NS24-S06-01E/2E

THRUMCAP SURVEY GEOPHYSICAL REVIEW

November 2002

3D Seismic Survey over licenses EL2359, EL2381 and EL2382 Offshore Nova Scotia

Program No. NS24-S6-1E/2E

Operator:	**Shell Canada Ltd**
Seismic Acquisition Contractors:	**Western Geophysical (2000)** **WesternGeco (2001)**
Seismic Data Processing Contractor:	**CGG Canada Services Ltd**

VOLUME 1 OF 2

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1. INTRODUCTION

The Thrumcap 3D seismic survey was acquired during the summers of 2000 and 2001. The data was acquired for exploration purposes and the survey was named 'Thrumcap' after one of the prospects in the area. The survey totals some 4530 km^2 and covers the license blocks EL2359, EL2381 and EL2382 located SW of Sable Island, offshore Nova Scotia.

The EL2359 partnership (ChevronTexaco and PetroCanada) and the EL2381 & 2382 partnership (Shell Canada, ExxonMobil and ChevronTexaco) own the data covering their respective licenses. This report provides a summary of the acquisition and processing of the whole survey, whereas the discussion of the interpretation results is restricted to the southern part of the survey covering EL2381 & 2382. A separate report will be submitted by the License owners of EL2359.

The interpretation of the data is currently ongoing. The structural elements of the area are illustrated in this report by a series of time, depth and isopach maps spanning Tertiary through to Top Basement horizons.

Significant improvement in seismic imaging has been attained by the 3D data compared to the previous 2D data. In particular, a better resolution beneath and adjacent to the allochthonous salt structures has been obtained.

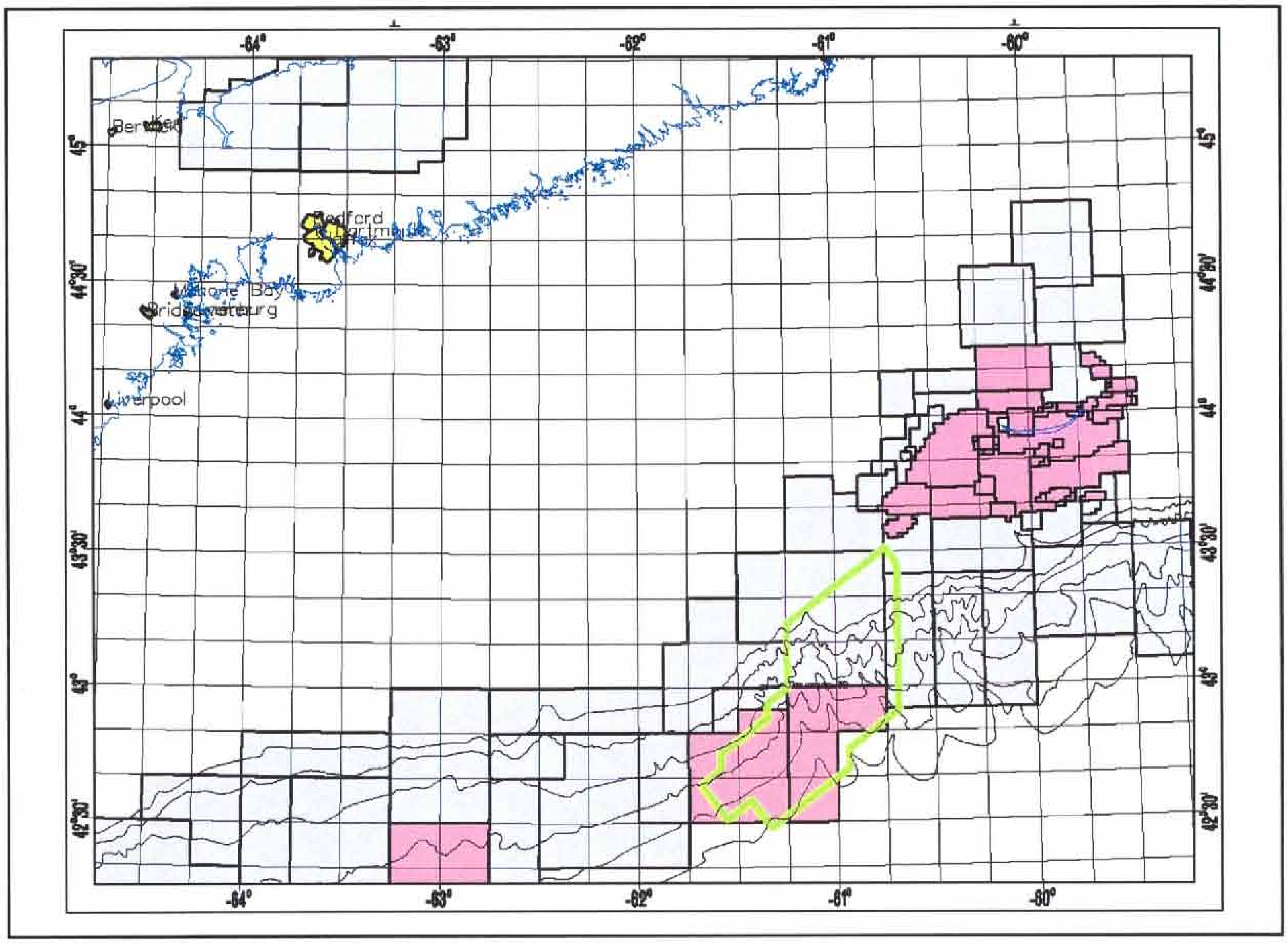


Figure 1.1: Map showing the Thrumcap 3D survey situated SW of Sable Island, in waterdepths from 70 to 3,300 meters.

2. DATA ACQUISITION

Western Geophysical was awarded the contract for the acquisition of approximately 4530 square kilometers of seismic data over license blocks EL2359, EL2381 and EL2382 offshore Nova Scotia. The survey was named 'Thrumcap' after one of the prospects in the area and was to be completed within one season, i.e. 2000. However, due to a late start, some technical downtime and periods of bad weather, the vessel had to return in April 2001 to finish the program. The survey area is positioned on the edge of the continental shelf 100 kilometers south of Sable Island in water depths that vary from 70 meters in the North-East to 3200 meters in the South. Data acquisition commenced in 2000 on May 30th but was not completed until June 15th 2001 after a total of 202 operating days during which, a daily average of 22 square kilometers of data were recorded. One Lost Time Injury was suffered when a seaman on the support vessel, Ocean Foxtrot, slipped on deck and sustained a rib injury.

The vessel used was the Western Monarch, a modern purpose built seismic ship, capable of towing eight streamers. The vessel was configured to acquire data using two source arrays, firing alternately every 31.25 meters, and eight streamers each of 6400 meters in length. On occasions however, due to either a temporary reduction in engine power or a short period of good weather within an overall bad weather period, the vessel was configured to tow only six streamers.

The recording instrument was an Input/Output MSX 24-bit system with up to 4096 data channels utilizing fiber optic telemetry. Each source comprised three strings of twelve sleeve air guns with a total volume of 3750 cubic inches, operated at a pressure of 1900 p.s.i. The digital streamers were of the new solid foam construction, which offer greater stability in rougher sea states and, since they are not filled with buoyancy oil, present less risk to the environment. Being of a thinner diameter to conventional oil-filled streamers they require less reel capacity onboard.

Onboard seismic data processing was conducted to help assess data quality using WesternGeco's IBM SP-2 based OMEGA system. Processed data products included brute stacks, filtered migrations and a near trace data cube. Real time binning of the data was performed with Concept Systems Ltd's REFLEX Coverage Monitoring System.

The survey used standard dGPS methods for positioning the vessel, the gun floats and the tailbuoy floats. The vessel used dGPS correction values from two contractors – Fugro and RACAL – who each have a number of reference stations in the East Coast of Canada and the NE USA. Estimated absolute accuracy of the vessel position is 2 to 3 meters. The gun and tailbuoy floats were positioned relative to the vessel using rGPS techniques. This yields an estimated absolute accuracy of 3 to 5 meters.

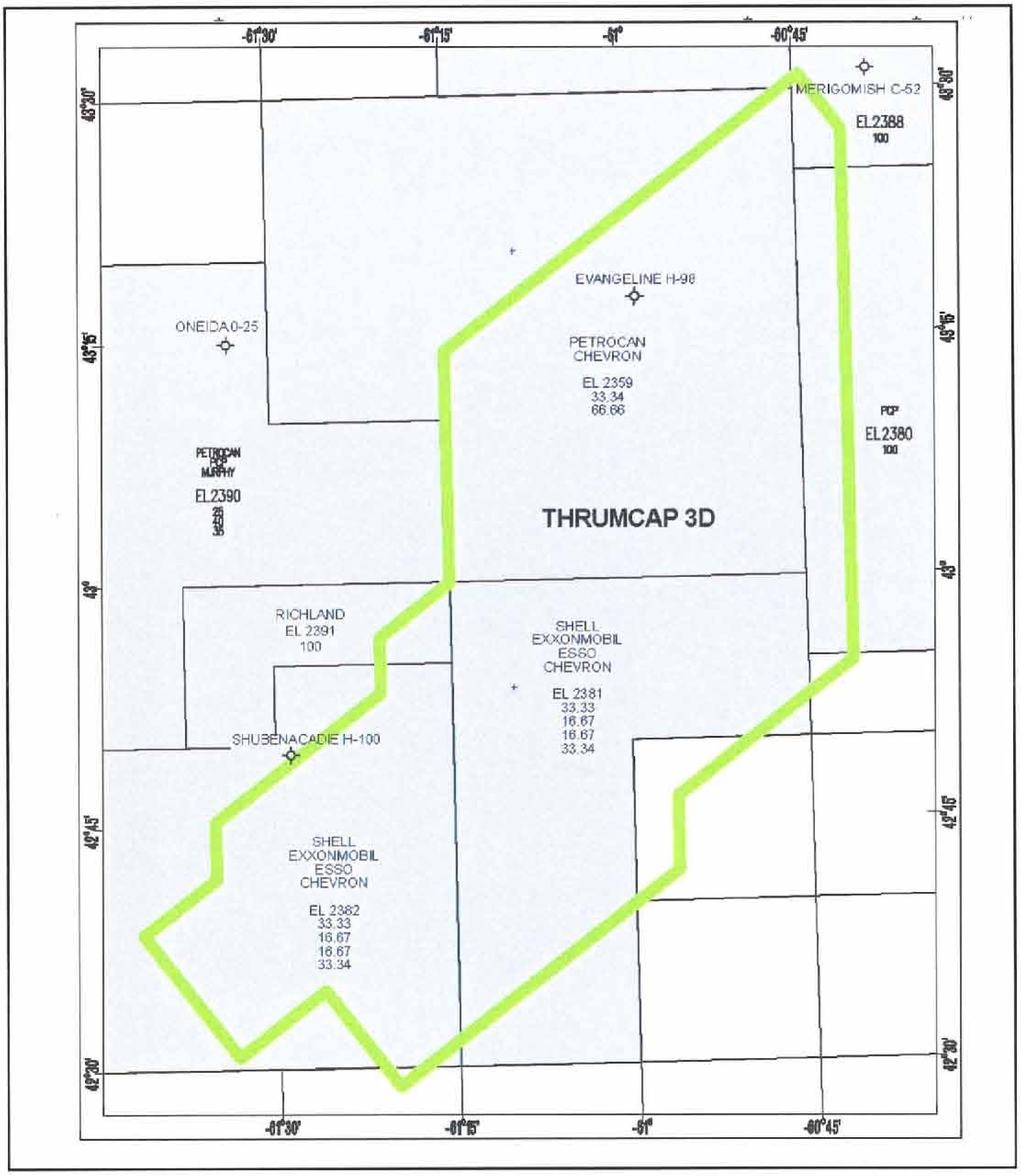


Figure 2.1: Map showing survey outline, block boundaries, percentage ownerships, and wells in the survey area

Guns and streamer positions were computed using measurements from several different in-water systems along with the GPS methods mentioned above. Acoustic networks were used to measure the distances between different parts of the front end of the in-water gear, the distances between the streamers at the approximate middle of the streamers, and at the end of the streamers where they attach to the tailbuoys. Compasses were used on each streamer to estimate the magnetic heading along each streamer. Physical relationships between devices held at fixed distances from each other were described as distances and relative angles. All measurements were entered into a least squares network to calculate positions of critical points in the system, along with accuracy estimates. Lowest accuracy is experienced at mid-streamer, where the absolute accuracy approaches 10 meters at times. For every shotpoint there were approximately 4,100 positions calculated.

Bathymetric readings were recorded at every shotpoint using an echosounder, and temperature/salinity measurements were collected for the first 1,700 meters of the water column every month or so during the survey period. Additional measurements of the near-surface water temperature and currents were collected using an Acoustic Doppler Current Profiler throughout the survey, in order to get a better estimate of the behaviour of the currents in the region in anticipation of drilling activity in future years.

Bad weather hampered progress in 2000, particularly from September to November. Fog restricted the use of the workboat for fixing cable problems as well as severely disrupting crew changes by helicopter. High seas, particularly those due to hurricanes during the months of September, October and November, were responsible for the loss of 30% of the total survey time. A prompt start on May 7th the following year took advantage of particularly good weather during a six-week period in which only three days were lost due to high seas.

Currents in the area appeared to have some correlation with the bathymetric trends and, in particular, with the canyons which cross the continental slope. However, they were not sufficiently predictable to allow feather matching and, at times, appeared to be responsible for irregular separation of adjacent streamers.

The readiness of the vessel and crew for the start of the survey in 2000 was poor. Insufficient spares caused more technical downtime than anticipated and a lack of awareness of the crew of the requirements of the operator caused some difficulties. A late start and technical downtime forced the survey to continue into the bad weather season in order to acquire the priority dataset.

The following year saw the vessel and crew return much better prepared. Significant preemptive maintenance of equipment minimized technical downtime and a prompt start took full advantage of favorable weather. As a result productivity improved by 30%. HSE performance also improved with excellent reporting and zero recordable incidents.

A summary of performance indicators is given in Table 3.

3. DATA PROCESSING

The processing contract was awarded to CGG Canada in Calgary. In order to ensure that the processing was completed as early as possible, the data were shipped to CGG approximately every 2 weeks beginning early June 2000. Although CGG had originally indicated that the processing would be completed by the end of 2000, delays in the acquisition made that impossible. The final migrated volumes were delivered in October 2001.

The signal processing flow attempted to preserve amplitude and phase as much as possible. Decon was limited to a deterministic shaping of the data in order to remove gun and cable effects and zero the phase. The source signatures were provided by Western Geophysical. In the shallow water parts of the survey, a gap deco was applied to attenuate water-bottom reverberation. A smoothly varying mute function was picked using representative data from a variety of water depths, and it was then applied by hanging the function from the water bottom time. Initial velocities were picked using semblances and local constant velocity stacks on a one kilometer grid to provide a good function for subsequent multiple attenuation.

The long duration of the acquisition meant that there was a relatively high likelihood that water temperatures could produce statics problems from swath to swath. A lot of time was put into assessing this problem, however the amplitude and error bars of the solution were roughly equivalent, so cold water statics were not applied. Analysis did indicate that one line was shifted from the rest (apparently due to a recording instrument problem), and it was subsequently corrected. When the data from 2001 acquisition was compared to equivalent data from the 2000 acquisition, a very good match was observed, requiring only a small static shift.

The highly variable water-bottom caused a number of processing difficulties. The biggest of these was the high amplitude multiples, particularly the diffractions. After considerable testing, Radon multiple attenuation (using CGG's proprietary Ramur routine) combined with an inside trace mute was chosen as the primary approach to deal with the multiples. While it generally performed very well, it was unable to attenuate some of the diffracted multiples from steep sided valleys on the water bottom. However, given the size of the survey and the turn-around required, it was deemed to be our best option.

The processing flow that was used was a fairly routine pre-stack time migration (PSTM) flow, using a '*Moves*'-style approach. Following initial signal processing, the dataset was DMOed using 52 offset planes, and then each offset was migrated by a fast migration algorithm using a very smooth velocity function. The velocities were then re-picked on a denser 500m grid, the offsets were stacked, and the stack was demigrated using the original smoothed velocities. Finally, the stack was migrated with the new re-picked velocities.

Overall, the processing was performed very well. However, there was one major problem: the irregular nature of the early data deliveries caused some problems with the consistency of the velocity function interpolation. When the problem was identified, CGG was quick to correct the problem, and all of the data that were affected were reprocessed and new tapes were written.

4. DATA INTERPRETATION

4.1. Data Quality

4.1.1. Tertiary Section.

Data quality is good to excellent in the first 2s below sea floor (aka water bottom or mudline). Faults, slump features and channel incisions are generally well imaged.

4.1.2. Juro-Cretaceous Section.

Data quality is poor to fair below the base Tertiary chalk/marl sequence.

Major responsible factors include

- Variable thickness of the high-velocity chalks associated with submarine erosion. This leads to (a) absorption-related variations in bandwidth and amplitude in the underlying seismic record and (b) potential imaging artifacts due to rapid changes in the velocity field (as with salt, see below).
- Allochthonous salt bodies that introduce abrupt lateral variations in the subsurface velocity field resulting in poor illumination/imaging of base-salt and underlying sedimentary reflectors.
- Diffractive multiples associated with rough sea-floor topography, which migrate through the stacked data and impair correlations and attribute extractions in the prospective C5-C30 section.
- Random noise in the deep section, which makes basement mapping difficult to impossible.

These problems are illustrated in Fig. 4.1.1 - 4.1.5. Some of the problems can be mitigated by further processing, now underway on selected prospects.

