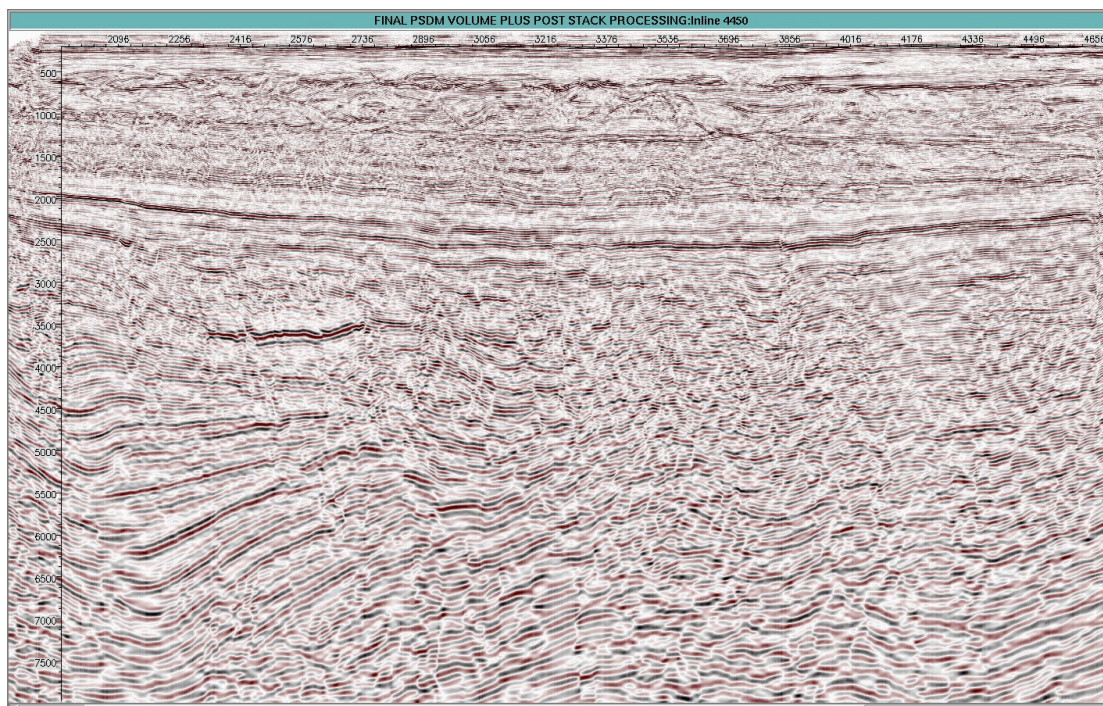
Figure 63. Final PSDM cross-section
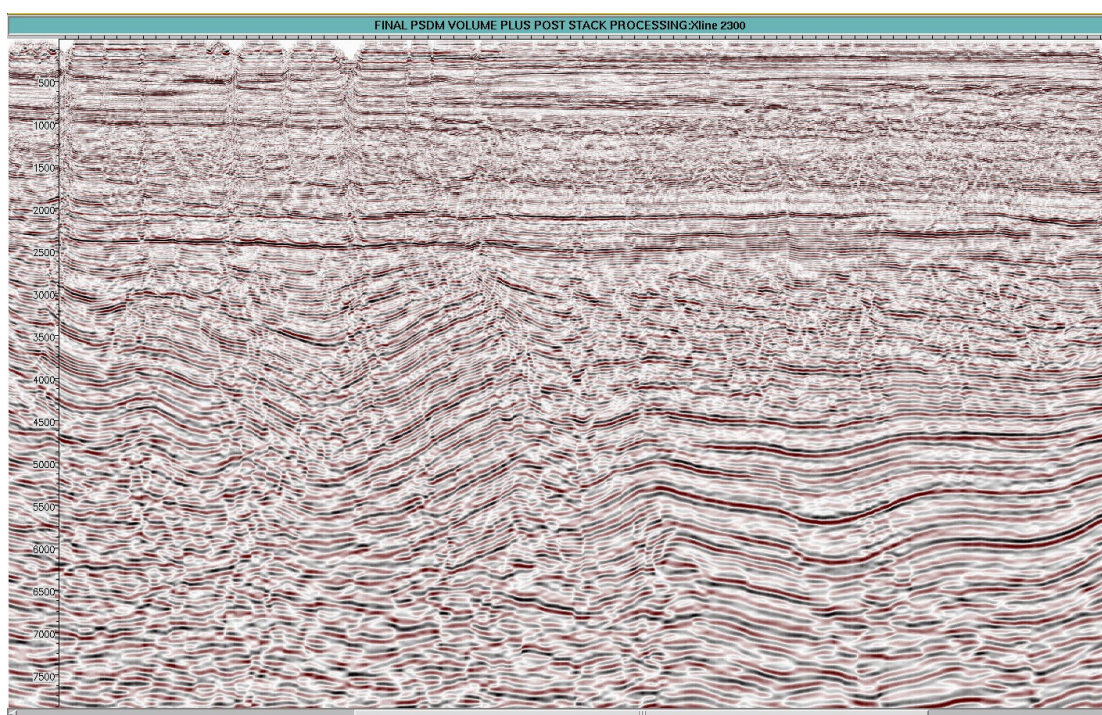
Figure 64. Final PSDM cross-section
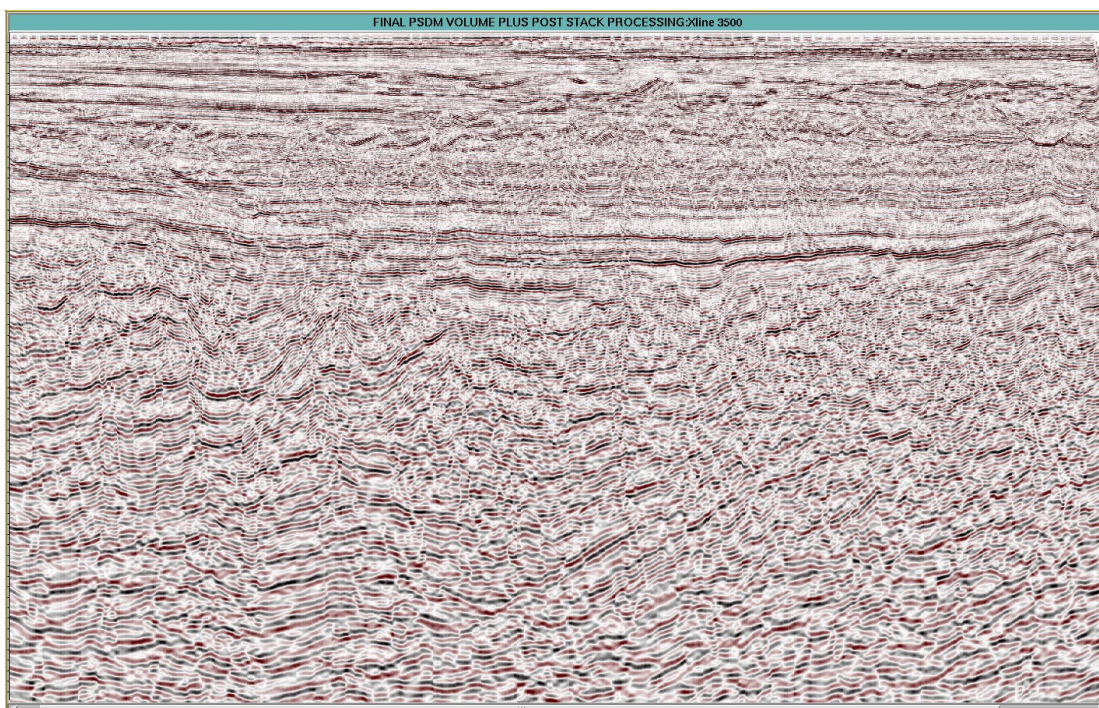
Figure 65. Final PSDM cross-section
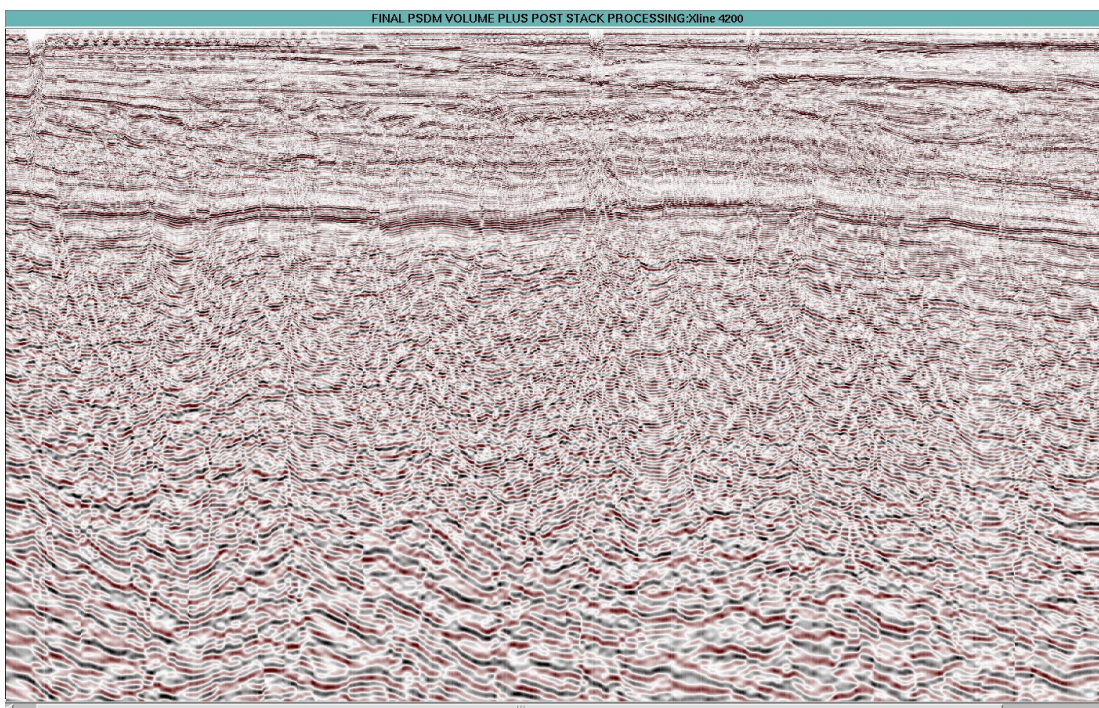
Figure 66. Final PSDM cross-section

