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# Structural Interpretation of 3D Seismic Data of a Passive Rift Margin: A Case Study of Bellatrix Basin

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ABSTRACT

The Bay of Biscay is considered France’s most prospective offshore region, but a complex geodynamic history has so far hindered its development. The landward side of the Parentis Basin has significant oil shows in late Barremian Limestones and early middle Jurassic dolomites. The offshore extension however has a thicker depocentre with a contrasting burial history resulting in plays more difficult to define – dampening drilling enthusiasm to date.

Although the basin remains poorly understood this study has found the evidence of petroleum potential. Due to somewhat limited well control the risk remains a significant factor in further exploration. A maturity window in the Early Cretaceous has suggested targeting of more subtle structural and robust stratigraphic intervals on the footwall block could potentially be prospective. This study would recommend a rigorous 3D basin modeling project (outside the scope of this study) and acquisition of minimum 2D seismic between the existing block and onshore Parentis fields – this would allow better understanding of the transitional structure and subsequently the disparity in burial history/charge timing.

## Introduction

The Aquitaine Basin is located in south-western France, situated between the Gironde Arch in the north and the Pyrenean Mountain Chain in the south (Figure 1). It exists as a triangular shaped domain extending over 35,000 km$^2$ (Biteau et al., 2006). The wider basin can be subdivided into four smaller sub-basins – the Parentis, Ardour-Arzaqh, Tarbes and Comminges areas. The lozenge shape of the depocentres is related to the Hercynian tectonic framework of the Palaeozoic basement which was subsequently re-activated during the Early Cretaceous rifting (Biteau et al., 2006). Basin evolution has been studied in detail from the early Jurassic rifting sequence up to the present, revealing a complex tectonic history encompassing multiple episodes of extension and inversion with the plate-scale tectonic regime marginally controlled by the failed rift arm of the Bay of Biscay. As a result of the complex tectonic history, offshore petroleum systems are quite difficult to assess. Superimposed rifting and compressive events plus halokinesis of Triassic salt has led to complex and rapidly changing geometries of the whole basin and consequently the individual structural and stratigraphic traps within. The Parentis Basin has been explored for over 50 years though most significant oil fields have been discovered onshore, with no significant oil or gas reported offshore (Mascle et al., 1994).

The study area Bellatrix basin is located just offshore of Archachon Bay (32 m water depth) in the Parentis sub-basin (Figure 1). This study aims to reveal the complex tectonic history of this area based on 3D seismic data interpretation.

## Geodynamics, Plate Tectonic Setting & Tectonic Evolution

The Bay of Biscay is an east-west oriented embayment of the Atlantic Ocean between the Iberian Peninsula and the western coast of France. Development of the Aquitaine Basin is characterized by a polyphase geodynamic evolution (Villien & Matheron 1989). Inherited fault zones played an integral role in the Mesozoic extensional regime and the subsequent Pyrenean Orogeny. Evolution was controlled by the relative motion of the Iberian and Eurasian plates as the North Atlantic Ocean opened.

The first rifting episode occurred in the Late Carboniferous-Permian, with N-S and E-W grabens

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developed in both the Pyrenees and the Aquitaine Basin, filled with 1000m of continental redbeds and volcanics (Bourouillh et al., 1995). The following rifting, during Triassic and Early Liassic is associated with the break-up of Pangea and formed a transtensional to extensional plate boundary between Iberia and Eurasia and is characterised by a thick evaporitic section (Keuper salt). The opening of the Atlantic Ocean was contemporaneous with the development of a carbonate platform across most of the area (Canerot, 1989). These marine transgressive phases provide the framework for the major petroleum systems. A regional unconformity marks the transition between Jurassic and Cretaceous. (Since the primary goal is to provide a structural interpretation)

A new phase of rifting commenced at the end of the Jurassic-Early Cretaceous (Figure 2) resulting large areas of the basin to become emergent and the main sub-basins became separate entities due to increased subsidence and the first large salt structures were emplaced. This extensional phase resulted in the separation of Iberia and Europe in continental conjunction – this occurred in four main phases: (Biteau et al., 2006)

- Barremian – guided by a NE–SW extensional stress inducing normal faulting, the main consequence being the individualization of the Arzacq–Tarbes and Parentis subsiding depocentres.
- Aptian–Mid-Albian – dominated by a major NW–SE rapid extensional phase (60–80 km overall displacement) which was corresponded with the creation of the Arzacq and Parentis depocentres. As a result of the important Aptian–Albian sediment overload, Triassic evaporites migrated towards the edges of the newly formed basins, where salt ridges formed and where the overlying sediments were breached.
- Mid-Late Albian–Early Senonian – responsible for the displacement of Iberia, 100 km to the east, through sinistral transtension
- Coniacian–Campanian – guided by the rotation of Iberia around a pole located near the city of Bordeaux (Total, internal research) resulting a transpressive sinistral system in the Eastern Pyrenees and a strike-slip motion to the west.