4.1.3 Data Quality Summary

GATE/affected zone *(Gates referenced are shown in Fig. 4.1.1 - 4.1.5. Table times/horizon tops refer to zones in which mapping is adversely impacted)*					**BAND WIDTH (hz)**		**LIMITING QUALITY FACTOR**	**MAPPING IMPACT**	**POTENTIAL MITIGATION**
1	3000	WB	3800	T65	8	60	Source	Shallow Hazards	NONE
1a	3800	T65	4600	T45	8	52	Source	None	NONE
2	4600	T20	5200	Base marls	8	30	Absorptive chalks	Inconsistent bandwidth, attribute estimation	Spectral balancing beneath chalks
3	5200	Base marls	6400	C5	8	30	Allochthonous salt bodies Migrated diffractive multiples	Impossible to map subsalt traps Multiples hamper correlation and amplitude extraction	Prestack depth migration/velocity modelling Prestack multiple attenuation
4	6400	C5	8000	J210	8	24	Allochthonous salt bodies Migrated multiples Poor Signal/Noise	As above; also difficult to impossible to map basement or autochthonous salt	As above; unlikely that deep mapping will ever be convincing on this dataset

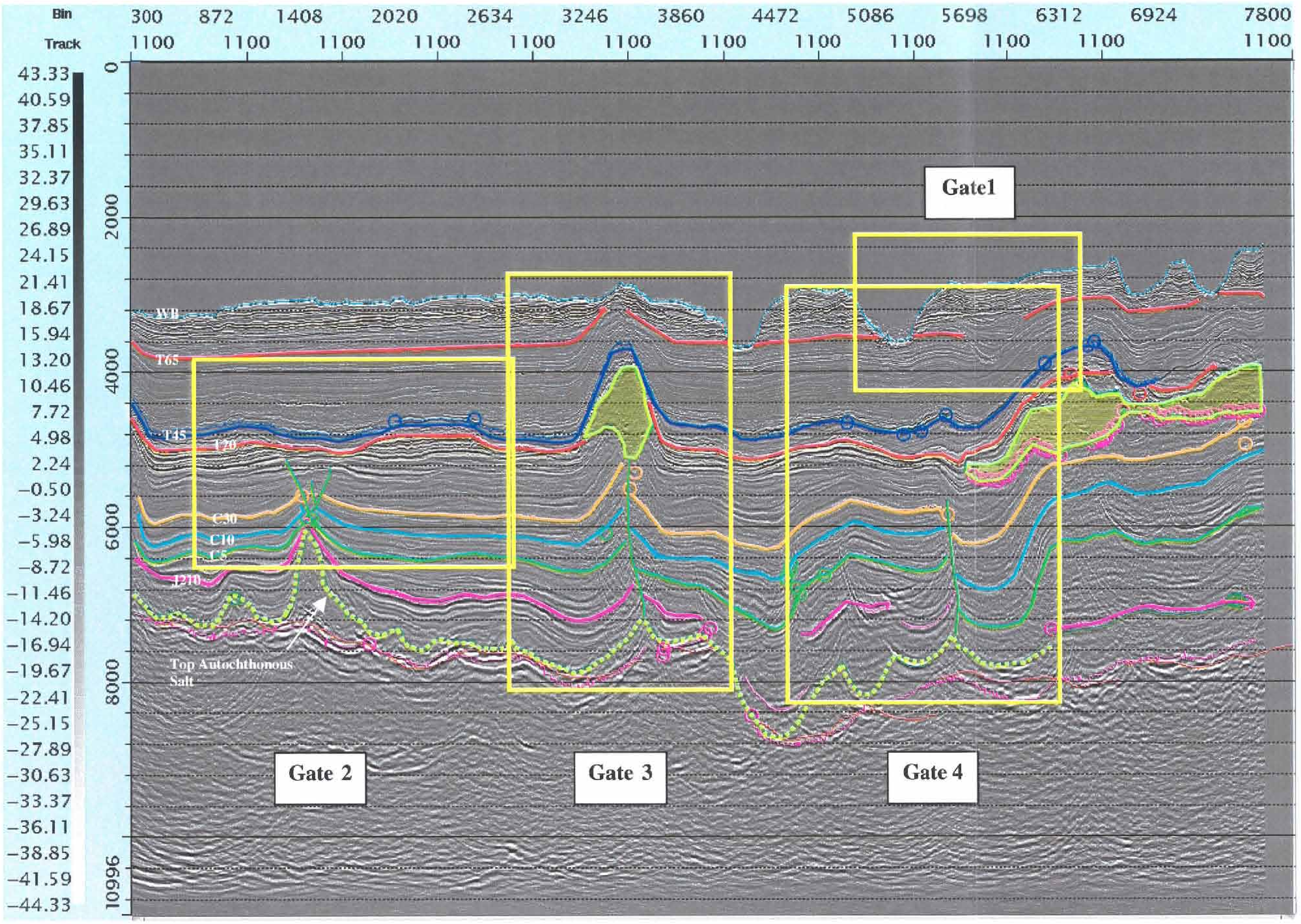
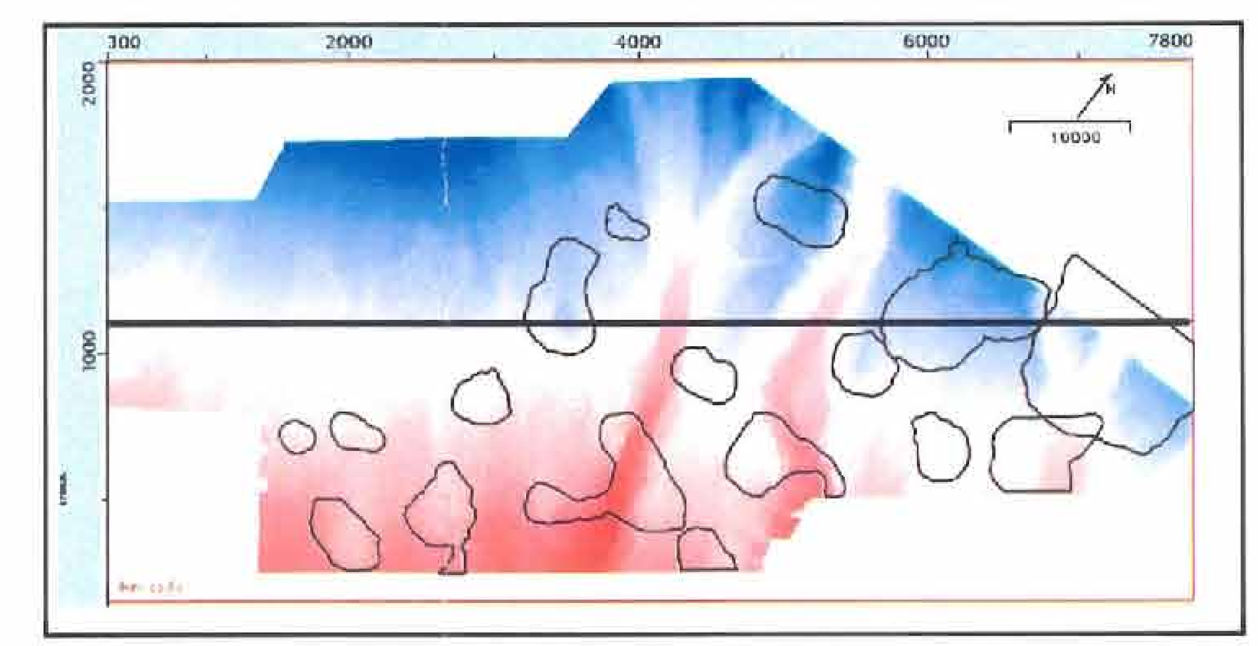


Fig. 4.1.1 *Thrumcap Survey PSTM Track 1100.*
Data quality windows demonstrate different problems. Shallow Gate 1 shows clear definition of near-surface features. Gate 2 shows variable late Cretaceous marls and chalks, Gate 3 the problems of time-domain imaging subsalt, and Gate 4 the effect of diffracted seafloor multiples propagated via migration through the stacked image.



Thrumcap Survey PSTM Track 1100 superimposed on seafloor time event. Note prominent expression of Dawson and Verrill Canyons.

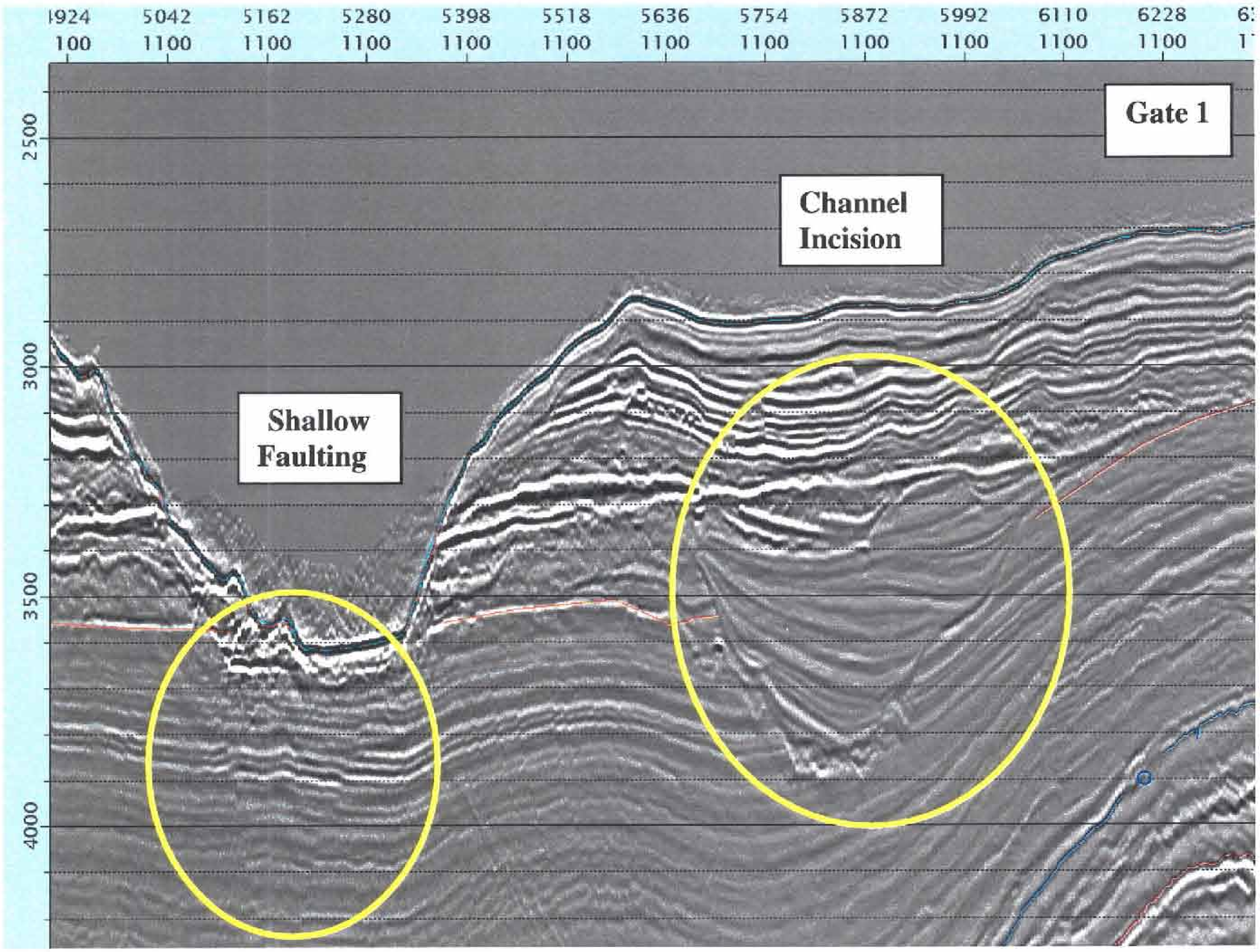


Fig. 4.1.2 Thrumcap Survey PSTM Track 1100, Gate 1, near Sea Floor.
Near-surface extensional faulting is associated with present day seafloor canyon (Verrill Canyon). Late Tertiary channel incision is plainly visible. Bandwidth ~ 8-60hz allows confident mapping of most types of shallow drilling hazard.

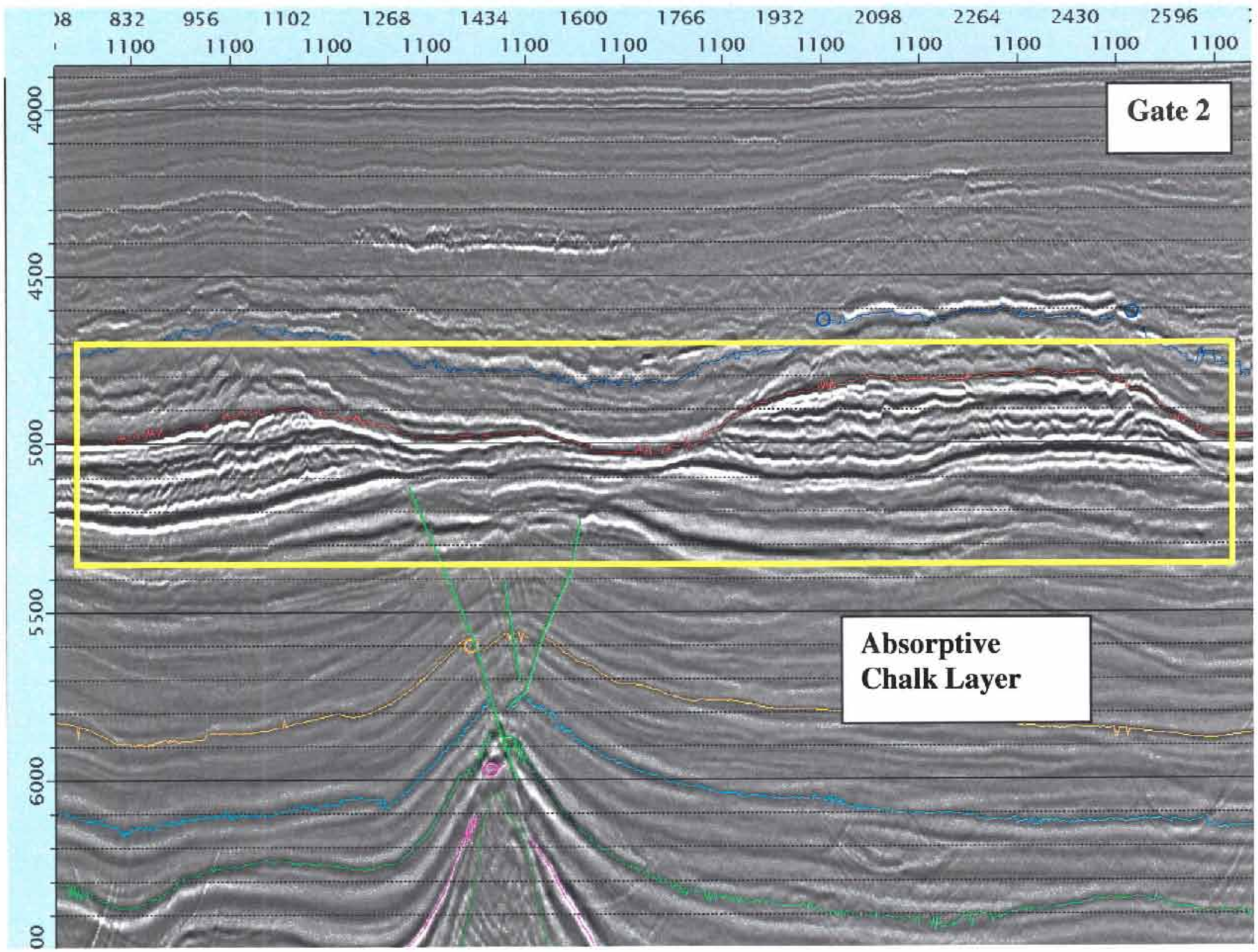


Fig. 4.1.3 Thrumcap Survey PSTM Track 1100, Gate 2, Late Cretaceous Marls/Chalks.
Subsea erosion has created a substantial thin in the regional chalk layer overlying this late salt structure. Associated rapid lateral velocity variations and absorption typically result in imaging problems and difficulties in attribute estimation within 1s 2-way time beneath such features, which are common on the survey.

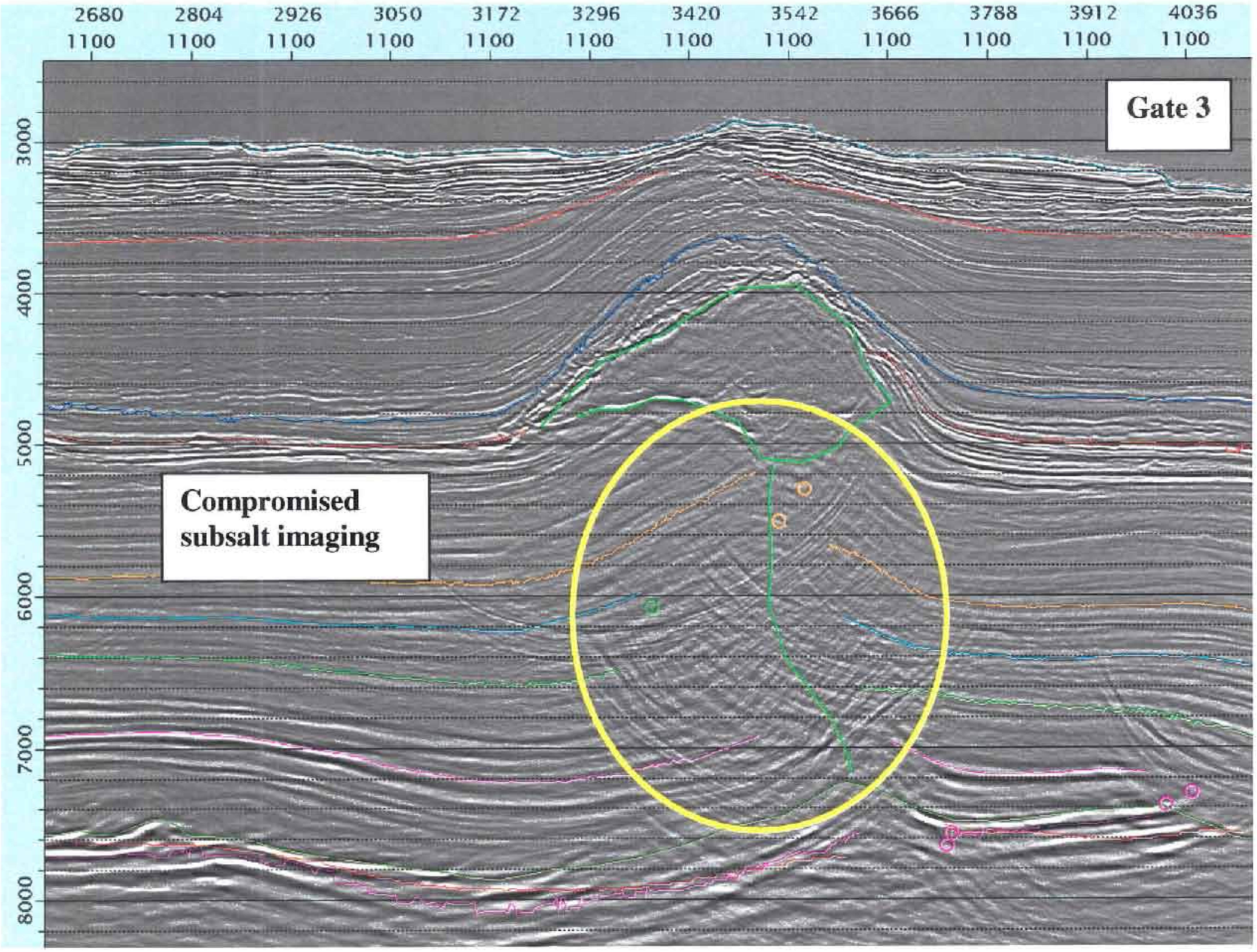


Fig. 4.1.4 Thrumcap Survey PSTM Track 1100, Gate 3, Subsalt Image Degradation.
Raypath distortion due to shallow salt makes it impossible to estimate the structural attitude of reservoir beds in this potential prospect. Prestack depth migration (now underway in selected areas of the survey) is required to clarify this image for purposes of confident mapping.