18.5 Calibration

Apache provided four horizons and markers to be used as the main calibration locations. Furthermore, additional control points per well were given to use in conjunction with the markers.

The calibration process had many steps that can be summarized to a workflow:
- Convert final velocity volume to average velocity,
- Compute pseudo average velocity per well per marker,
- Compute pseudo average velocity to each additional control point,
- Compute a factor value per marker per well and to the additional points,
- Interpolate between the control points,
- Slice the factor functions in a 20m interval using "minimum curvature" interpolation, QC and condition. The horizons for calibration are mostly flat and the well data points are sparse. Therefore, the "minimum curvature" interpolation was found to be the best interpolation method in that case.
- Create a factor volume,
- Apply factor volume to IT7 average velocity and create a calibrated average velocity volume,
- Scale volume to depth

Please note:
- The Gippsland area is SEG standard. WB marker is along the positive amplitudes.
- The calibrated seismic volume has no misties in most wells and less than half a sample mistie in few wells. The reason for that is the difference in the marker values between two very close wells. To avoid "jumps" in the seismic this small flexibility was allowed.

Figures
Figure67: Calibration factor volume
Figure68: Calibration factor volume
Figure69: Calibration factor volume
Figure70: Calibration factor volume
Figure71: Non-calibrated and calibrated maps - horizon 005
Figure72: Non-calibrated and calibrated maps - horizon 024
Figure73: Non-calibrated and calibrated maps - horizon 035
Figure74: Non-calibrated and calibrated maps - horizon 051
Figure75: Calibration misties horizon 005
Figure76: Calibration misties horizon 024
Figure77: Calibration misties horizon 035
Figure78: Calibration misties horizon 051
Figure79: Final PSDM cross-section non-calibrated and calibrated
Figure80: Final PSDM cross-section non-calibrated and calibrated
Figure81: Final PSDM cross-section non-calibrated and calibrated
Figure82: Final PSDM cross-section non-calibrated and calibrated

Figure 67. Calibration factor volume
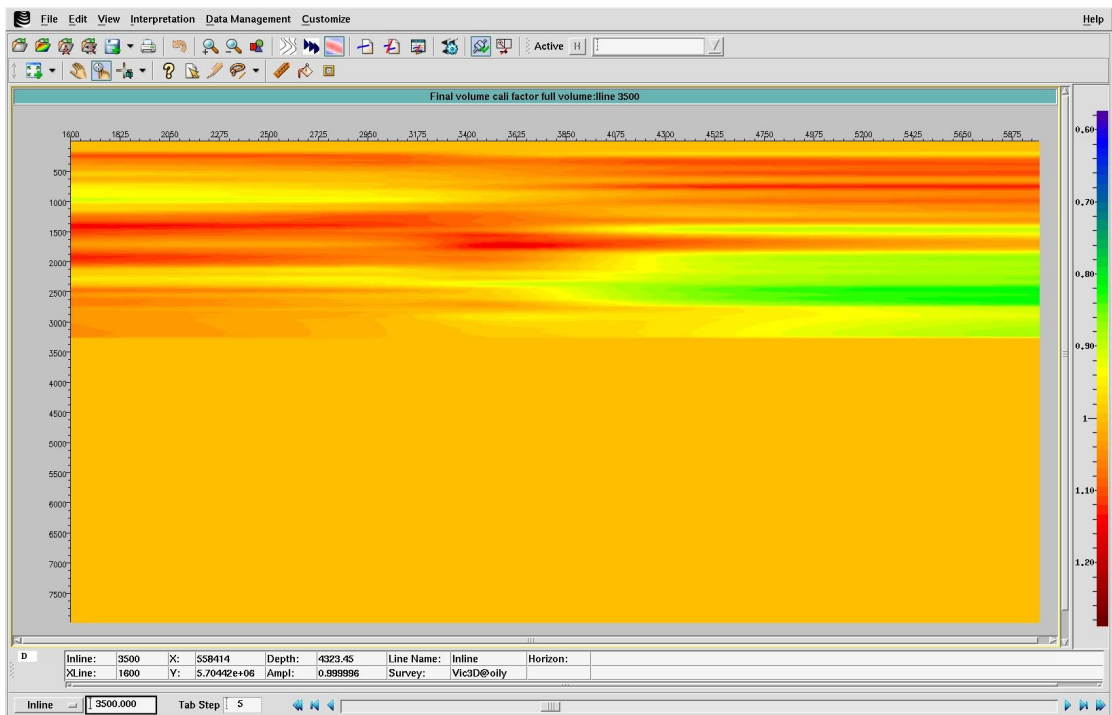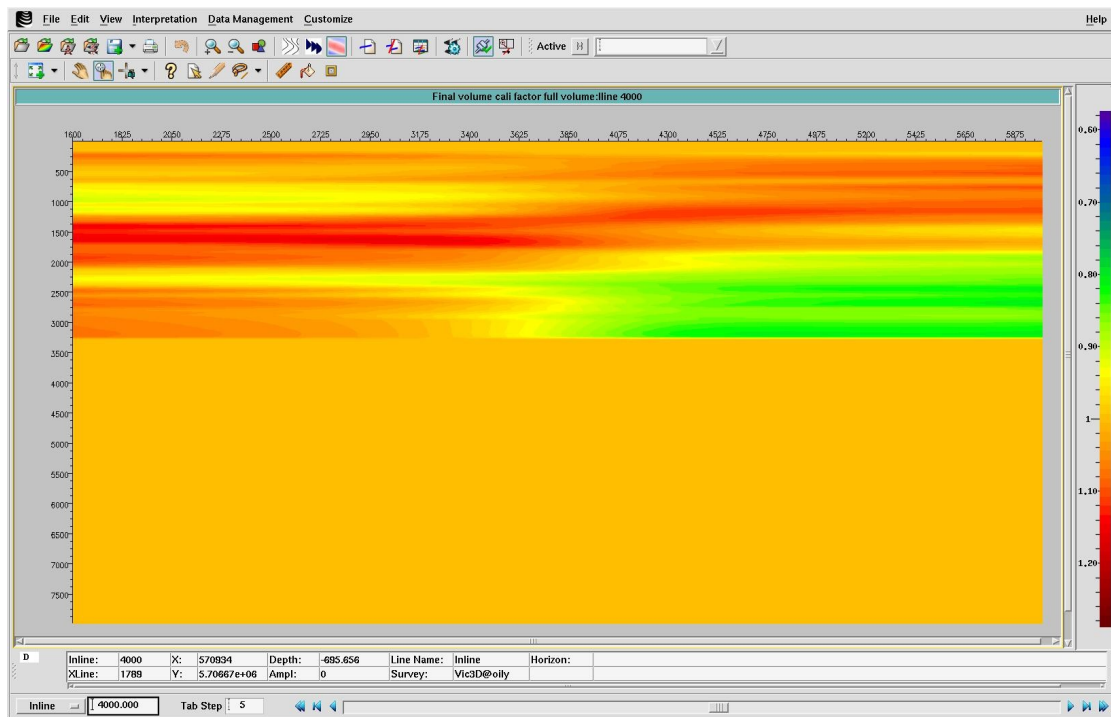
Figure 68. Calibration factor volume