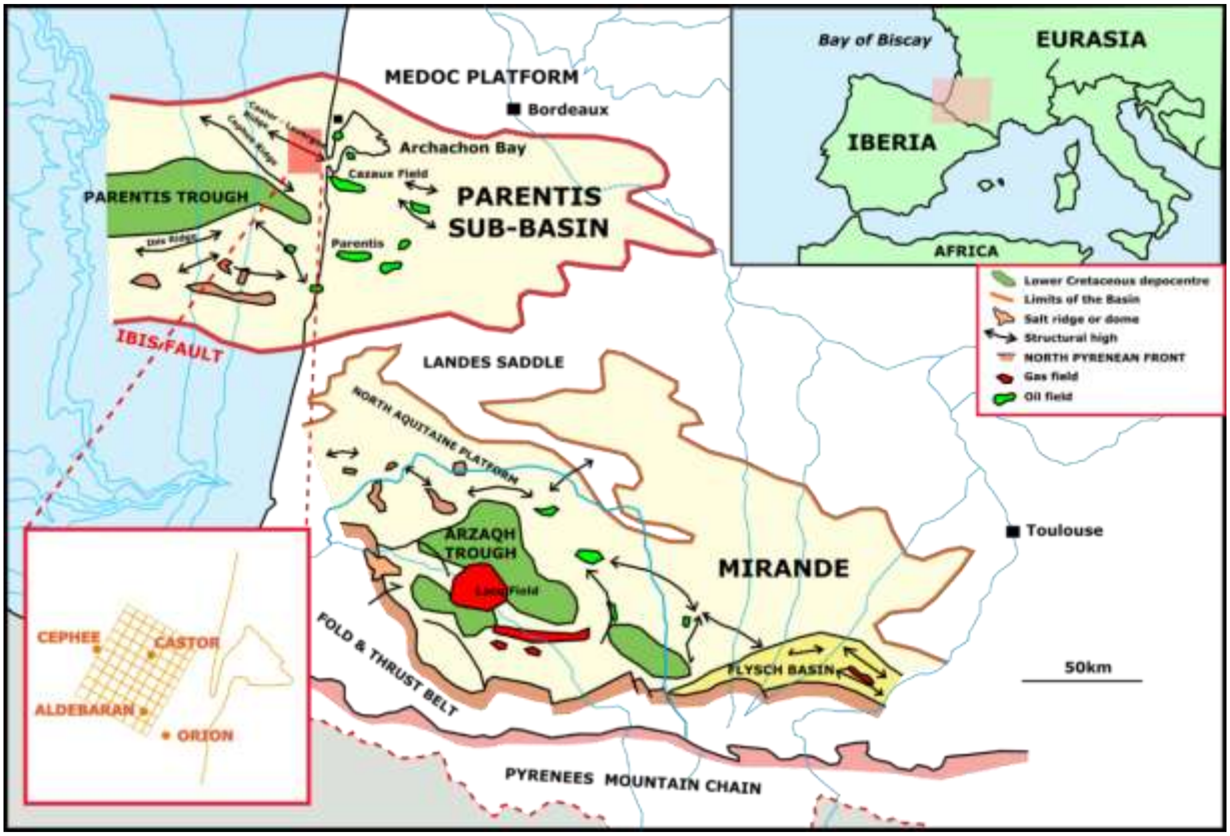

**Figure 1:** Aquitaine Basin with main structural domains, hydrocarbon occurrences and petroleum system context. (Inset left) Location of 4 wells within the study area (red box); (Inset right); Location of the Aquitaine Basin within plate continental context. Sub basins adapted from Biteau et al., (2006)