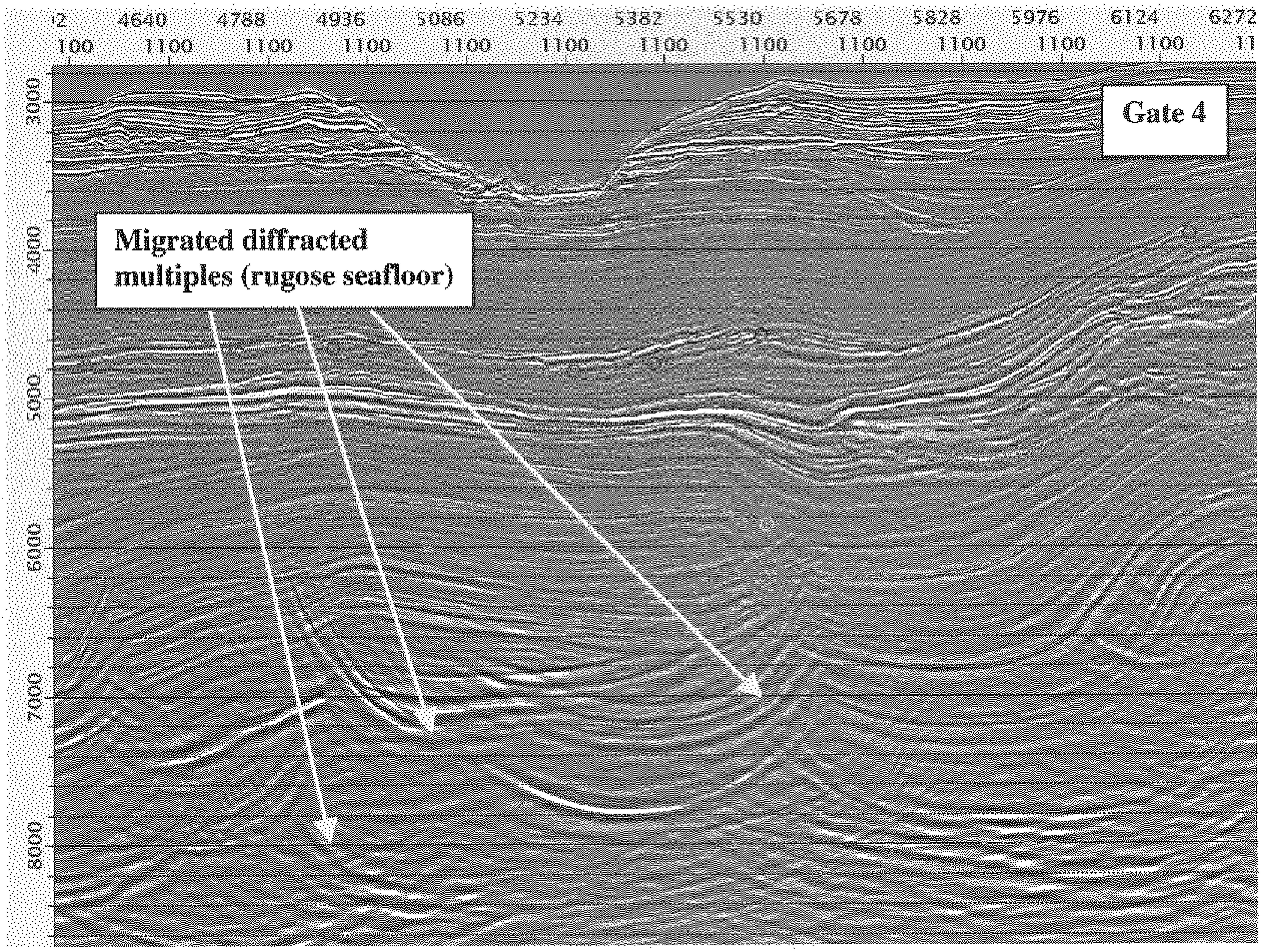


Fig. 4.1.5 Thrumcap Survey PSTM Track 1100, Gate4, Seafloor Multiple Interference.
Multiples associated with rugose seafloor often interfere with event correlation and attribute extraction, as seen on this typical survey section. Advanced multiple prediction/removal algorithms are being used locally to try to reduce this problem.

4.2. Time Structure Mapping

There are no wells within the EL2381/2382 part of the 3D survey. Shubenacadie H-100 is the closest well, located a few kilometres north of the 3D coverage (Fig. 2.1). Evangeline H-98 is located within the EL2359 part of the survey.

Well to seismic correlation for events in the EL2381/2382 area is therefore based on regional 2D lines tied to the 3D data. The ages of the mapped sequence boundaries and their relationship to the standard lithostratigraphic nomenclature can be found in figure 4.2.1. The ages were determined using high-resolution biostratigraphy from numerous wells on the shelf as well as the available deep-water wells on the slope.

The main focus of the mapping effort was the C5 to C30 interval which forms the primary exploration objective in the Thrumcap area. Figures 4.2.2 to 4.2.4 show three seismic sections from the 3D survey with the mapped horizons annotated. The location of the lines is illustrated on the key map on each figure.

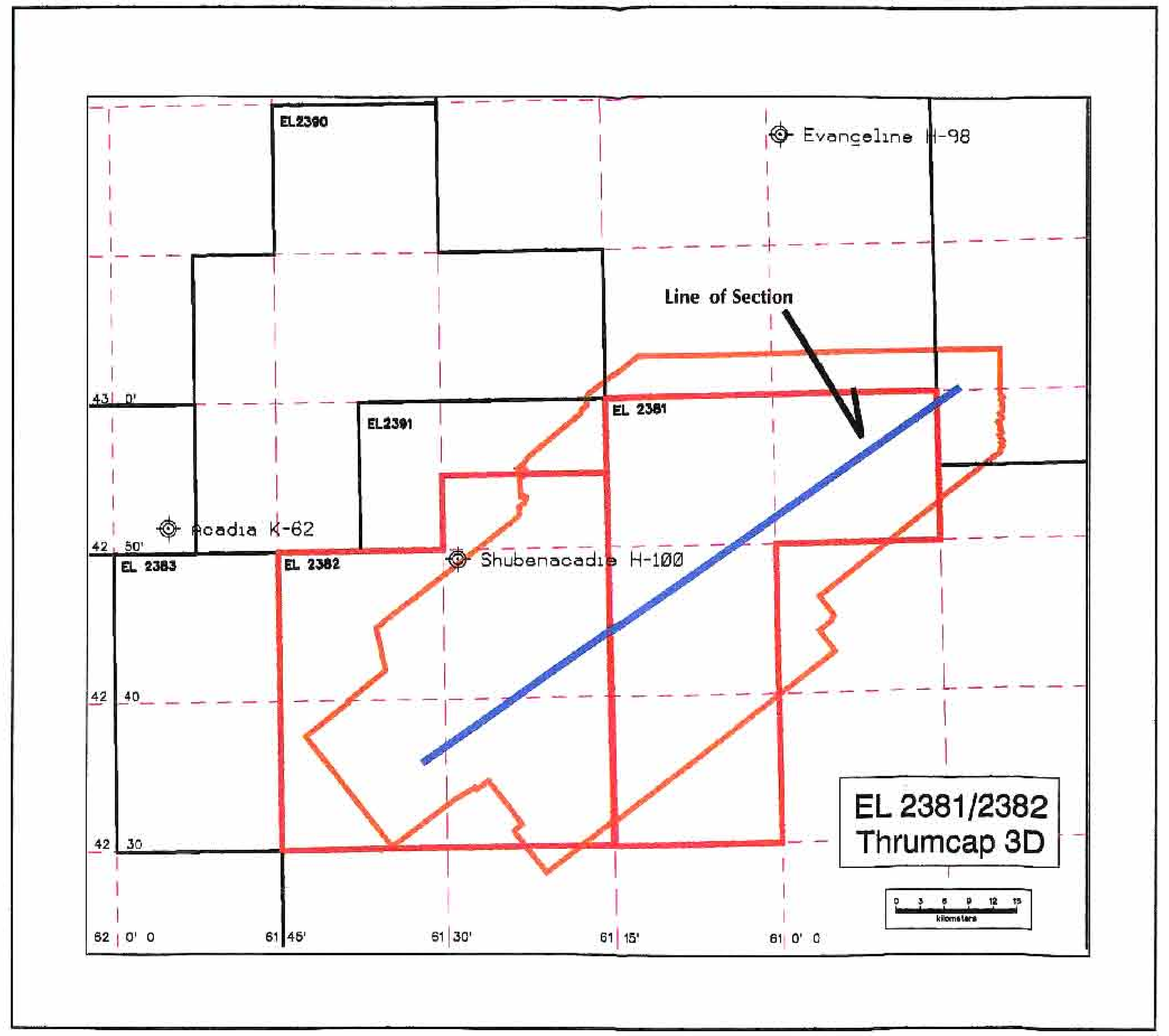
The following section (Figs. 4.2.5 - 4.2.13) comprises page size displays of the time structure maps. Large-scale (1:100 000) versions of these maps as well as the associated depth maps are also included as enclosures to this report.

4.3. Seismic Attribute Analyses

A series of horizon- and interval based attribute extractions have been made throughout the 3D survey to aid reservoir facies mapping and de-risking of prospects. However, attribute analysis remains uncalibrated because of lack of well control within the 3D survey. At this stage the results are inconclusive and the maps are not of sufficient quality or significance to include in this report.

Fig. 4.2.2 Seismic Line 910

LINE 910



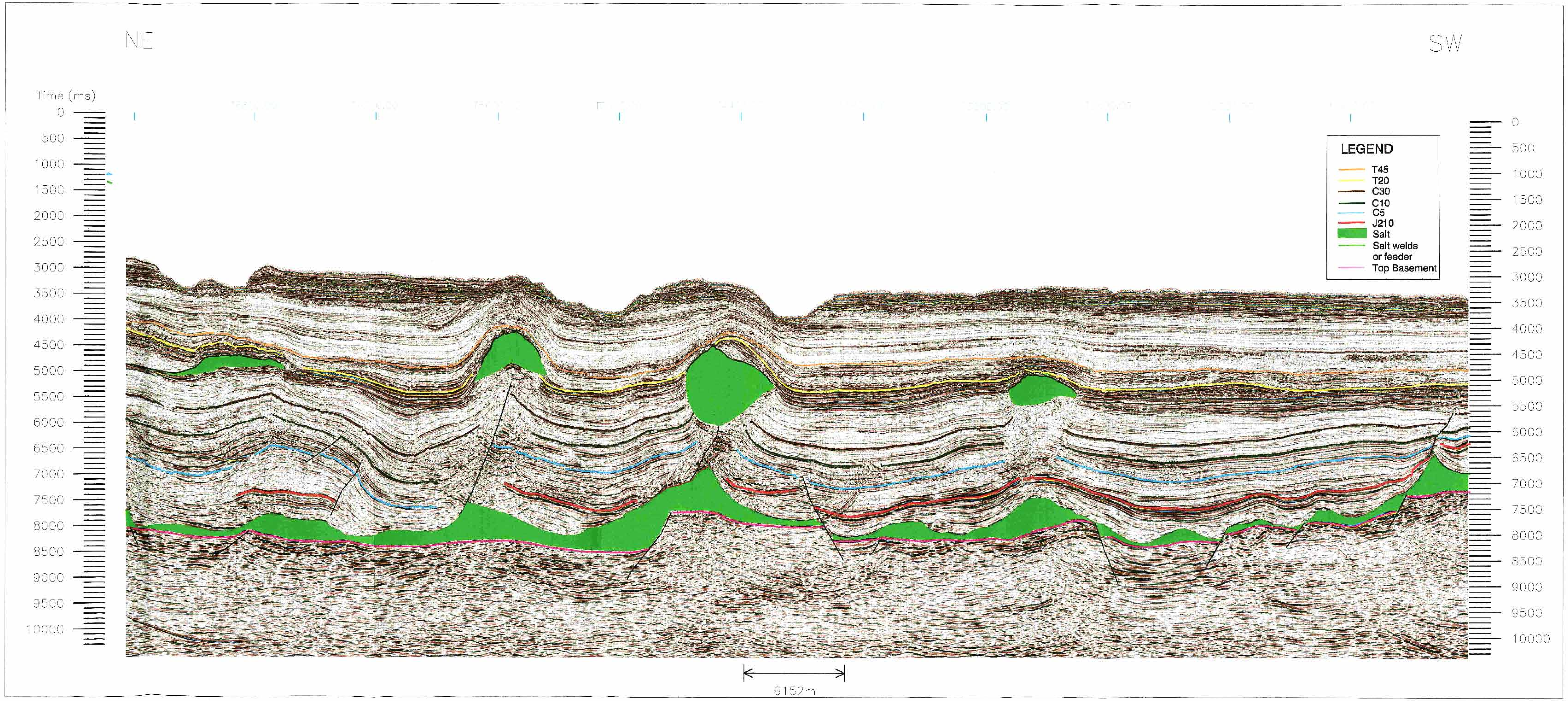


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Fig. 4.2.3 Seismic Trace 1600