Figure 69. Calibration factor volume
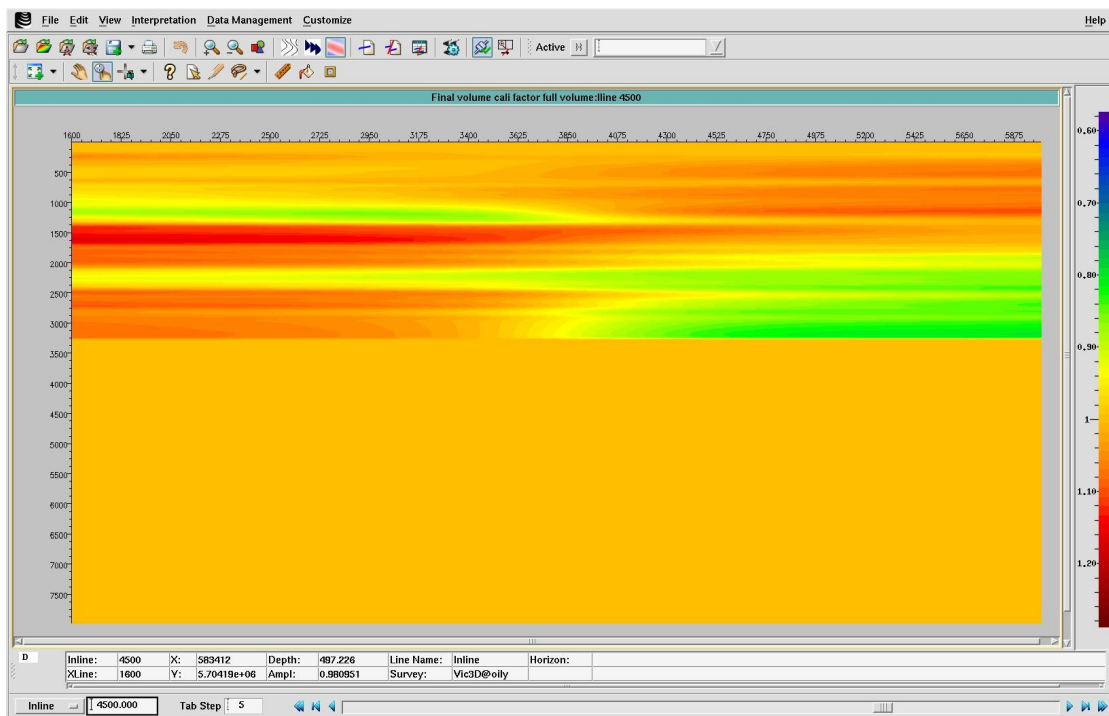
Figure 70. Calibration factor volume
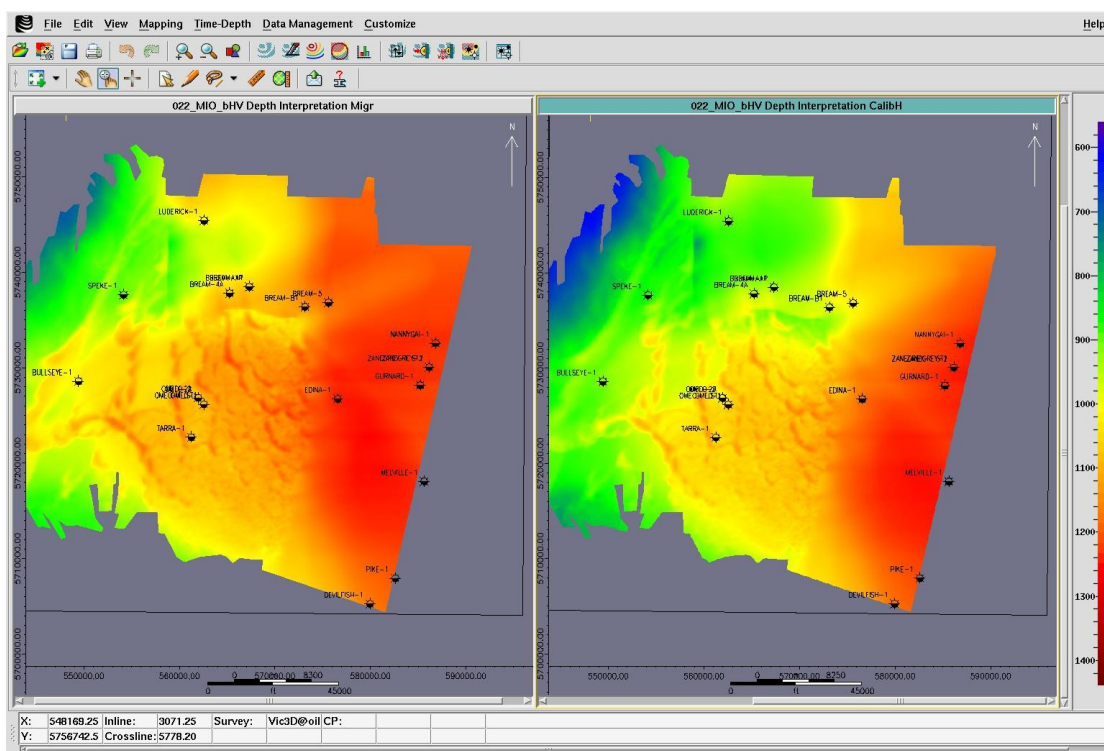
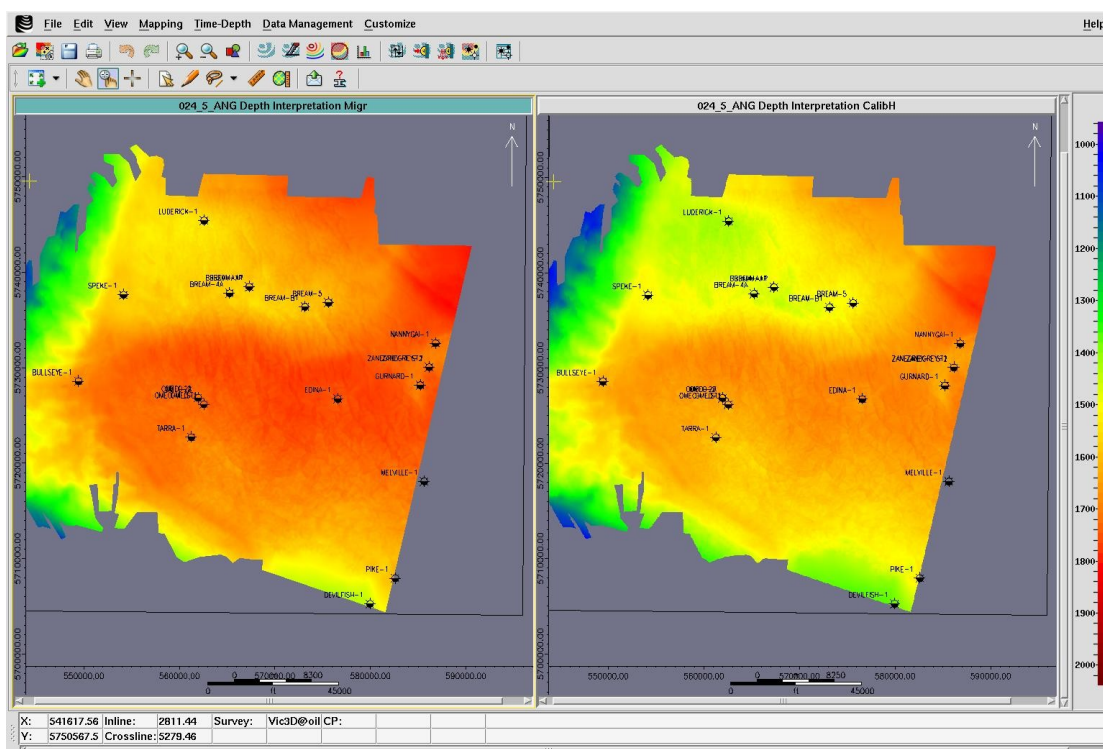Figure 71. Non-calibrated and calibrated maps – horizon 022