TRACE 1600

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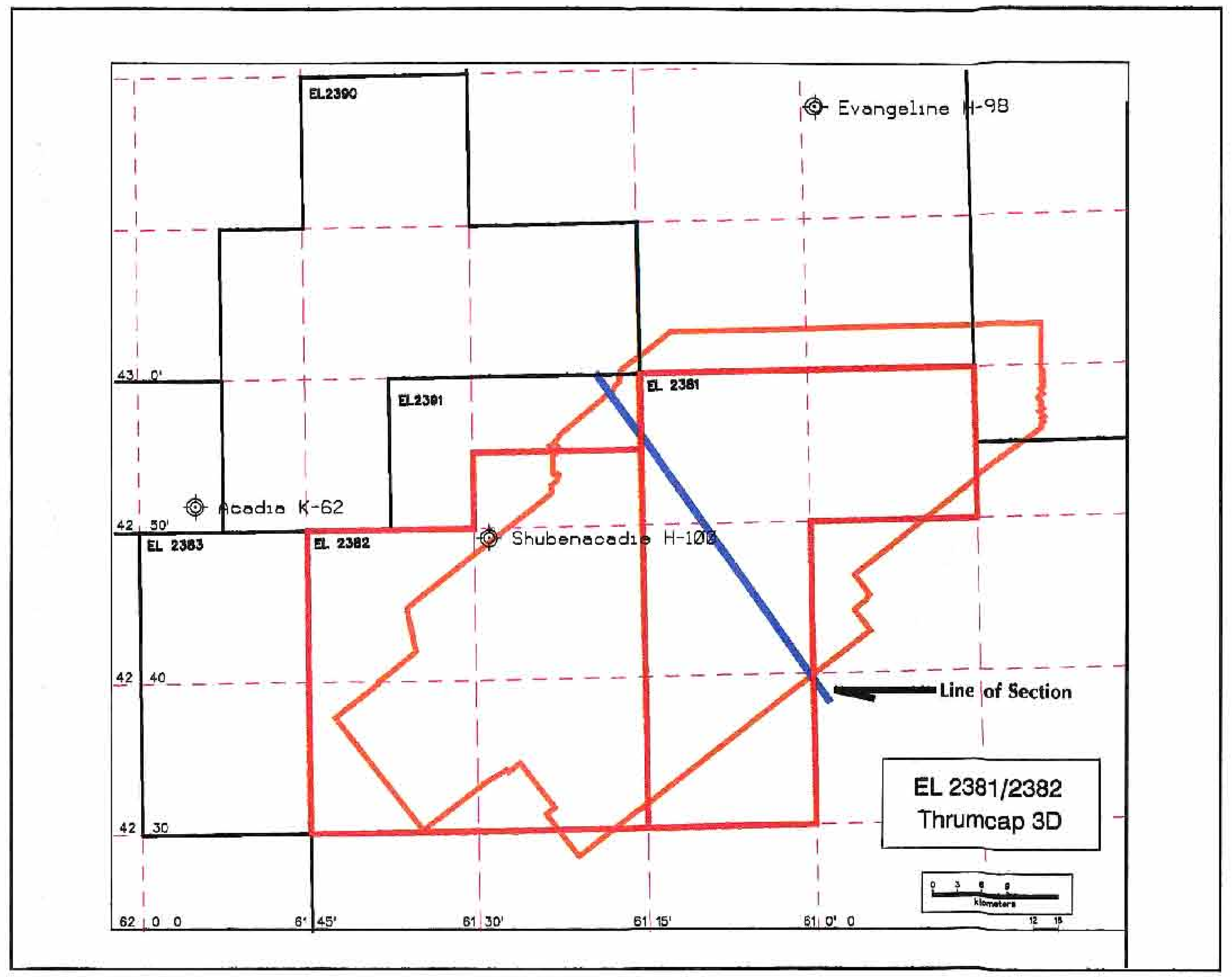
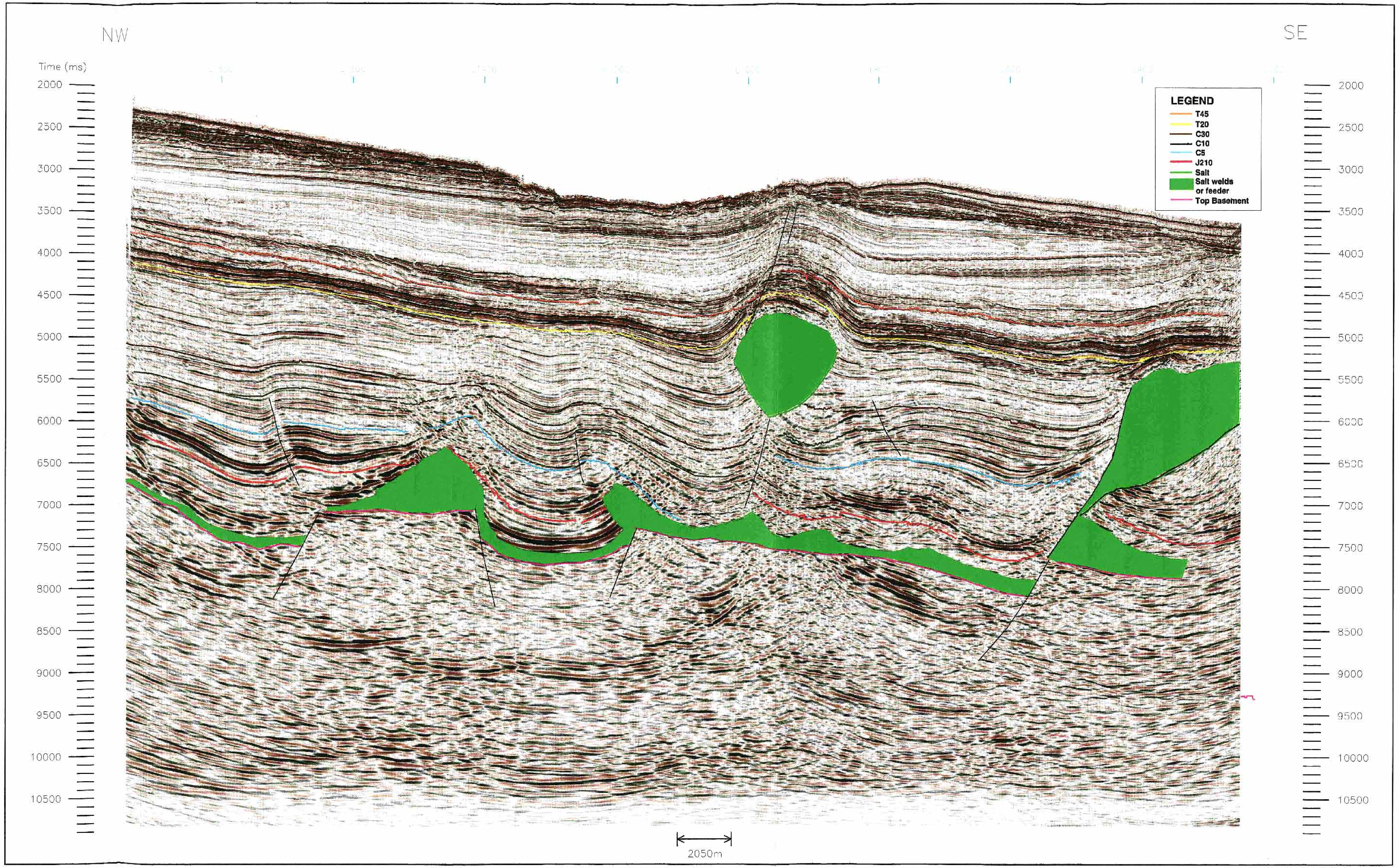
Fig 4.2.4

TRACE 4320





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SCOTIAN BASIN STRATIGRAPHY CHART

Fig. 4.2.1

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Updated August 26, 2002

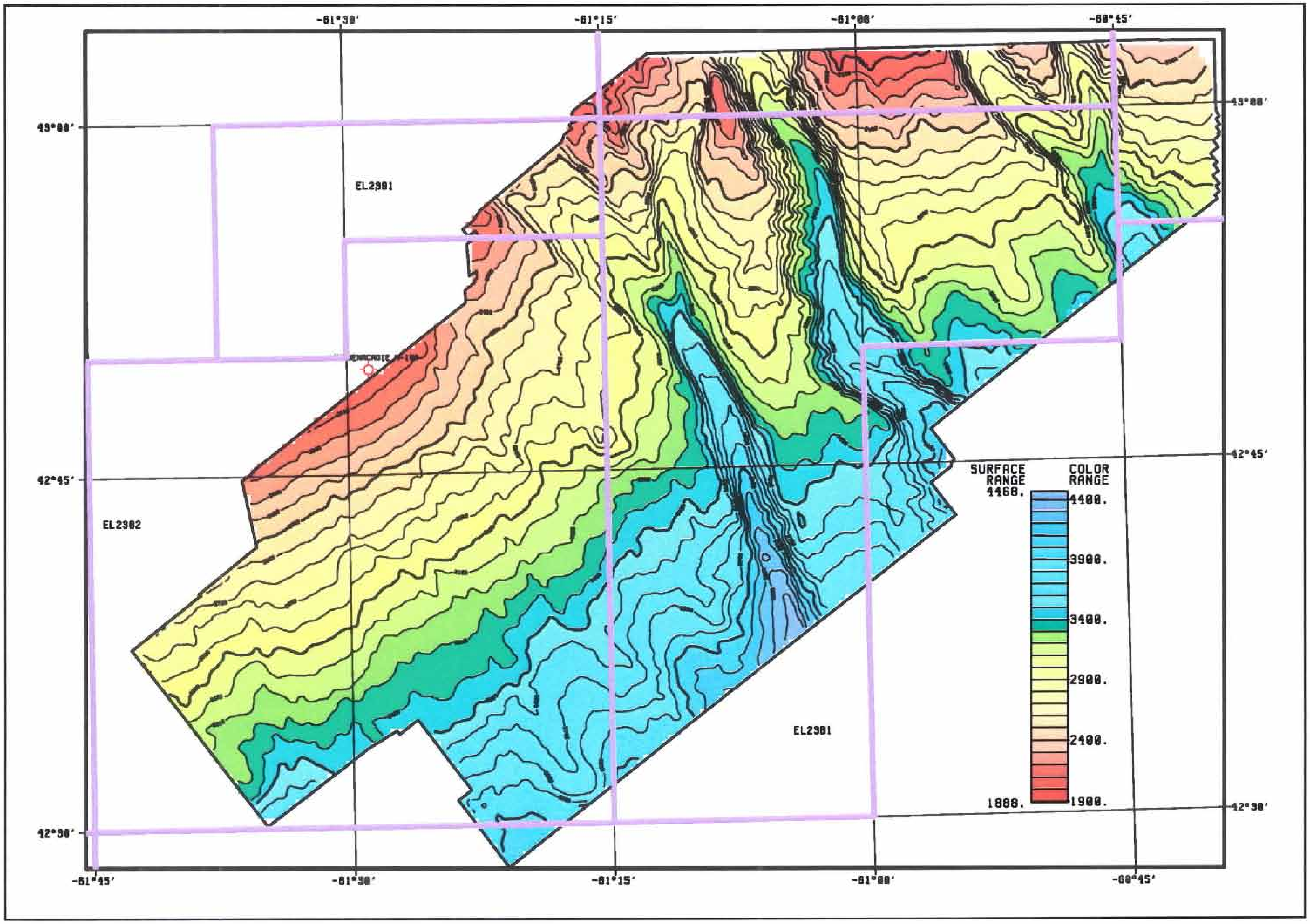


Fig. 4.2.5 Seabed Time Map
The water depth ranges from 2000 ms to 4400 ms two-way-time (1500 m to 3300 m) with a dip towards southeast. Three major channel incisions can be seen. A full-scale version of this map is included as Enclosure 1.

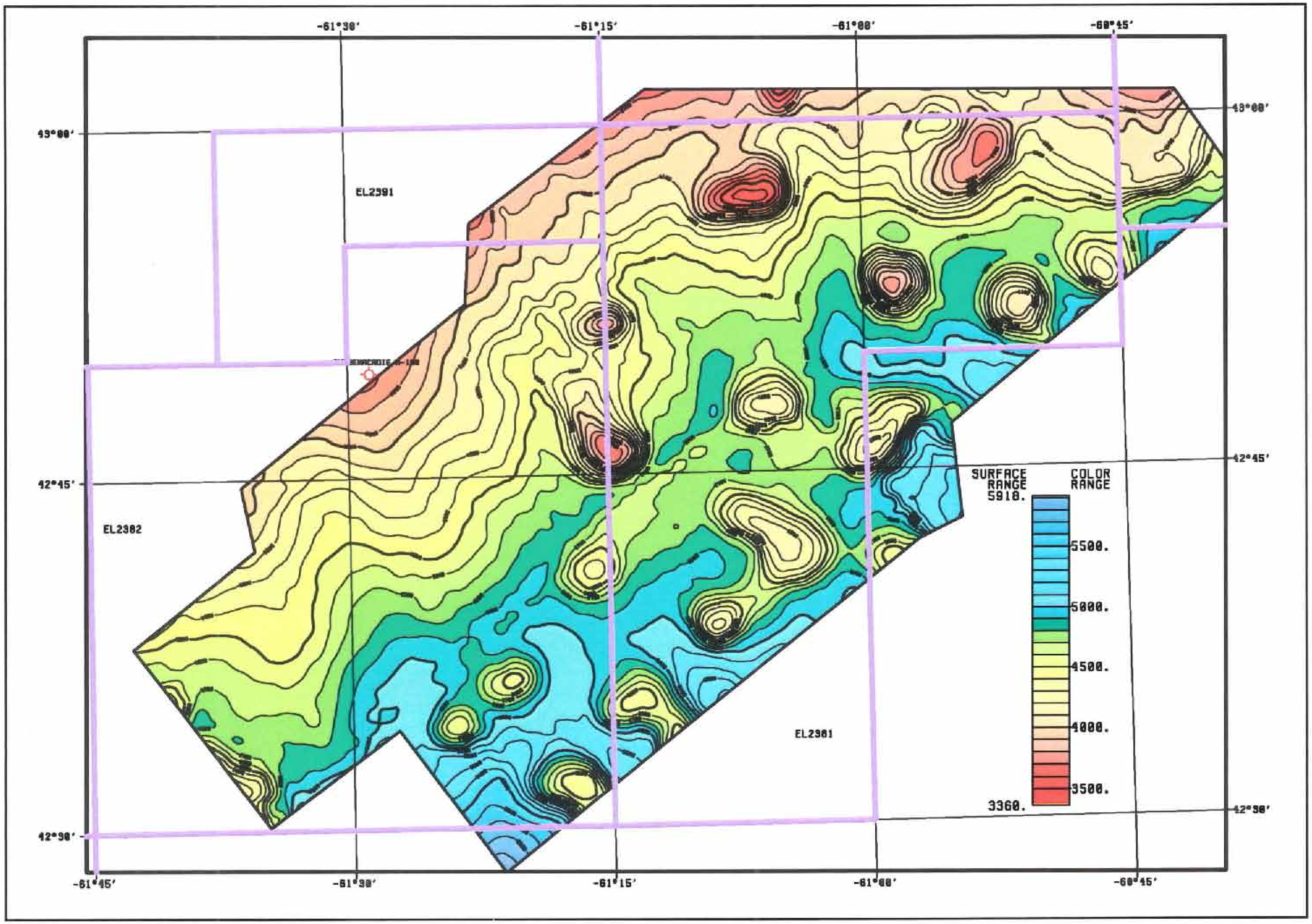


Fig. 4.2.6 T45 Time Map
The T45 marker forms a major unconformity and is correlated with a regional mid-Oligocene lowstand event. The time structure map shows a regional southeasterly dip and a number of structural closures located over underlying allochthonous salt structures. Sediments overlying the salt domes have been folded by late reactivation (inflation) of salt. A full-scale version of this map is included as Enclosure 2.

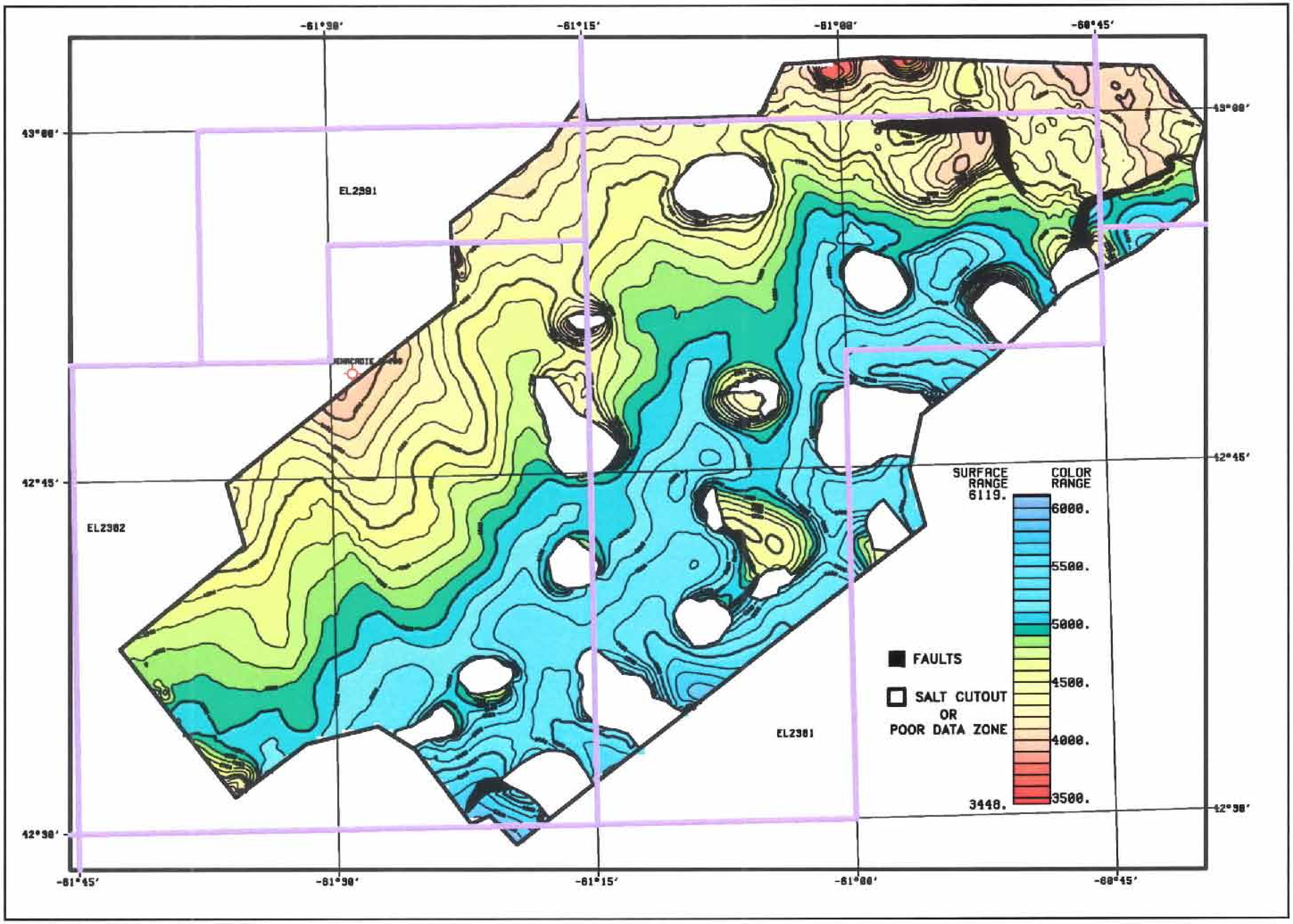


Fig. 4.2.7 T20 Time Map
The T20 event is a regionally, correlative horizon picked on top of a package of high amplitude, continuous reflectors believed to represent interbedded chalks and marls deposited near the Cretaceous/Tertiary boundary. The time structure map shows a regional southeasterly dip with occasional faulting and erosion. Structural closures are formed over some of the underlying allochthonous salt structures. The T20 event is in some areas dissected by the allochthonous salt or not interpreted due to uncertainty in the pick on the steep flanks and over the top of the salt structures. A full-scale version of this map is included as Enclosure 3.

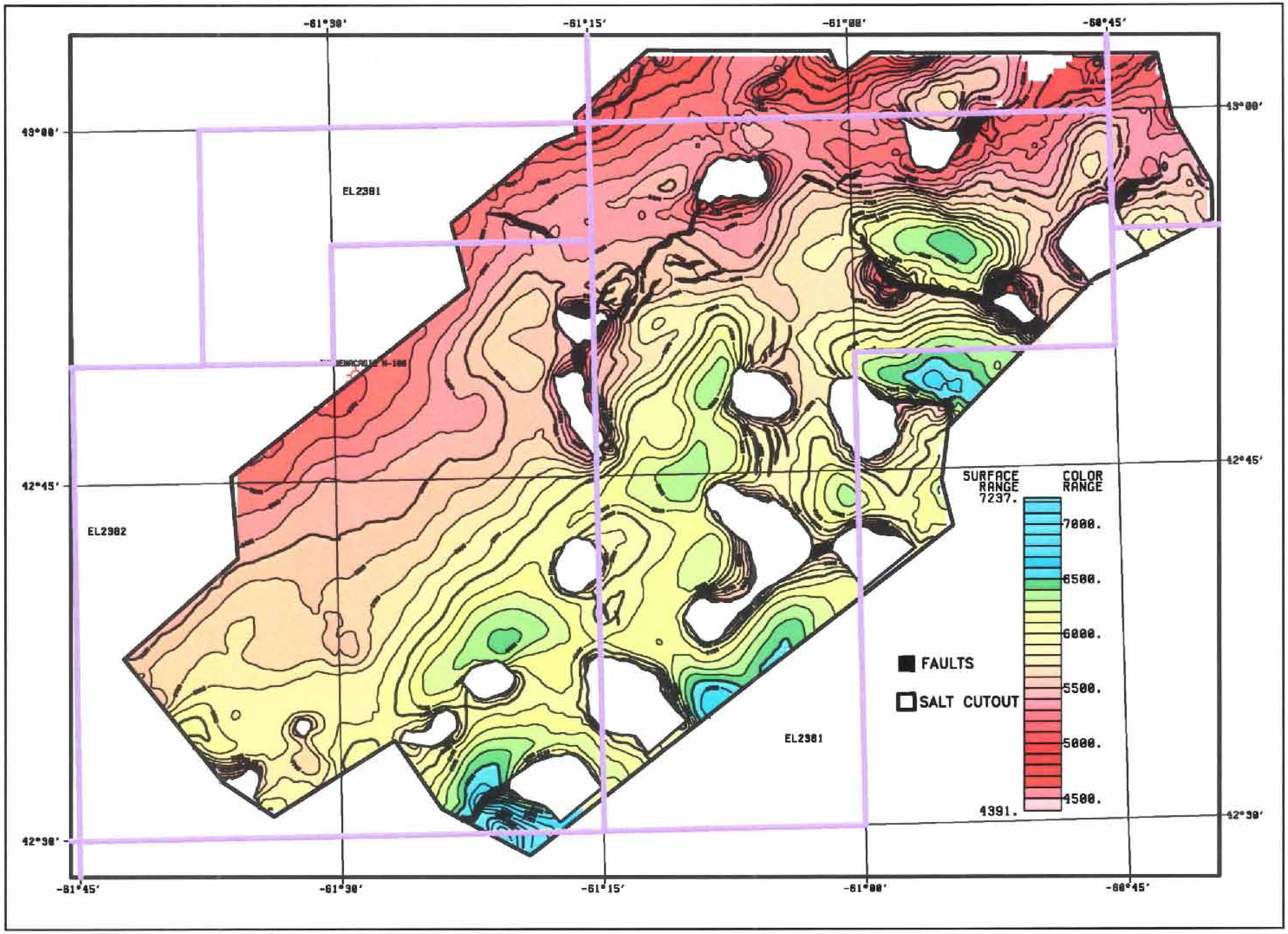


Fig. 4.2.8 C30 Time Map

The C30 event generally forms the base of a less reflective seismic package believed to represent more shale prone Upper Cretaceous sediments. The time structure map shows a general dip towards southeast. A number of allochthonous salt structure and faults dissect the horizon creating potential trapping configurations. A full-scale version of this map is included as Enclosure 4.

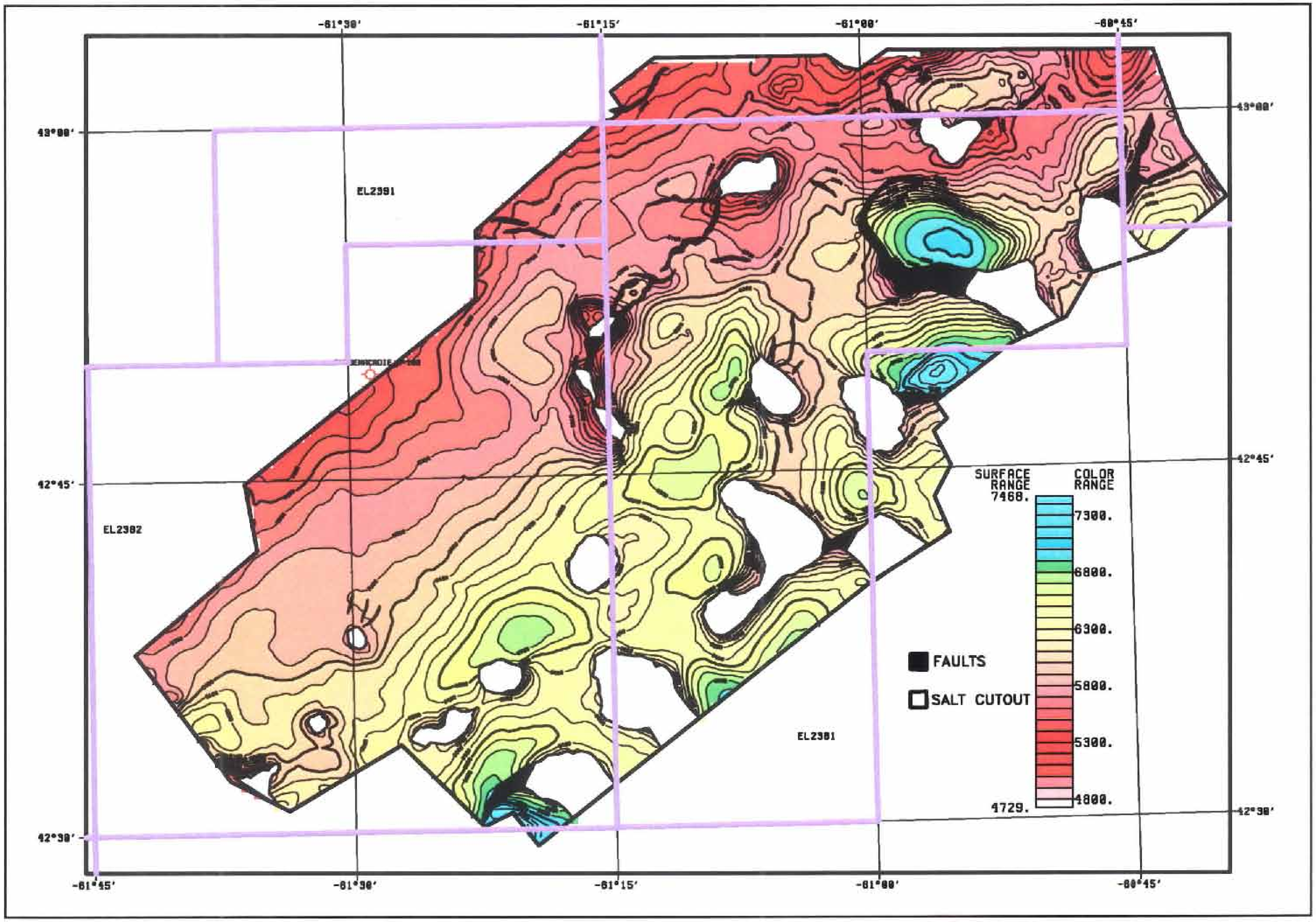


Fig. 4.2.9 C10 Time Map

The C10 event is correlated into the deepwater from the shelf where it generally coincides with the top of a high amplitude seismic package. In the deepwater it is believed to represent a lowstand event with the potential for overlying sandy facies. The time structure map shows a general dip towards southeast. A number of allochthonous salt structures and faults dissect the horizon creating potential trapping configurations. A full-scale version of this map is included as Enclosure 5.

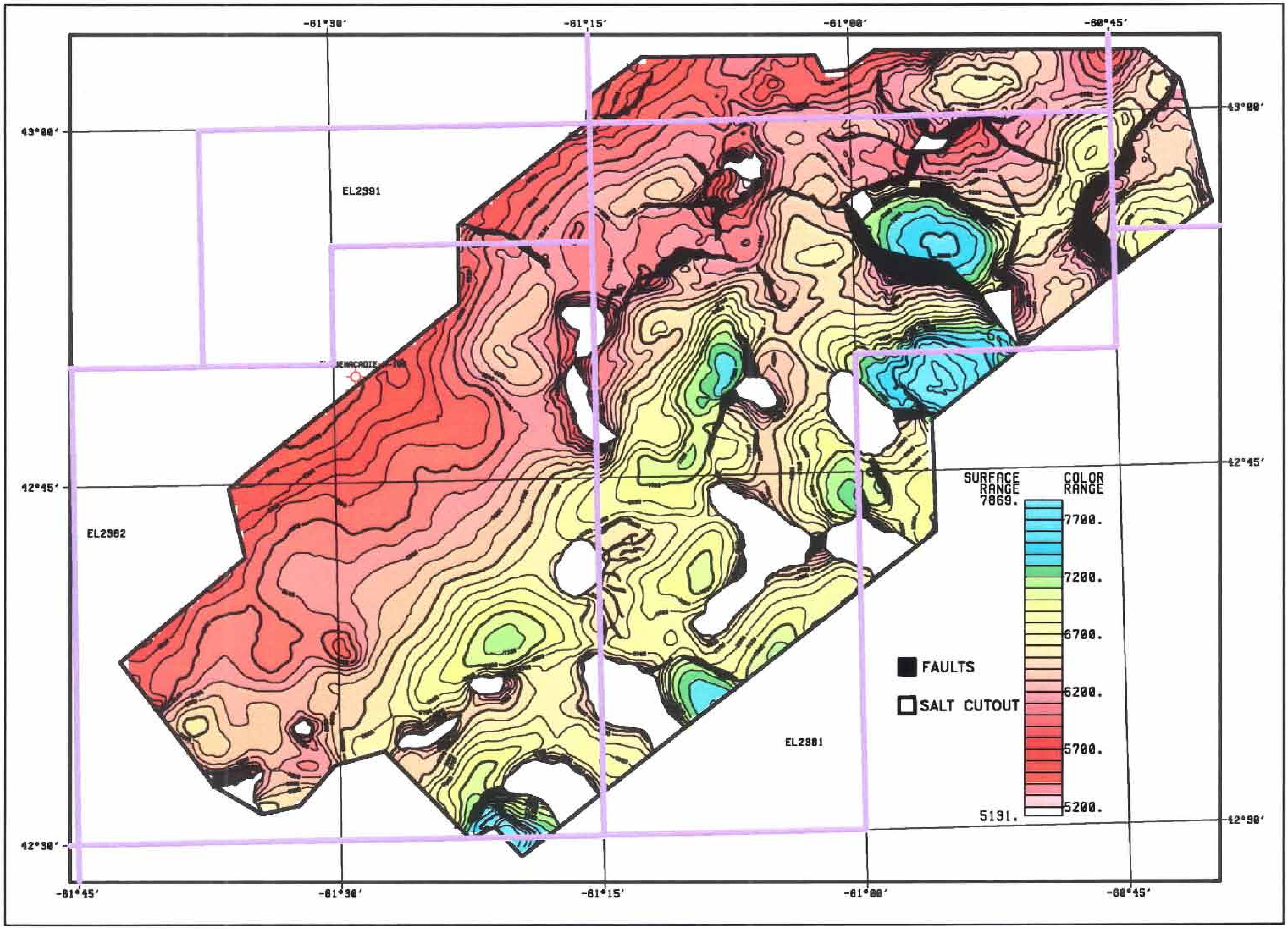


Fig. 4.2.10 C5 Time Map
The C5 event is associated with a regional lowstand event, generally overlain by a high amplitude seismic package believed to represent sandy facies. The time structure map shows a general dip towards southeast. A number of allochthonous salt structures and faults dissect the horizon creating potential trapping configurations. A full-scale version of this map is included as Enclosure 6.

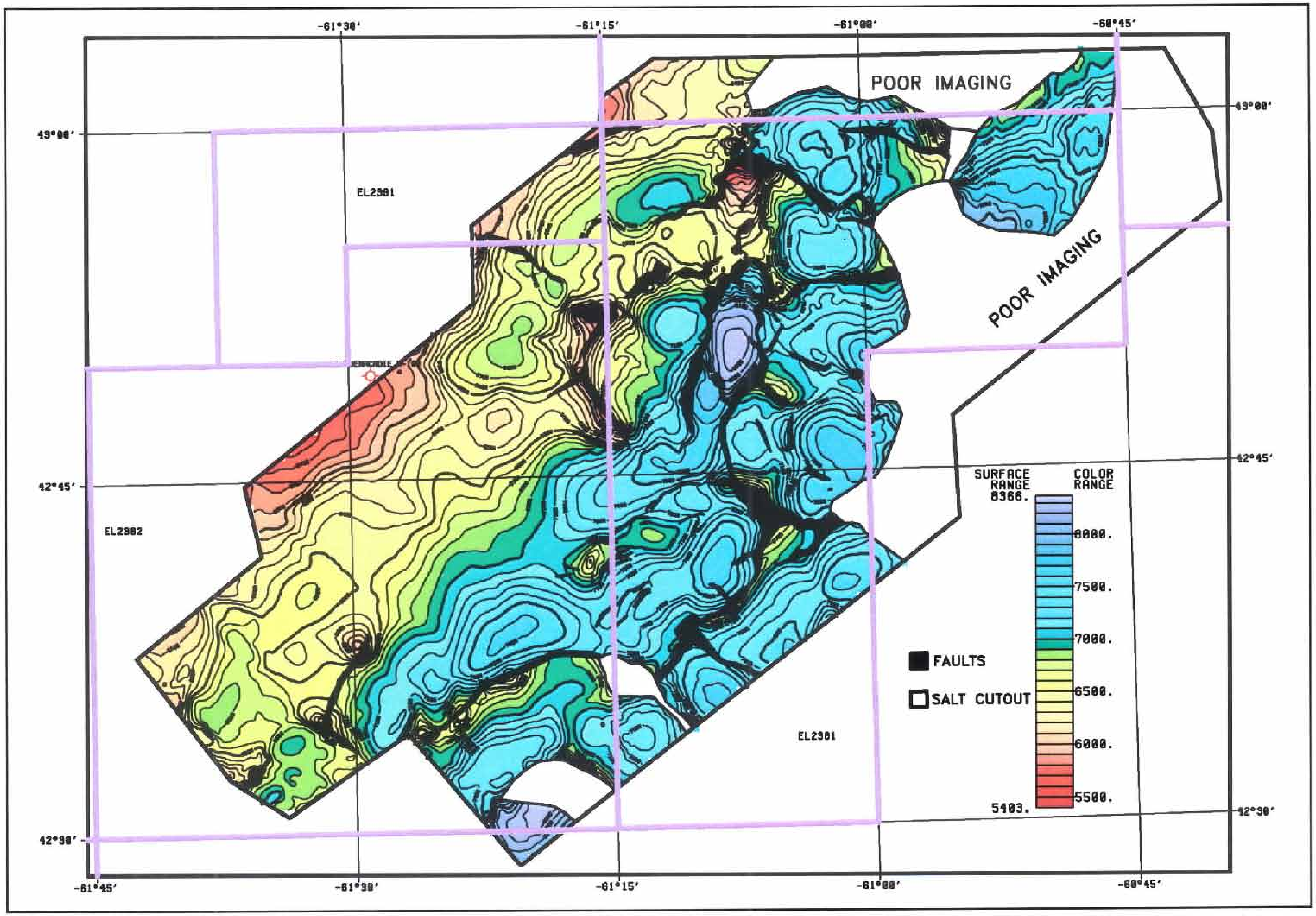


Fig. 4.2.11 J210 Time Map
The J210 event is a regionally continuous unconformity representing the Jurassic/Cretaceous boundary. The map shows the impact of the underlying basement framework and the areas of salt withdrawal. Note the difference in structural style between the area in the NW versus the area to the SE. The latter is characterised by early basin formation due to salt withdrawal. The J210 event is not mapped in the NE due to poor imaging below allochthonous salt. A full-scale version of this map is included as Enclosure 7.