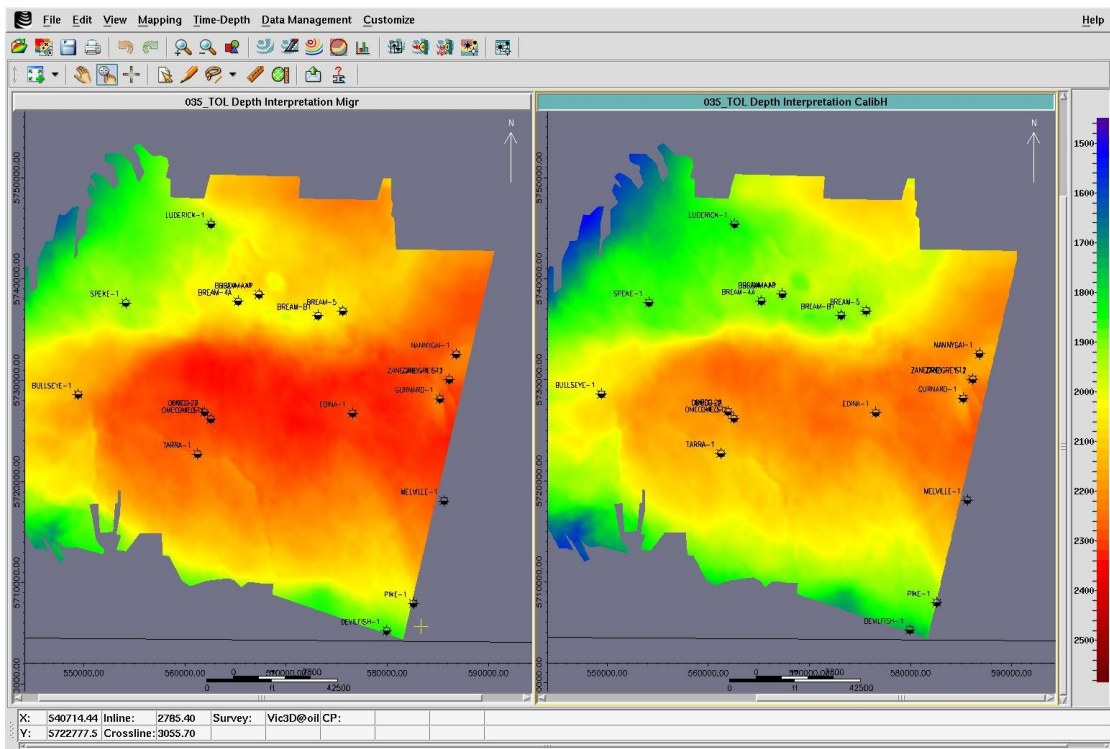Figure 72. Non-calibrated and calibrated maps – horizon 024

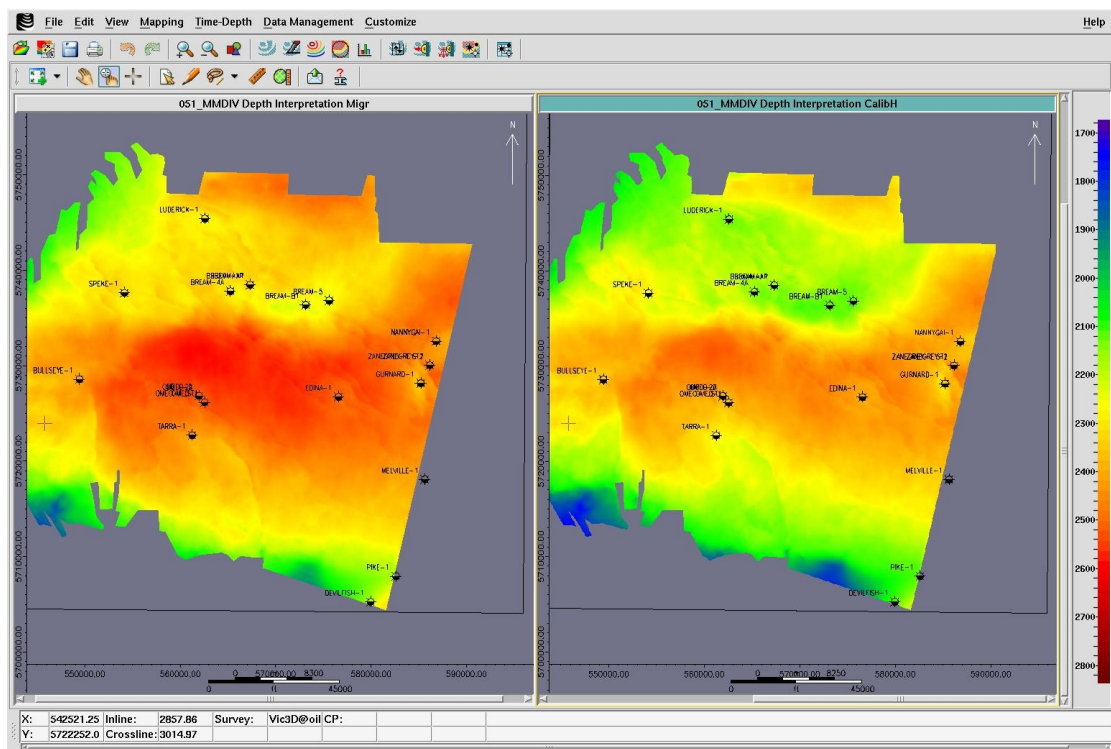Figure 73. Non-calibrated and calibrated maps – horizon 035

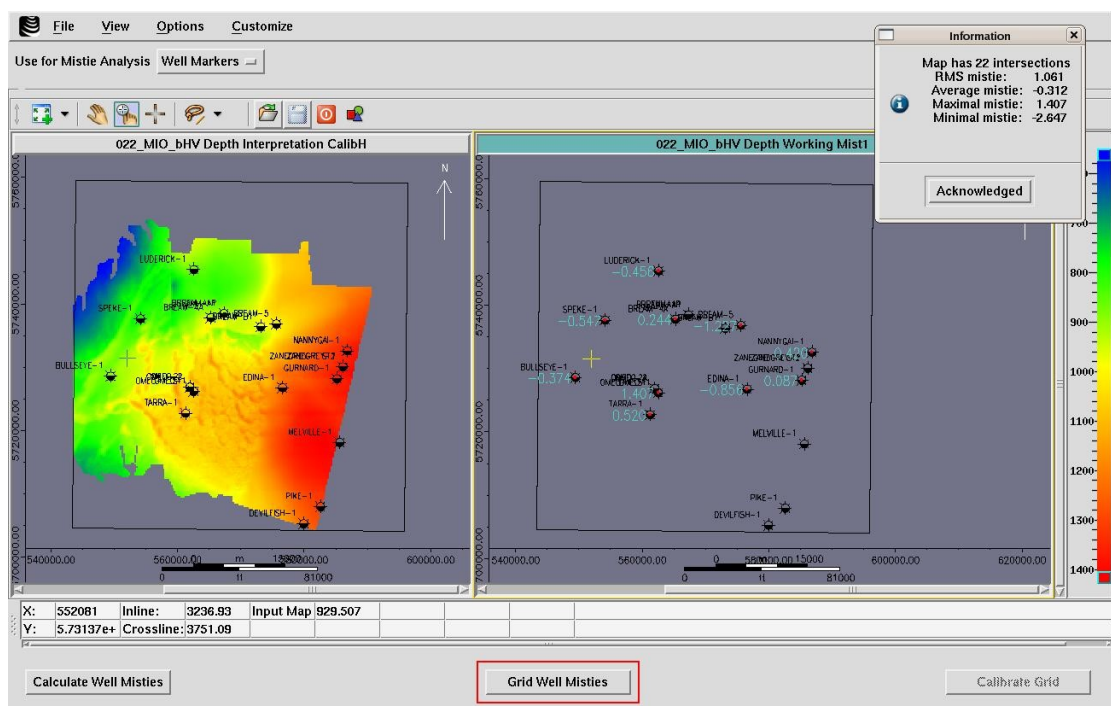Figure 74. Non-calibrated and calibrated maps – horizon 051
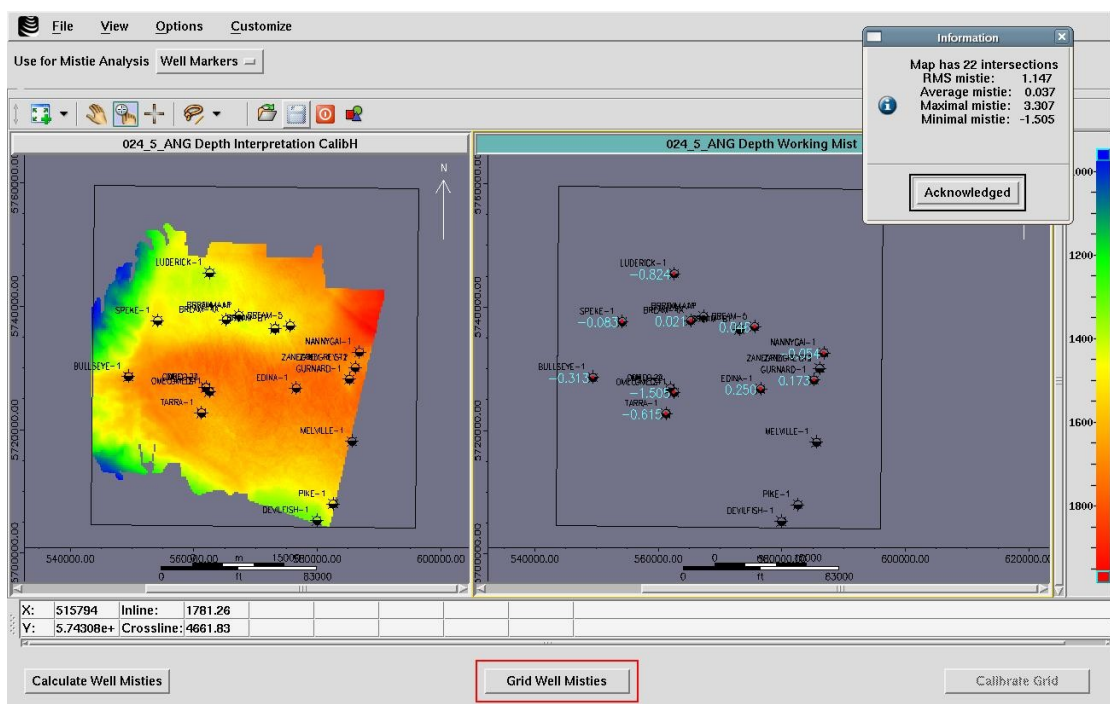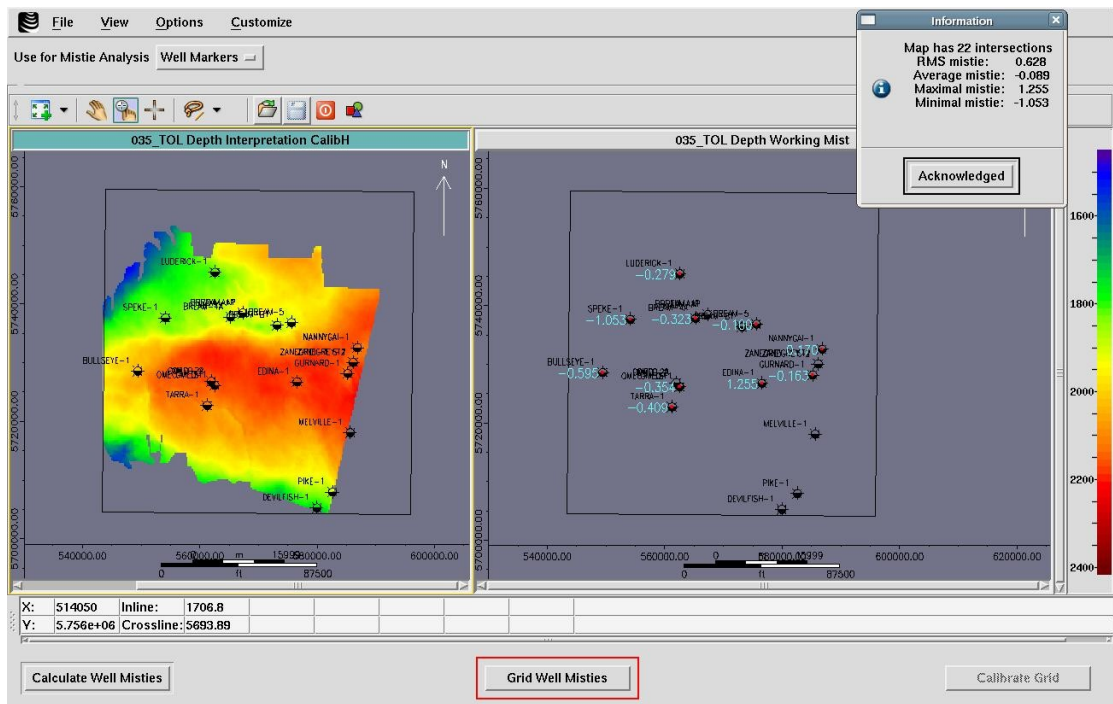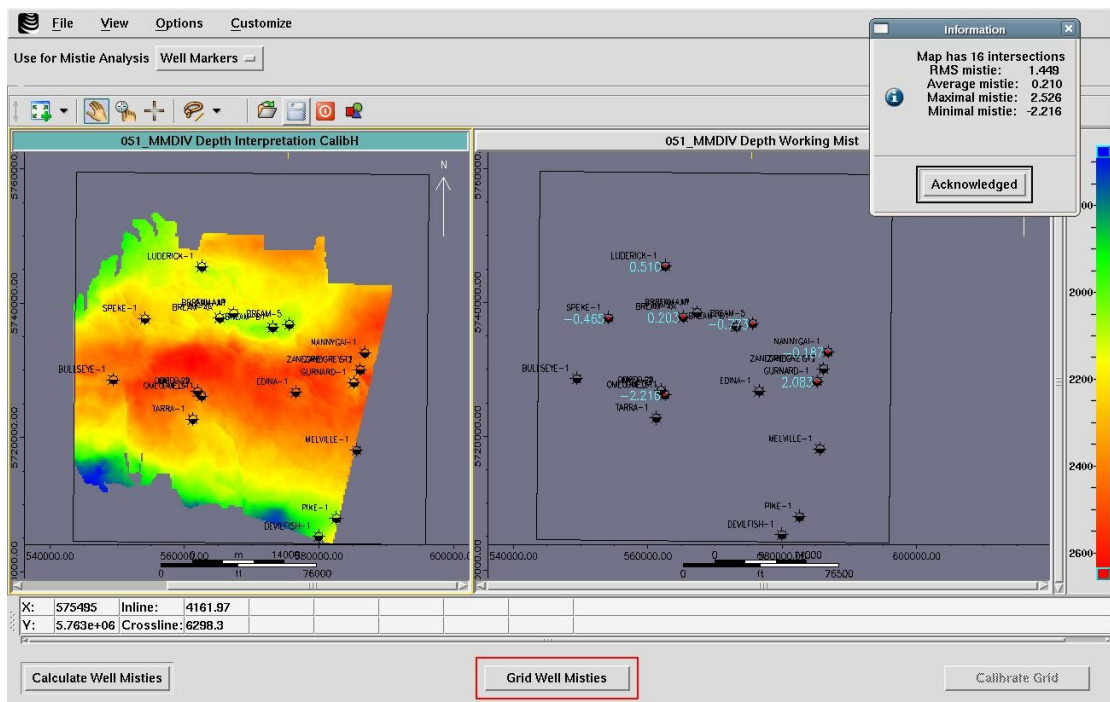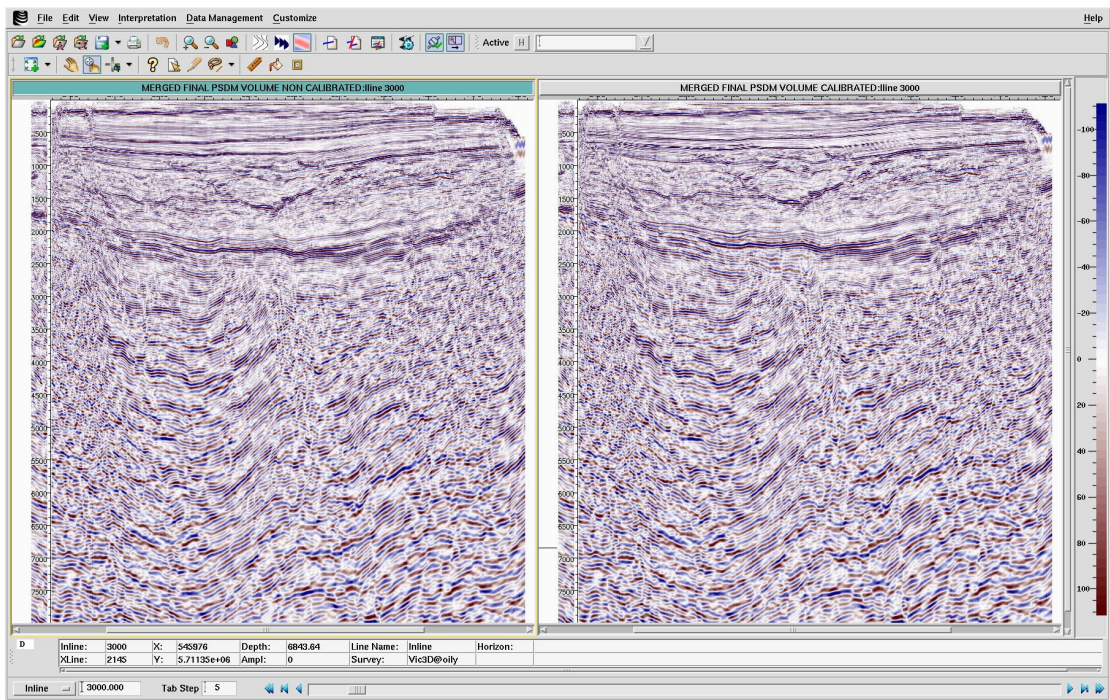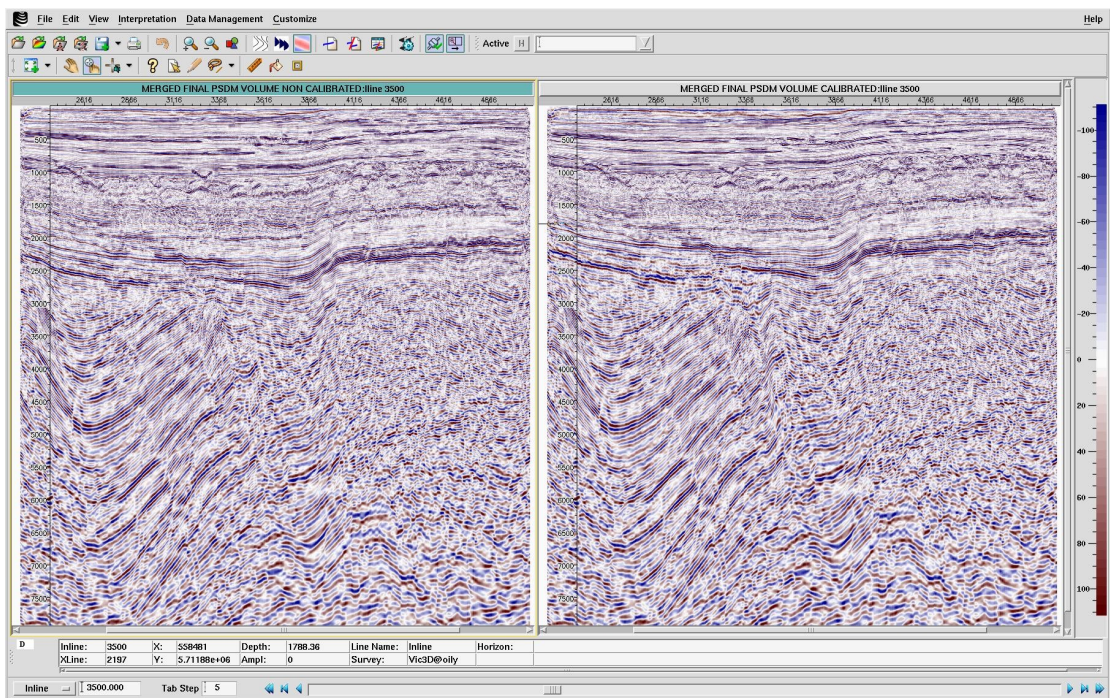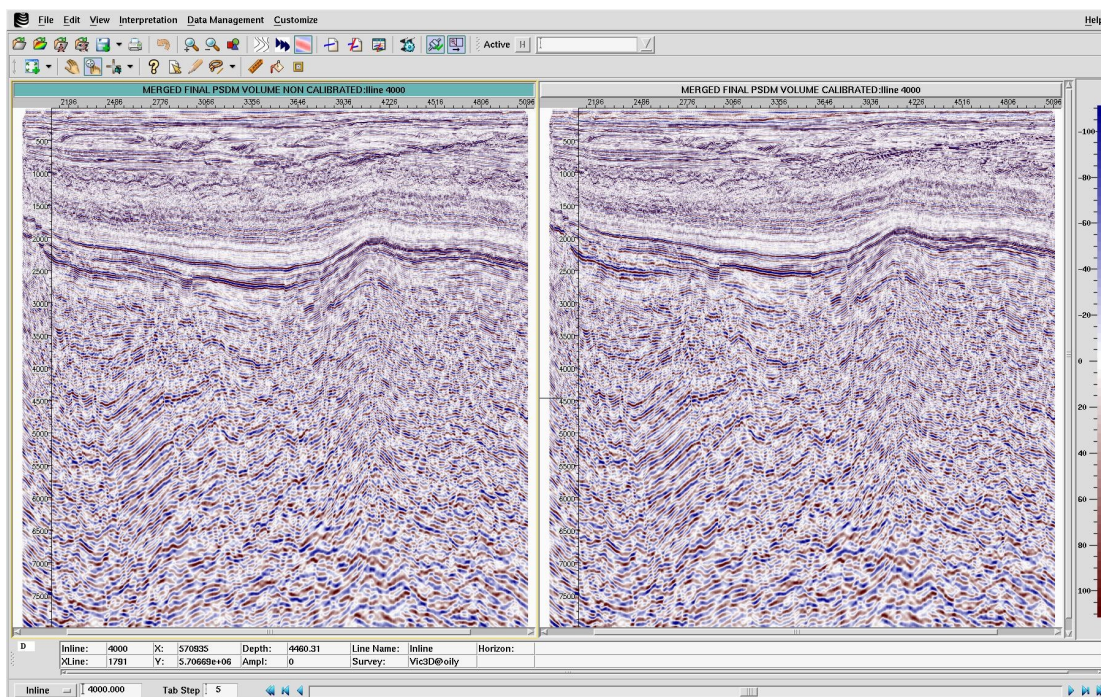
Figure 75. Calibration misties horizon 022