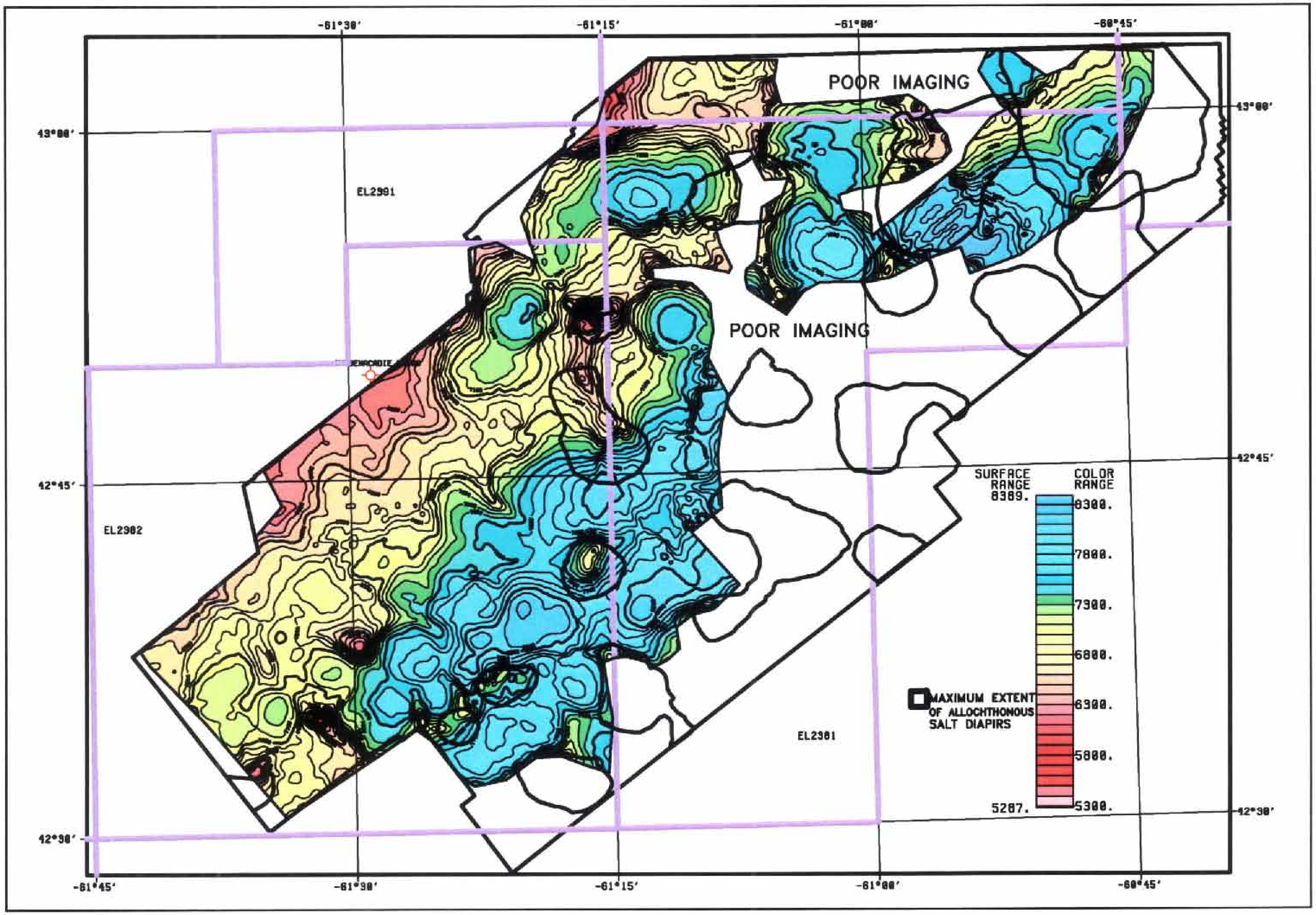


Fig. 4.2.12 Top Autochthonous Salt Time Map with Allochthonous Salt Cutouts
The map shows the present day depth of salt with the maximum lateral extent of the overlying salt diapirs/pillows marked as polygons. The top salt event has not been mapped over parts of the survey due to poor imaging. A full-scale version of this map is included as Enclosure 8.

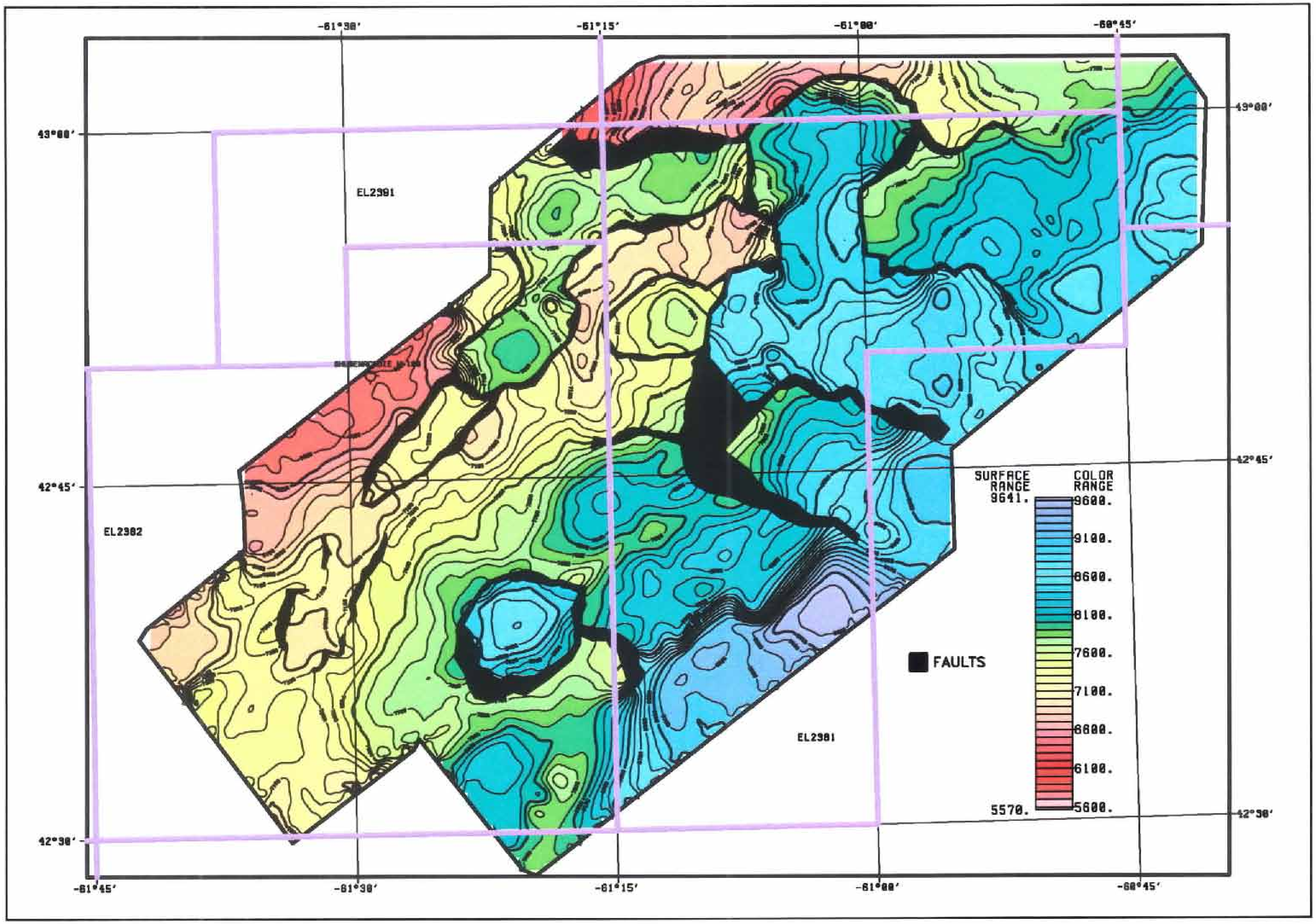


Fig. 4.2.13 Top Basement Time Map
The top basement event is difficult to map due to poor data imaging. The basic structural grain reflects a rifted margin with numerous horsts and grabens causing a nonuniform distribution of the overlying salt. A full-scale version of this map is included as Enclosure 9.

4.4. Depth Conversion

4.4.1. Initial Depthing/Velocity Model

Separate estimates were made of interval velocity (V_{int}) vs. two-way time (T_o) in the water column, background sediment layer, and salt bodies. The three layers were composited in a 3D gridded velocity model which was used to effect horizon depthing by simple vertical stretch in Shell Canada's proprietary 3D interpretation package 123DI. This method works only away from salt bodies. Work continues a) to improve the velocity model by constraining the sediment Vint inversion with picked horizons; b) to ground-truth the water V_{int} using known bathymetry at scattered G.S.C. drop-core locations; and c) to build local detailed velocity models via prestack depth migration over patches of the survey complicated by salt and seafloor canyons.

Vint(Water Column)

Field measurements of water velocity, temperature, pressure and salinity vs. depth were made at wide intervals (~monthly) using Sippican's system of shipboard sensors. Velocity profiles varied considerably for z<500m (Fig. 4.4.1) but then converged below the regional thermocline, which is much shallower than the shallowest water depth on the survey. Profiles were averaged across common depths. Average velocity was then computed vs. equivalent two-way time To; then the segment between To=2s and To=4s was plotted and fit to linear and quadratic functions, (Fig. 4.4.2) providing an equivalent integrated Vint(water column) as a function of two-way time to the sea-floor.

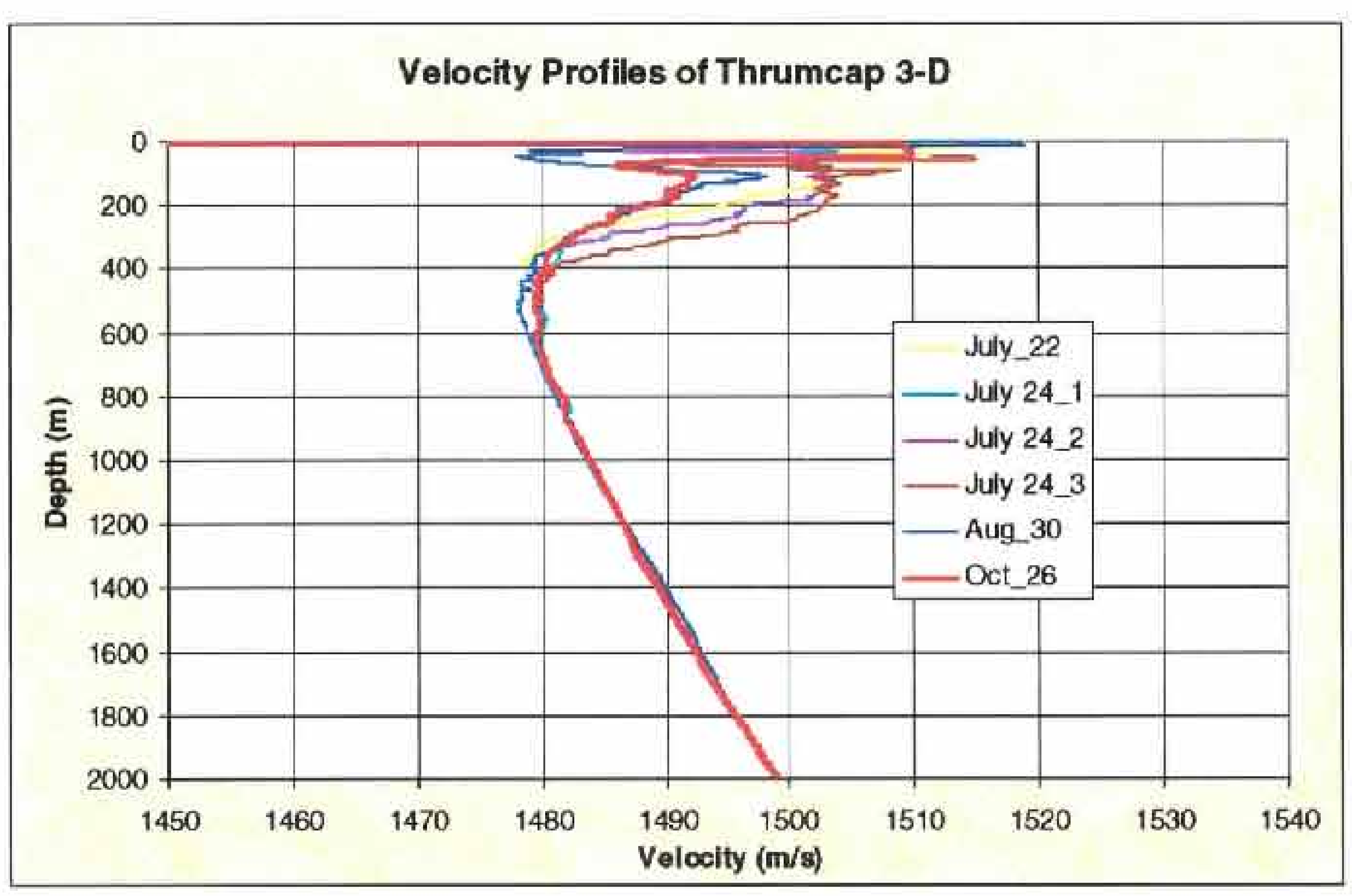


Fig. 4.4.1 Various velocity profiles measured during the recording of the Thrumcap 3-D in the year 2000. Notice the higher velocities recorded during the summer time due to the warmer seawater temperatures

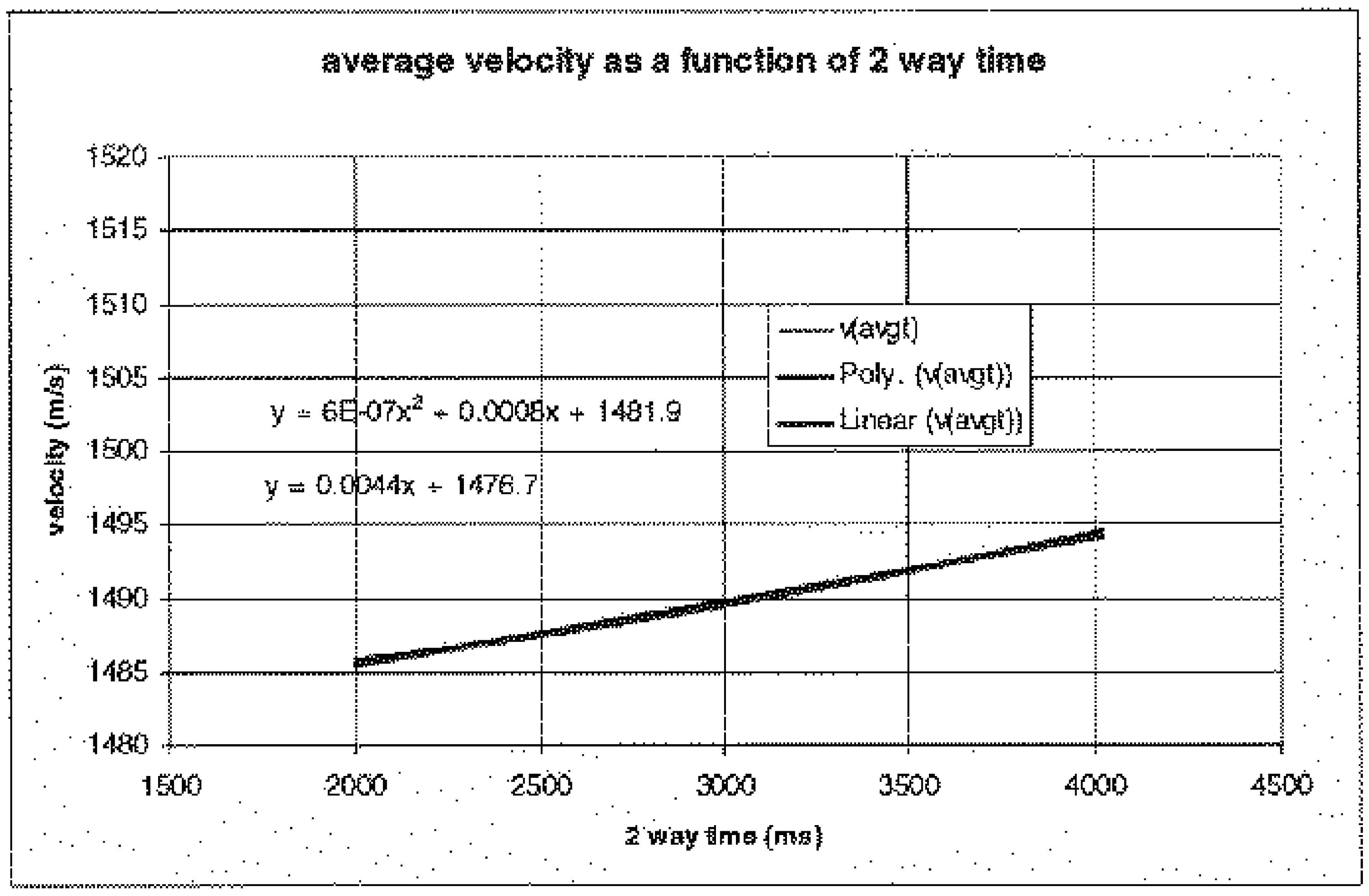


Fig. 4.4.2 The segment between 2 and 4 seconds two-way travel time of the time averaged velocity profile is plotted and fit to linear and quadratic functions.

Vint(Sediment Column)

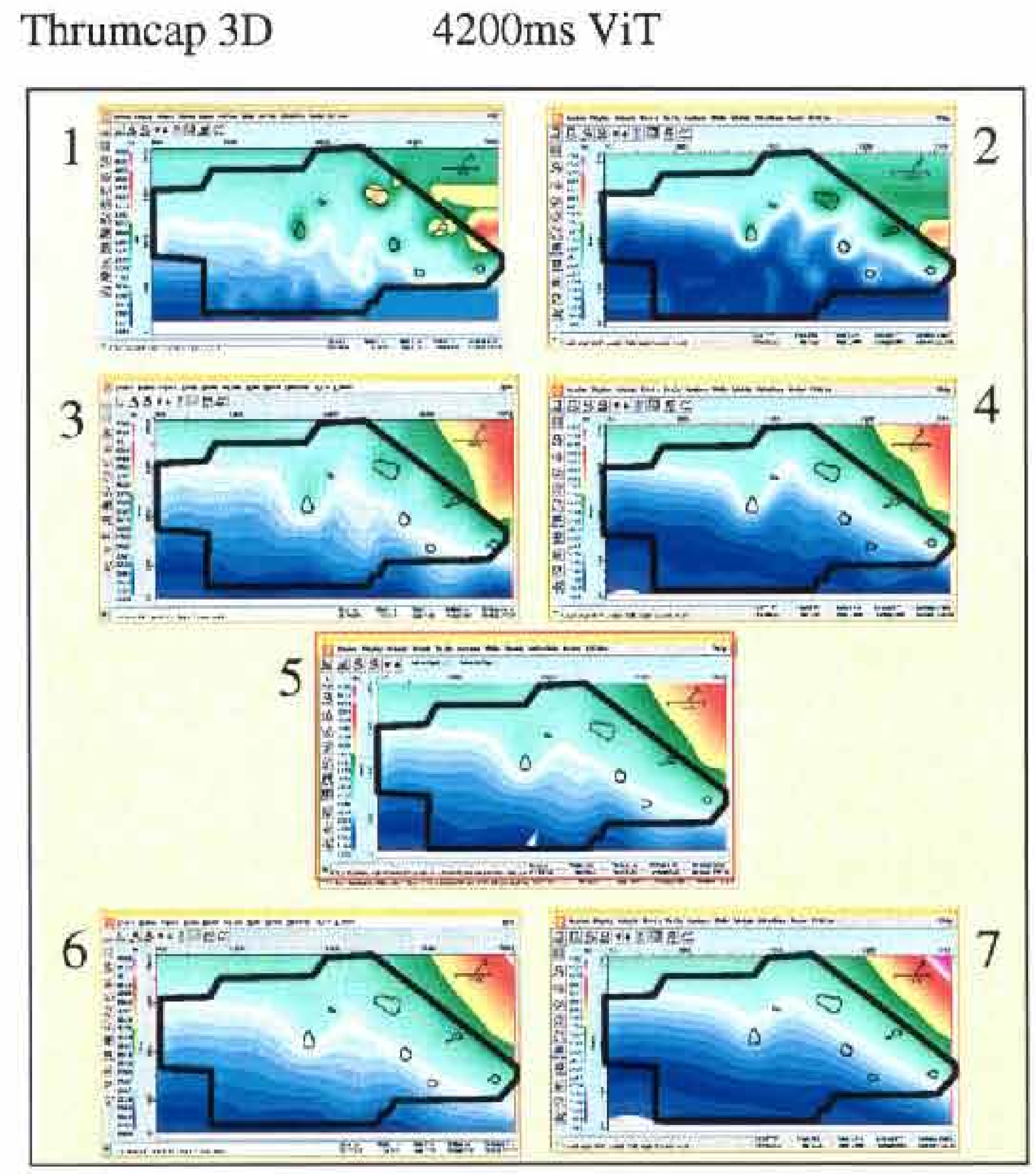
In the absence of nearby well data initial input for V_{int} estimation was a suite of contractor-picked DMO velocity vs T_o functions picked on a 500m grid over the survey. This grid was inverted along constant time lines to an equivalent V_{int} vs. T_o grid and smoothed. The grid was nulled in the vicinity of salt bodies and the resulting gaps infilled with sediment velocities interpolated from surrounding minibasins. The resulting 'sediment background cube' was appended to the water velocity cube using Shell proprietary software and the combined water-sediment background model exported to GOCAD for final addition of the salt bodies. Fig. 4.4.3 shows several slices through the sediment background velocity cube.