Figure 76. Calibration misties horizon 024

Figure 77. Calibration misties horizon 035

Figure 78. Calibration misties horizon 051

Figure 79. Final PSDM cross-section non-calibrated and calibrated

Figure 80. Final PSDM cross-section non-calibrated and calibrated

Figure 81. Final PSDM cross-section non-calibrated and calibrated
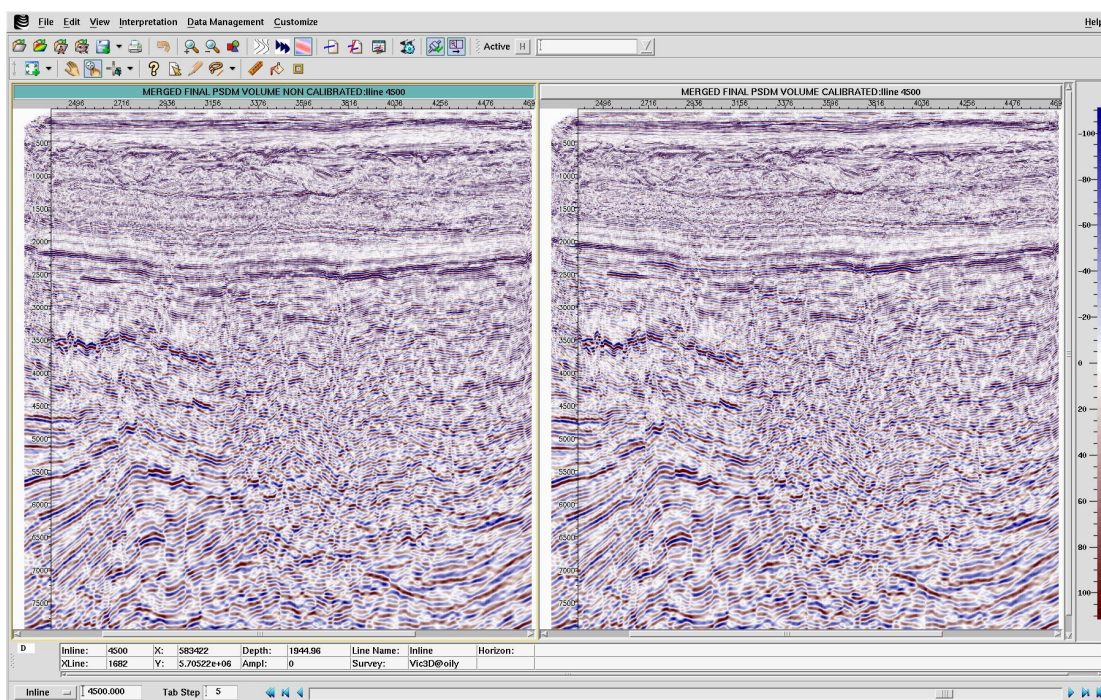
Figure 82. Final PSDM cross-section non-calibrated and calibrated

18.6 Anisotropy Calculations

a) Anisotropy Overview

The propagation of elastic waves in media is which velocity varies with direction and azimuth of propagation is referred to an anisotropy. Delta (**Δ**) and Epsilon (**E**) are the crucial anisotropy parameters, where Delta is a parameter for near vertical P-wave propagation and Epsilon describes the fractional differences of the P-wave velocities in the vertical and horizontal directions. Both Delta and Epsilon are usually of the same order of magnitude and for the small angle (is the phase angle between the wavefront normal and the symmetry vertical axis). Therefore since most reflection profiling takes places with small E, Delta will dominate most anisotropic effects for P-wave propagation.

b) Technical Workflow for obtaining Delta Interval Parameter

1. Obtaining the optimal Isotropy Interval velocity (V0)

2. Converting Sonic Slowness logs into Sonic Velocity log (Va), which represents the vertical anisotropy velocity from the well.