Vint(Salt Bodies)

Top and base of individual bodies were correlated as suites of fault segments, which were converted to closed tesselated surfaces ('salt bags'). These were exported to GOCAD and used to create regions in the water-sediment model, which were then infilled with a constant salt velocity of 4 180m/s. (Fig. 4.4.4)

Fig. 4.4.3

Time slices through variously smoothed sediment background velocity cubes. Small polygons indicate maximum extent of allochthonous salt at this level. The upper right-hand corner of the model is ill-constrained since the input data is limited to the outline of the survey as shown in black.



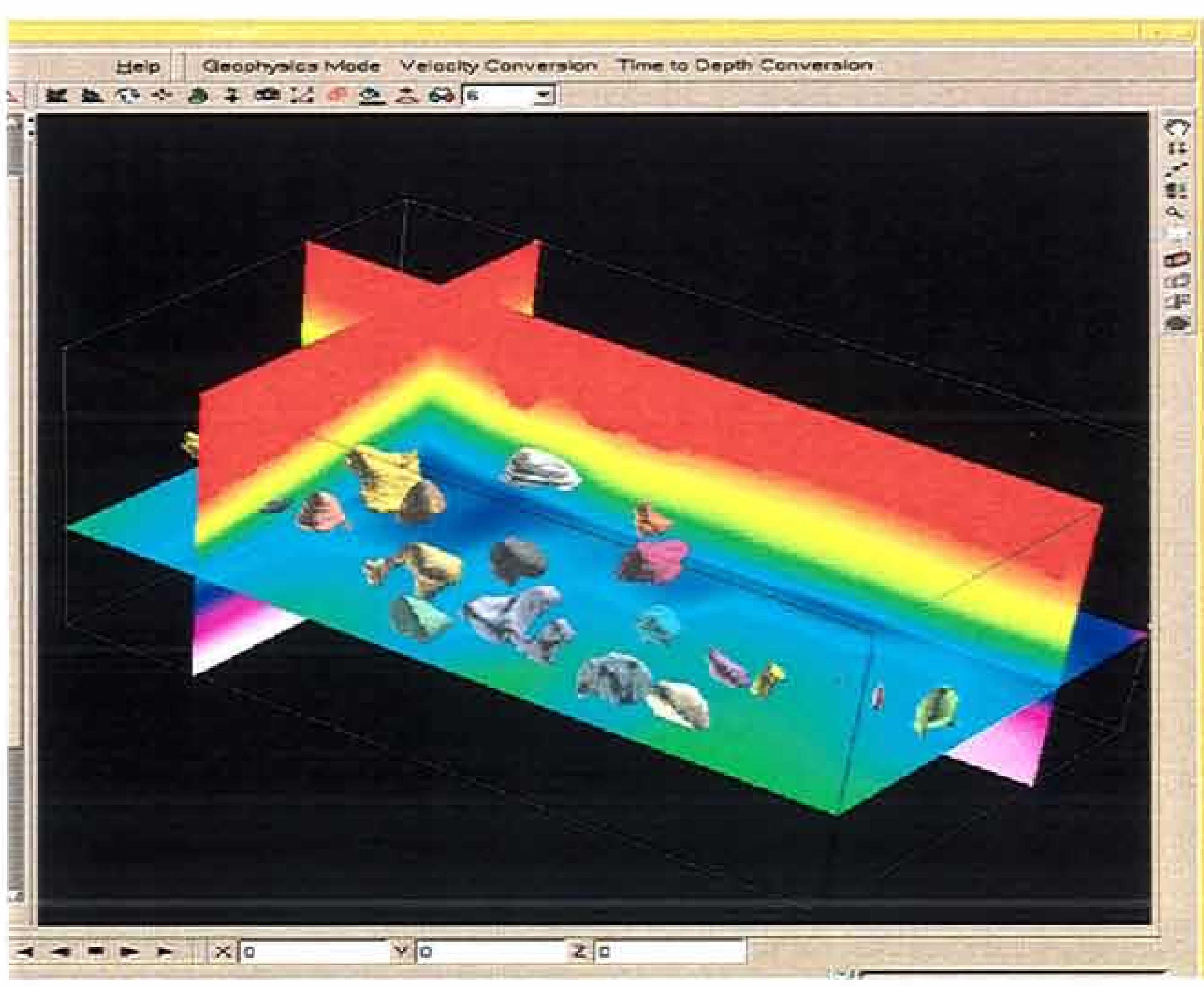


Fig. 4.4.4

GOCAD rendition of gridded velocity model version including water wedge (constant velocity), sediment background and interpreted salt bodies. The final step in initial model construction is simply to fill the salt-bags with constant velocity = 4 180 m/s.

Depthing Errors

Chief sources of error are a) the lack of well calibration, and associated lack of correction for anisotropy effects and b) ray-bending problems related to complex structure near the Tertiary chalks and allochtonous salt, making a vertical stretch approach inapplicable. The first uncertainty will yield only to future drilling. The second is being addressed in the next phase of depthing/velocity modelling (4.4.2 below).

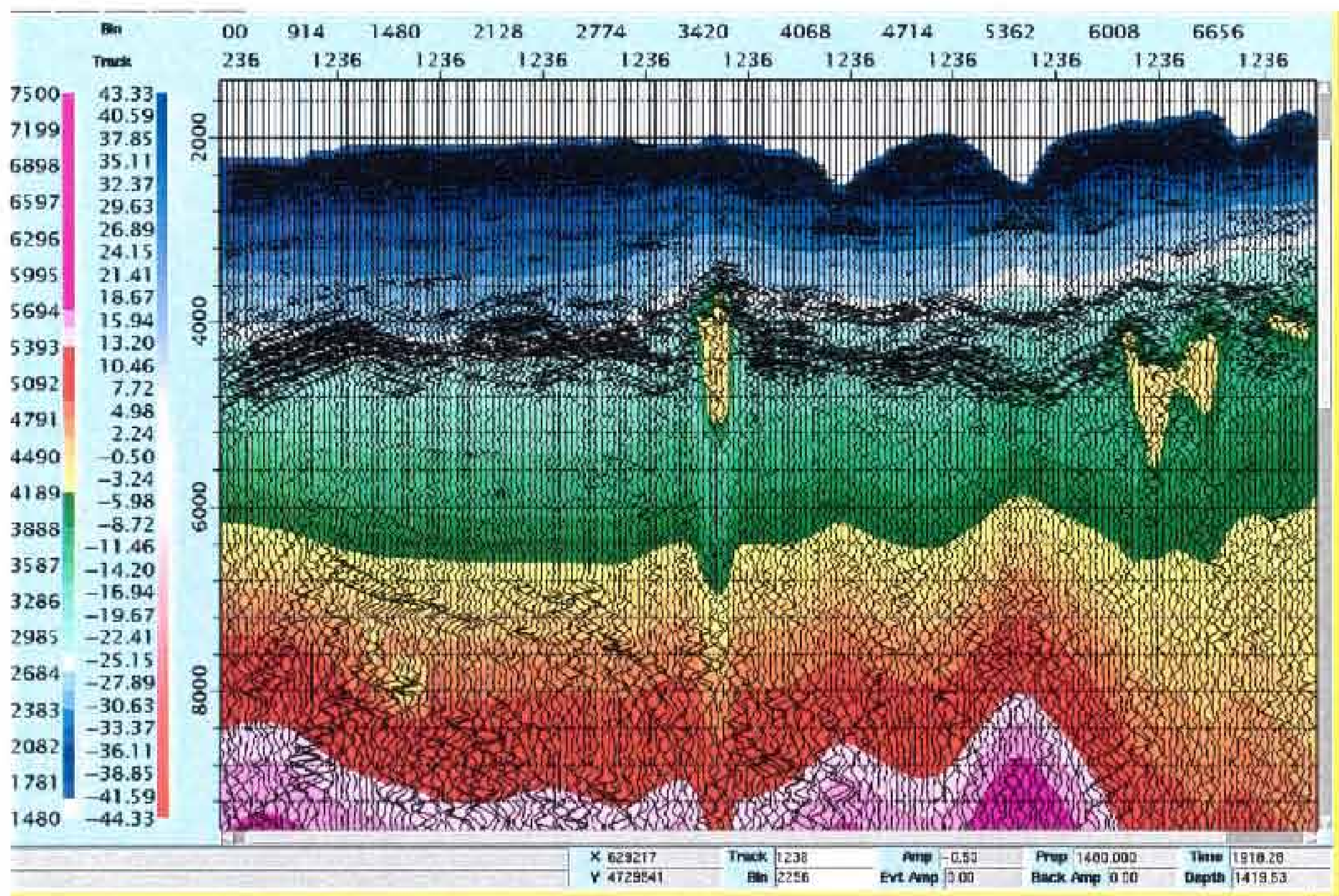


Fig. 4.4.5 Depth-section through initial complete velocity model including salt bodies. Note the obvious errors/anomalies beneath the allochthonous salt. Work is underway to re-extract the sediment background cube using correlated horizons, and local depth migration projcts will improve the subsalt picture.

Model used for Initial Depthing

Pending the completion of depth migration projects all depth maps included in this report have been created via vertical stretch using a sediment background velocity+water model only.

4.4.2. Next Phase: Depthing/Velocity Model

Since most prospective traps lie below shallow salt the initial model is being used to seed several prestack depth migration projects. When complete this work will provide local improvements to the initial model, especially in terms of salt body definition and subsalt sedimentary structure. Local prospect depth horizons will be interpreted on the associated output depth-migrated data volumes.

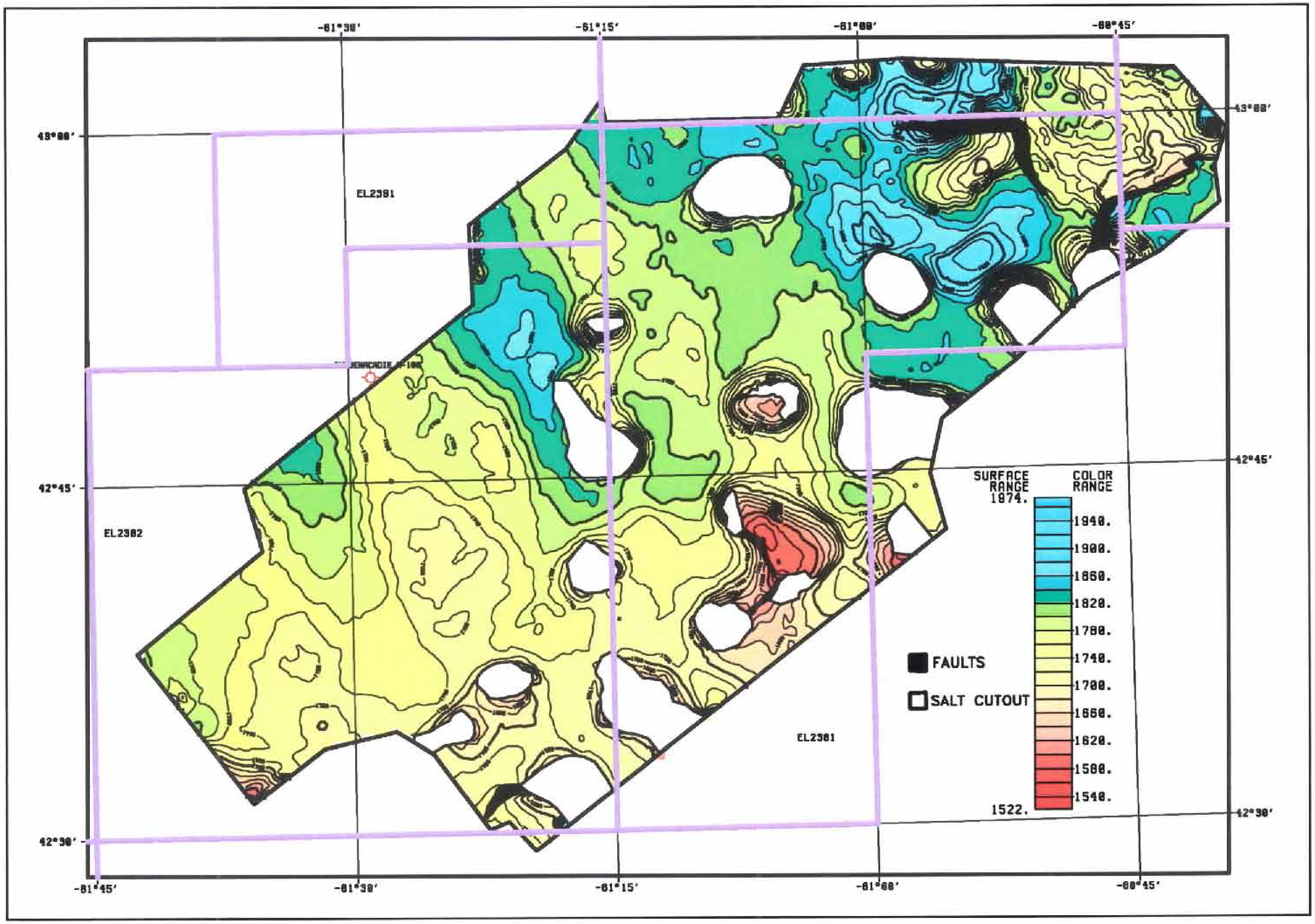


Fig. 4.4.6 T20 Average Velocity Map
*V_{avg} measured from sealevel. Depth (T20) = V_{avg} * T0 (2-way time) * 0.5.*
Velocity model used: water + sediment background.

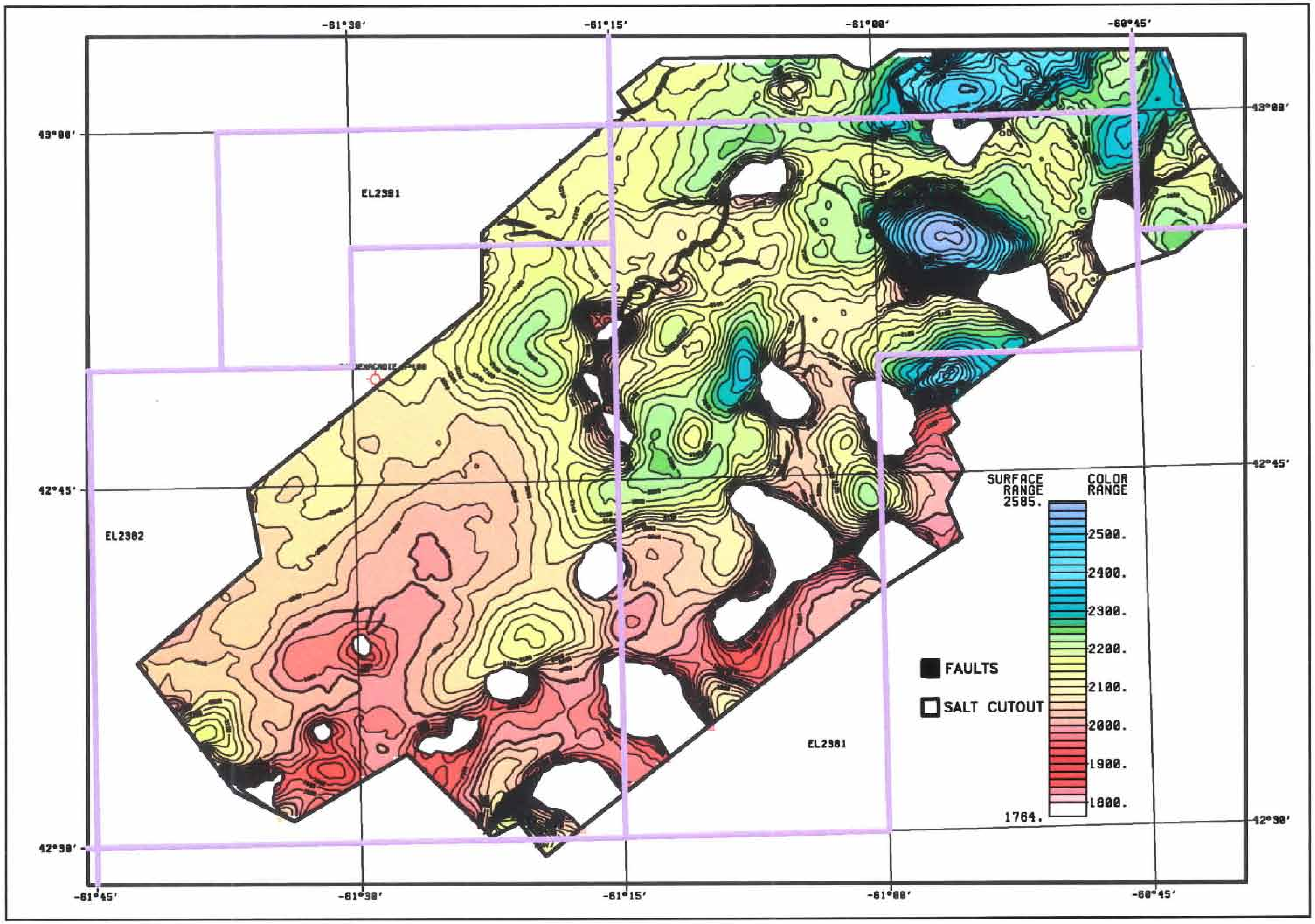


Fig. 4.4.7 C10 Average Velocity Map
*V_{avg} measured from sealevel. Depth (C10) = V_{avg} * T0 (2-way time) * 0.5.*
Velocity model used: water + sediment background.