3. Creating synthetic well logs from Isotropic Interval velocity (V0)

4. Applying the following relationship to the Synthetic Isotropy velocity log (V0) and the Sonic Log (Va):

$$n = \frac{1}{2}\left(\left[\frac{V0}{Va}\right]^2 - 1\right)$$

5. Gridding and analyzing the Delta log values along the Horizons

Calculating Delta Interval Parameters

Final Interval Velocity Volume was used as Optimal Isotropy Interval Velocity (V0).
For each of the Project wells Sonic Slowness logs were converted into Sonic Velocity and smoothed for more convenient delta log calculation. Figure 83 and Figure 84 show Sonic velocity Logs for wells Omeo-2A and Bream-5.

For all wells synthetic well logs from Interval Velocity volume were generated using Synthetic Modeling tool. Figure 85 and Figure 86 show Synthetic Sonic Velocity logs (Va) for wells Omeo-2A and Bream-5.

Formula $n = \frac{1}{2}\left(\left[\frac{V0}{Va}\right]^2 - 1\right)$ was applied in log calculation for each one of the wells where sonic logs were available and as a result Delta well logs generated and saved per each well. Figures 85 and 86 show Delta log at wells Omeo-2A and Bream-5.

Anisotropy calculation results and conclusions

Delta grids were generated using calculated Delta logs with intersection of TWT Maps. Figures 87-89 represent Delta map for Horizons 005. Control points show the values of Delta logs at the intersection with TWT map.

Table 1 represents Delta values for test locations at horizons intersections:

	LUDERICK-1	OMEO-1	OMEO-2A	TARRA-1
005	0.012	-0.034	-0.009	-0.028
024	0.042	0.0081	0.0083	0.125
094	-0.095	-0.029	-0.009	0.062

Average Delta values in this project are very close to the typical shale delta values and can be considered as a case of "weak" anisotropy (Thomsen L.,1986), where isotropic approach is generally successful. The conclusion to this study was that the calculated anisotropy variables are too small to have any impact on the migration and therefore should not be used.

Figures

Figure 83: Sonic Velocity log for well Omeo-2A
Figure 84: Sonic Velocity log for well Bream-5
Figure 85: Synthetic Sonic Velocity log (Va), well Omeo-2A
Figure 86: Synthetic Sonic Velocity log (Va), well Bream-5
Figure 87: Delta log for well Omeo-2A
Figure 88: Delta log for well Bream-5
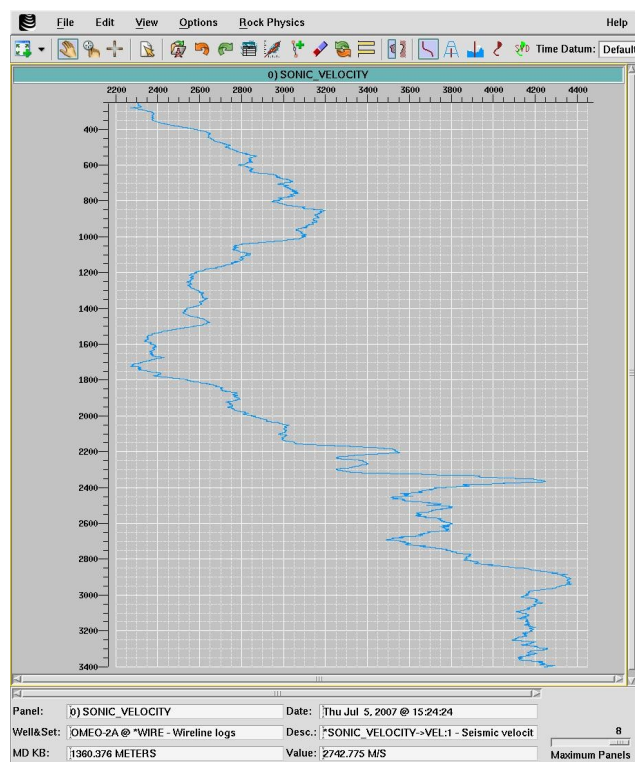Figure 89: Delta map for Horizon 005

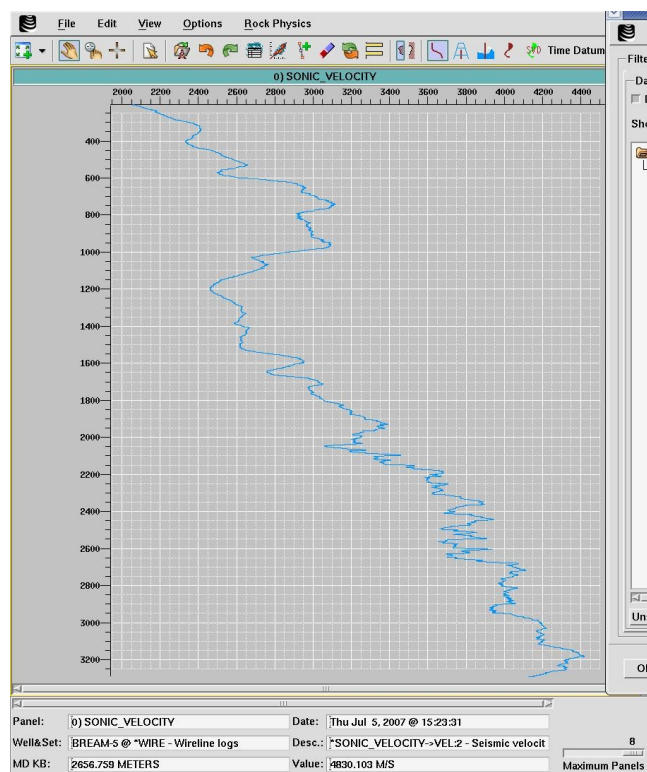Figure83. Sonic Velocity log for well Omeo-2A
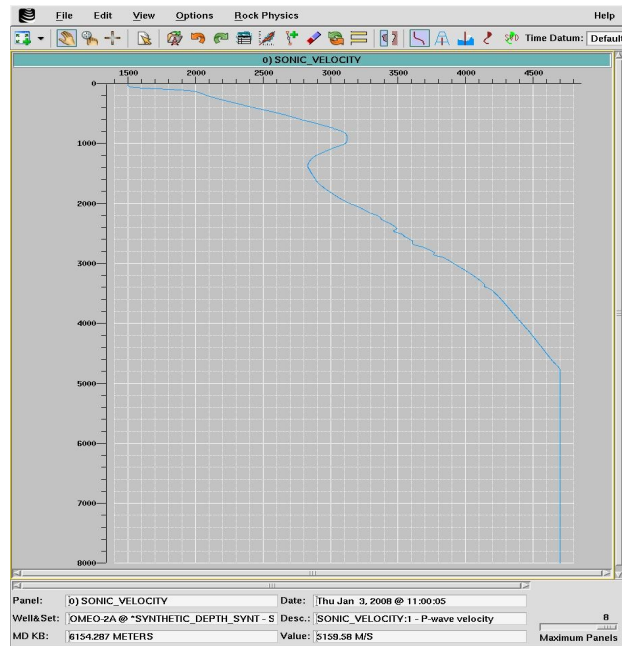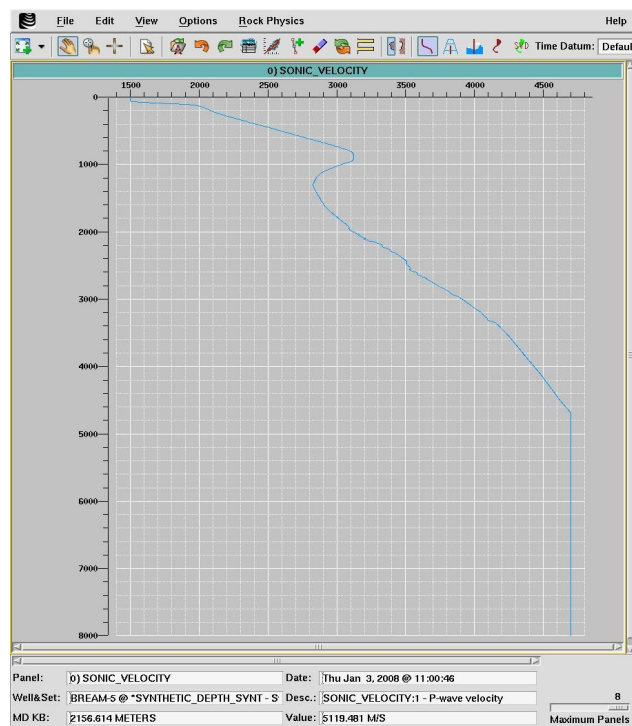