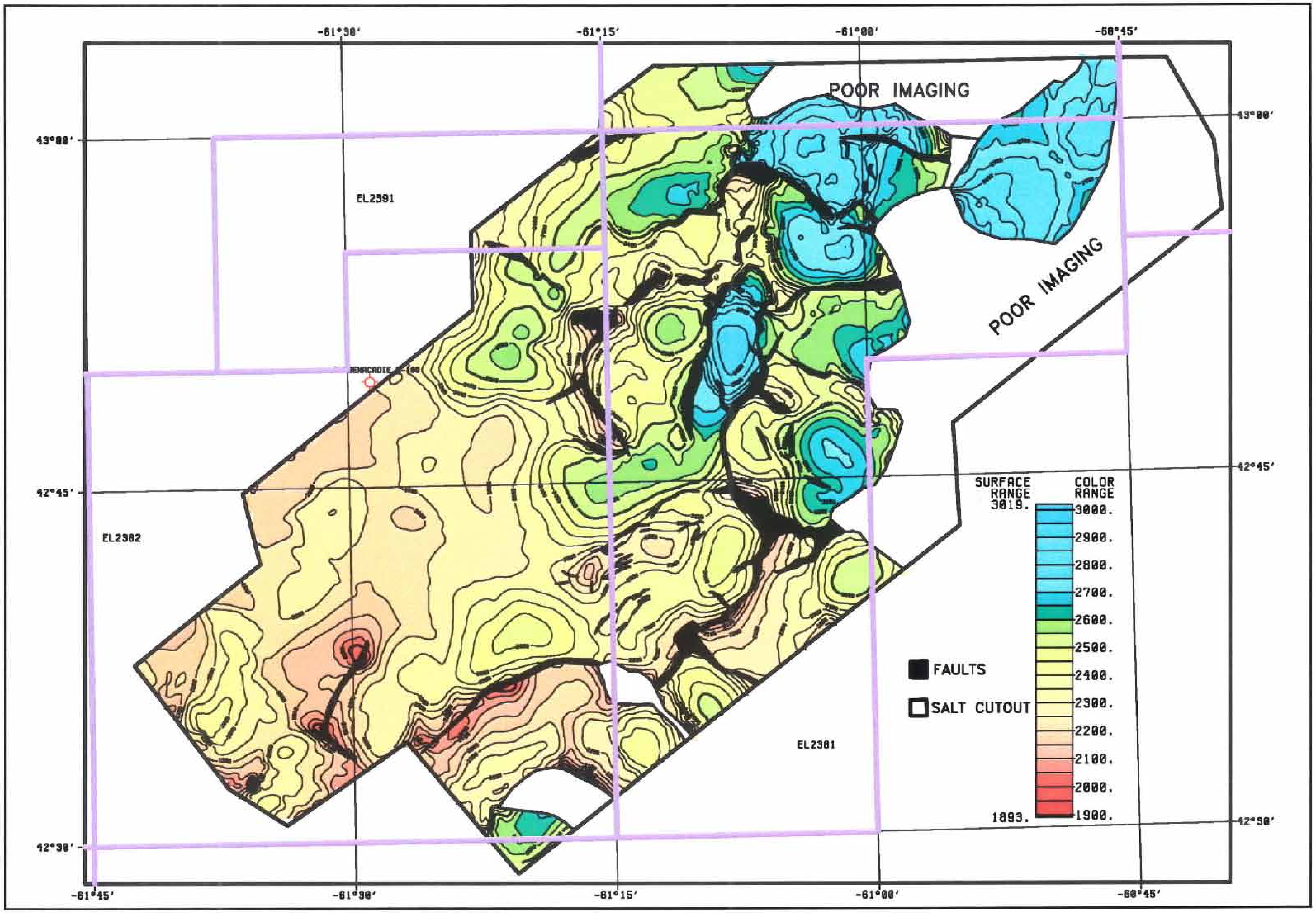


Fig. 4.4.8 J210 Average Velocity Map
*V_{avg} measured from sealevel. Depth (J210) = V_{avg} * T0 (2-way time) * 0.5.*
Velocity model used: water + sediment background.

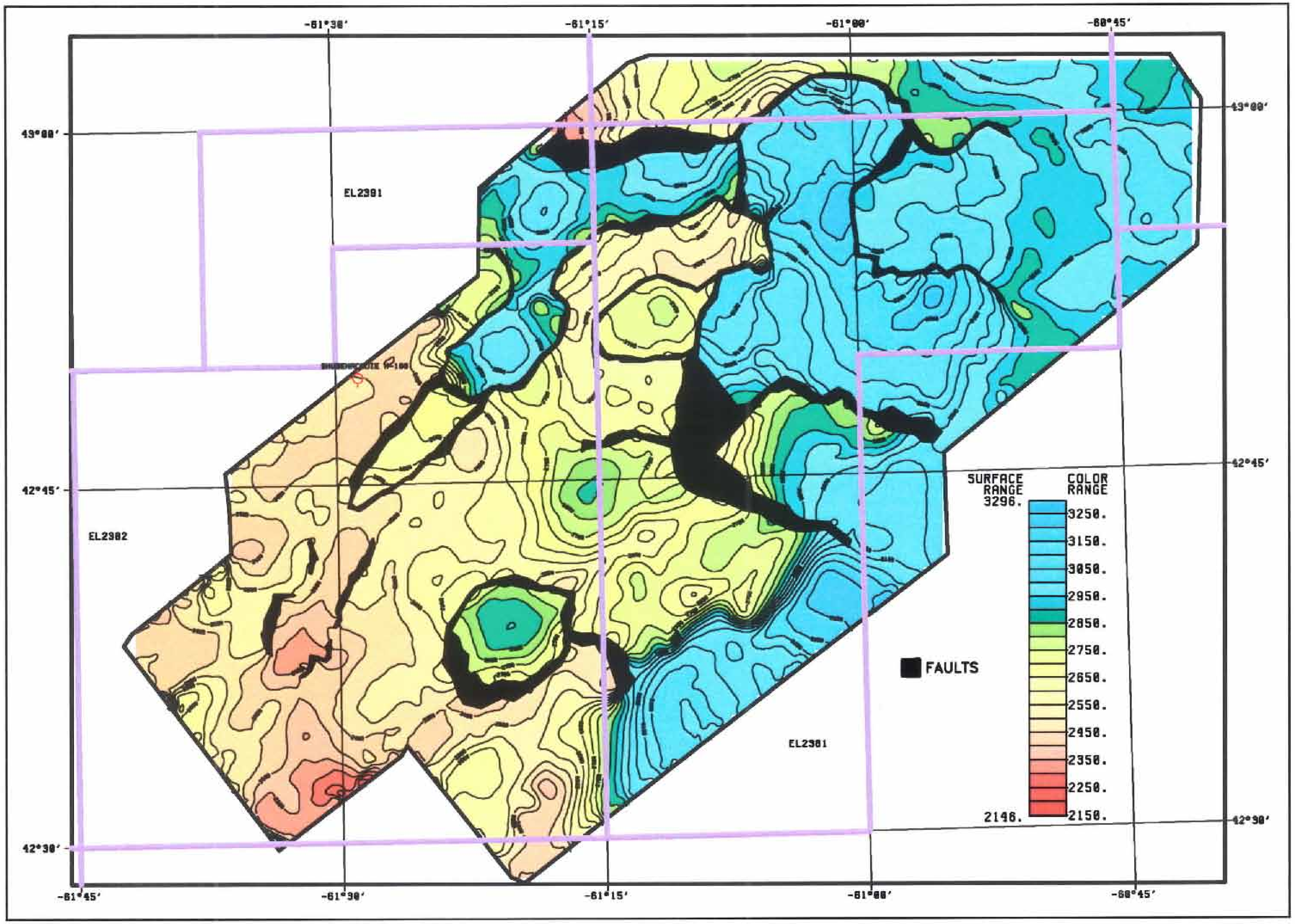


Fig. 4.4.9 Top Basement Average Velocity Map
*V_{avg} measured from sealevel. Depth (Top Basement) = V_{avg} * T0 (2-way time) * 0.5.*
Velocity model used: water + sediment background.

5. ENCLOSURES

Paper copies of the following large scale (1:100,000) maps are attached

Enclosure 1: Seabed Time Structure
Enclosure 2: T45 Time Structure
Enclosure 3: T20 Time Structure
Enclosure 4: C30 Time Structure
Enclosure 5: C10 Time Structure
Enclosure 6: C5 Time Structure
Enclosure 7: J210 Time Structure
Enclosure 8: Top Autochthonous Salt Time Structure
Enclosure 9: Basement Time Structure
Enclosure 10: Seabed Depth Structure
Enclosure 11: T45 Depth Structure
Enclosure 12: T20 Depth Structure
Enclosure 13: C30 Depth Structure
Enclosure 14: C10 Depth Structure
Enclosure 15: C5 Depth Structure
Enclosure 16: J210 Depth Structure
Enclosure 17: Top Autochthonous Salt Depth Structure
Enclosure 18: Basement Depth Structure
Enclosure 19: Cenozoic Isopach Map (Seabed → T20)
Enclosure 20: Cretaceous Isopach Map (T20 → J210)
Enclosure 21: Total Sediment Package Isopach Map (Seabed→Basement)

Table I - Summary of Significant Dates

7th September 1999	Issue of Data Acquisition Contract Tenders
22nd November 1999	Award of Acquisition Contract
27th March 2000	Application for Geophysical Program Authorization
4th May 2000	Geophysical Program Authorisation issued
20th May 2000	Mobilisation of vessel offshore Nova Scotia (first season)
24th May 2000	Main generator fault resulting in temporary loss of vessel power
30th May 2000	Start of Survey (first data acquisition)
	Start of seismic data processing
13th – 26th Sept. 2000	Survey interrupted due to Hurricane 'Florence'
18th-20th Oct. 2000	Survey interrupted due to Hurricane 'Michael'
27th November 2000	Suspension of survey
	Merger of contractors Western Geophysical & Geco-Prakla to form new company, 'WesternGeco'
30th April 2001	Re-mobilisation of Vessel in Halifax (second season)
7th May 2001	Start of Survey (resumption of data acquisition)
15 June 2001	Completion of Survey

Table II - Equipment List

Seismic Vessel	R/V Western Monarch – owned by: Western Sea Services of Panama – Port of Registry: Republic of Panama
Support Vessels	Ocean Foxtrot - owned by: Ocean Transport Inc. - Port of Registry: Quebec City Cape Sable East (Yr 2001 only) - owned by: North Atlantic Shipping Ltd - Port of Registry: Halifax Ocean Hercule (Yr 2000 only) - owned by: Ocean Transport Inc. - Port of Registry: Quebec City Scotia Diver (Yr 2000 only) - owned by: Martom Enterprises. - Port of Registry: Halifax
Seismic Recording Instrument	One Input/Output Inc MSX Marine Data Acquisition System featuring 24-bit digital resolution, fiber optic telemetry, SEG-D 8058 demultiplexed recording format, 4xIBM 3590 tape drives
Seismic Streamer	Up to eight TMS Sentry Solid streamers each 6400 metres in length. Manufactured by Thomas Marconi Sonar. Nominal streamer separation of 100 metres each pair, 700 metres total width.
Seismic Source	Two sources each comprising three sub-arrays of 1250 cubic inch. Each sub-array comprising 12 sleeve air-guns of volumes ranging from 40 to 150 cubic inches. Dimensions of each source array were 22 metres in length 20metres width. Nominal separation of 50metres between sources
Seismic Source Monitoring System	One Input/Output Inc Source Synchronisation System on a SunSPARC2 workstation
Navigation System	DGPS systems provided by Fugro (STARFIX), Racal (SKYFIX Spot and SKYFIX) and Western(Geco) (POSNET)
In Water Positioning Systems	Western(Geco) RGPS on source arrays and tailbuoys, Digicourse DigiRANGE acoustic system on source arrays and streamers, Digicourse 5011 Compass birds on streamers.
Ancillary Systems	1 x echosounder of type SIMRAD EA-500, 1 x ODOM Digibar (water) Velocimeter, 1 x RD Instruments Acoustic Doppler Current Profiler, *** x Sippican Ocean Systems Inc expendable sound velocimeter probes.

Table III - Performance Summary

	2000	2001	TOTAL
Total HSE Exposure Hours:	182,451	59,990	242,441
Lost Time Injury	1	0	1
High Potential Incidents	2	0	2
Spills	2 (30 litres and 2 litres)	0	2
Survey Duration (days)	165	37 (+3 re-configuring)	202
Operational Time (hours)	2026	762	2788
Standby Time (hours)	1332	87	1419
Technical Downtime (hours)	596	37	633
Average Downtime per Day	3.6	1.0	3.1
Total Sail Line Kms Acquired (including infill)	14974	4526	19500
Total Full Fold Sq. Kms Acquired	3456	1076	4532
Average Sail Line Km per Day	91	122	97
%. of Manhours: Canadian	41%	61%	45%
%. of Manhours: Non-Canadian	59%	39%	55%

Table IV - Seismic Acquisition Parameters

Type of source	Dual 3750 cu in, sleeve airgun arrays
Air-gun operating pressure	1900 ps.i.
Source depth	6m or 8m
Source Point Interval	Alternate source firing every 32.5m (62.5m per source)
Type of streamer	Thomson Marconi Sentry Solid Streamer
Number and length of streamers	6 or 8 x 6400 m
Number of groups (each streamer) and group interval	512 x 12.5m groups
Streamer depth	between 8m & 11m
Nominal in-line offset (guns to near-group)	290m (6 streamers), 320 (8 streamers)
Nominal Fold	51
Acquisition Bin Dimensions	6.25m x 25m
Recording instruments	Input/Output MSX
Total number of seismic data channels	3072 or 4096
Record length	10-11.5 seconds - variable
Sample rate	2 ms
Hi-cut filter	206 Hz @ 264 dB/Oct
Low-cut filter	2 Hz @ 12 dB/Oct
Geodectic Ellipsoid	WG-84
Geodectic Datum	WG-84
Grid Projection	UTM – Zone 20 N
Central Meridian	63 deg West

Table V - Seismic Data Processing Parameters

Signal Processing Flow

RAW FIELD DATA INPUT

REFORMATTING TO CGG INTERNAL FORMAT
SAMPLE INTERVAL : 2MS
RL: 11.5ms

BAD TRACE EDITING
(1) Manual edits according to observer logs
(2) Automatic de-spiking of traces

APPLY A BUTTERWORTH ANTI-ALIAS FILTER

RESAMPLE
SI: 4ms

SPHERICAL DIVERGENCE CORRECTION
T^2 CORRECTION

FK FILTER
APPLIED TO NMO CORRECTED SHOTS
CUT-OFF VELOCITIES (+/-) 1550m/s
300ms REMOVABLE AGC

SEISMIC BINNING
BIN SIZE: 12.5m x 25.0m

DETERMINISTIC DECONVOLUTION
Source signatures supplied by Western Geophysical

SINGLE-CHANNEL GAP DECON
(Only used on the data above 300ms water depth)
GAP:70ms
ACTIVE PORTION OF OPERATOR LENGTH (230ms)

SHALLOW:	NEAR OFFSET:	(270m):	[500ms – 4000ms]
	FAR OFFSET:	(6700m):	[5700ms – 9200ms]
DEEP:	NEAR OFFSET:	(270m):	[2500ms – 6000ms]
`	FAR OFFSET:	(6700m):	[5500ms – 9200ms]

PREWHITENING: 1%

CDP GATHERING

VELOCITY ANALYSIS
1000m X 1000m grid

MULTIPLE ATTENUATION - RAMUR
Shallow: Primaries located between Delta t of –660-680ms
Multiples located between delta t of 700-5500ms
Deep: Primaries located between Delta t of –660-380ms
Multiples located between Delta t of 400-3000ms
Parabolas every 20ms

SURFACE CONSISTANT GAIN CORRECTION
Both inline and crossline equalisation applied

SORT INTO 3D BIN

DMO Processing

FLEX-BINNING
Near trace: half bin each side
Far trace: full bin each side

3D-DMO
Kirchhoff – 52 Offsets
Include bin-spreading to control spatial aliasing
Aperture 1.2 ms/m
DMO step of 12.5 m

MISTR
Interpolate remaining holes post DMO

PSTM Migration Flow

PRE-STACK TIME MIGRATION
Stolt migration of 52 offset planes using smoothed velocity field

VELOCITY ANALYSIS
500m X 500m grid

STACKING
Using new velocities

DEMIGRATION
Inverse Stolt using original smoothed velocity function

FINAL MIGRATION
FX migration
Using smoothed 95% final velocities
(Smoothing operator approximately 1 cable length)

GAIN CORRECTION
2000ms AVC using "Robust" option for clipping high/low values from calculation