Figure84. Sonic Velocity log for well Bream-5

Figure 85. Synthetic Sonic Velocity log (Va), well Omeo-2A

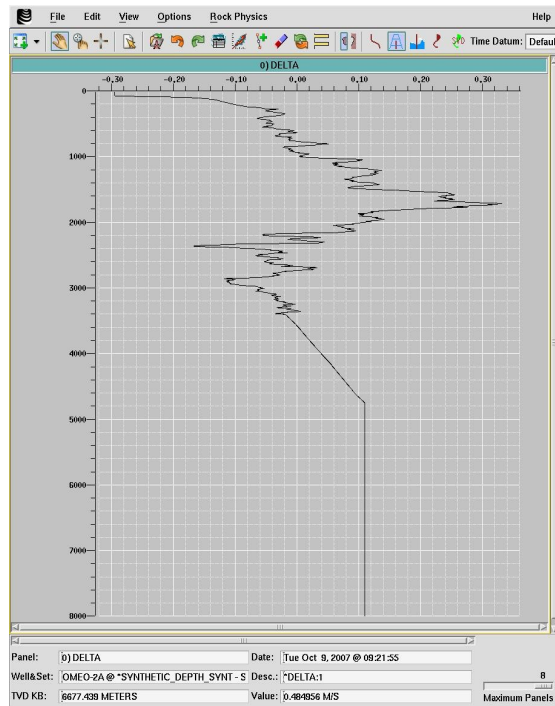Figure 86. Synthetic Sonic Velocity log (Va), well Bream-5
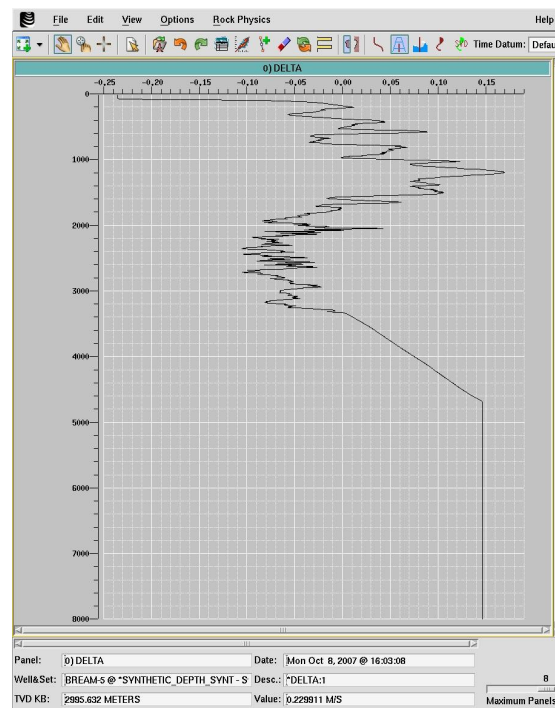
Figure 87. Delta log for well Omeo-2A
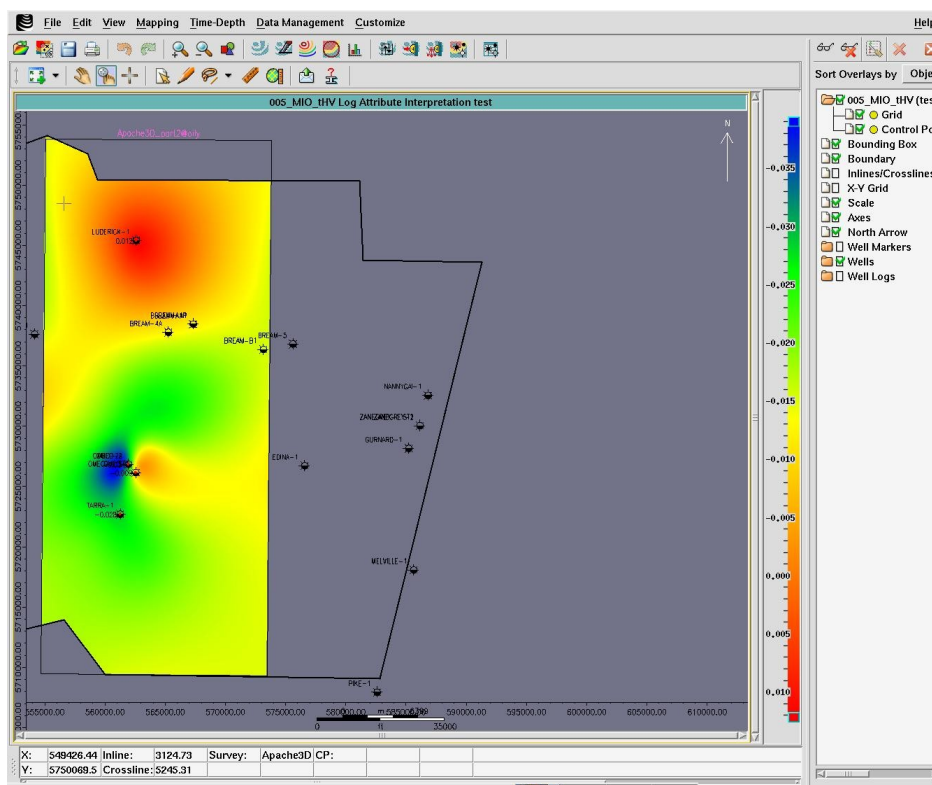

Figure 88. Delta log for well Bream-5

Figure 89. Delta map for Horizon 005

18.7 Conclusion and Recommendations

1. The Gippsland West project has three integrated surveys that were carefully merged and balanced in the preprocessing stage.
2. Vic42 permit is a good example for the importance PSDM in areas that have complex channels and rapid changes of velocity.
3. The input CMP gathers using all offsets derive a better image than the uniformed 80 fold dataset.
4. The initial velocity process was based on CVI above TOL and a combination of CVI and Vo+G below. The initial velocity volume showed excellent correlations to wells.
5. The Velocity below TOL was not well captured by the input stacking velocity VF. It is recommended to use RMS velocity as input (see FSI proposal).
6. The global update solution worked in the most consistent way and converged to the correct geophysical and geological model.
7. Velocity update: Six iterations of velocity update were used to converge to the final solution. It is recommended for future projects to use RMS (2nd pass if available) as input vertical function for the initial velocity estimation.
8. Velocity update: The phantom horizons below TOL did not follow the earth-model trend and could not help converging to the geological solution. It is recommended to provide as many horizons as possible for the initial velocity estimation and the update to enable the global update to converge quickly and accurately.
9. The additional horizons that were provided by the client for iterations IT4, IT5 and IT6 helped to converge to the correct geophysical and geological model.
10. After the final iteration IT6, the velocity volume captured the velocity variation above and below TOL.
11. Anisotropy values were small and were not used in the production migration.
12. The production CRP gathers had the uniformed range of 100-4700 meters. The minimum input offset is over 200m and outside Marie area the maximum cable length was 4200m. Therefore, the minimum offset (first two traces) and the far offsets in that area are the product of extrapolation and should be treated accordingly.
13. Inside the Marie area the gathers were flat to the full cable length.
14. The production migration derived a focused image and flat gathers.
15. The final 1D residual picking corrected the small residuals to enhance the final image.
16. The calibrated velocity volume preserved the velocity trend of the final Interval velocity volume.
17. The calibrated seismic volume has very small mistie to the wells (half a sample at the most).
18. The interpolation method that was used in the calibration process was adequate for the area and the number of control points.
19. This calibration is one of many calibration methods. It is recommended to explore other plays through depth conversion and statistical validation.