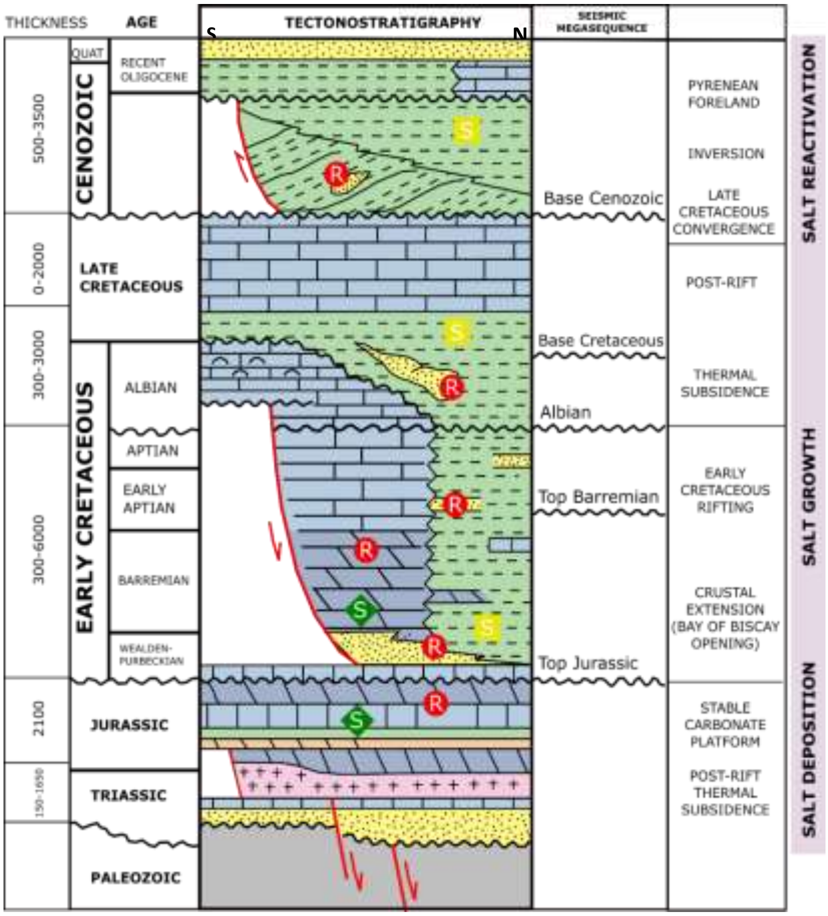

**Figure 2:** Tectono-stratigraphic chart of the Parentis Basin showing ages, lithologies, tectonic events and seismic horizons. South of area outside of data block – modified after Elf-Aquitaine (1991), Biteau et al. (2006) and Mathieu (1986)

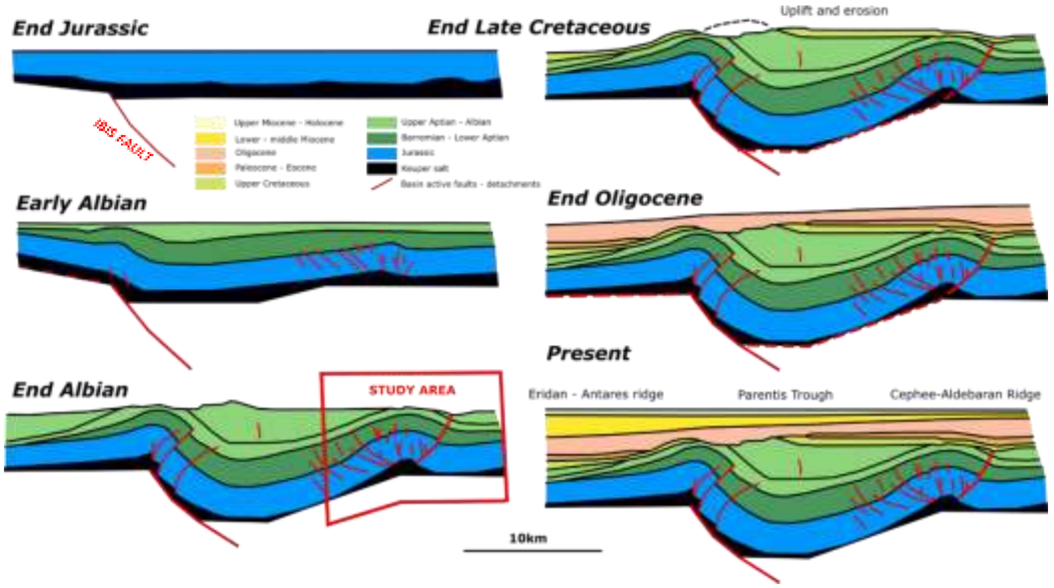

**Figure 3:** Structural restoration of the eastern offshore Parentis Basin. Study area shown in red box. Description from Ferrer et al. (2012) - Evaporite deposition in the Parentis Basin was bounded in the south by a basement high (Lands High) which also controlled the thinning of the Jurassic package. (b) and (c) extension produced a major Barremian–Albian depocentre in the Parentis Trough which expelled Keuper evaporites towards the north edge of the basin. A salt-cored anticline formed as a drape fold over the Ibis Fault. (d)– (f) During the Pyrenean compression the drape fold above the Ibis Fault was uplifted and its crest was eroded. In the south, previously buried dormant salt walls were rejuvenated by squeezing and arched their previously flat-lying roof. Later, buried salt walls have pinched off by regional compression. Salt tectonics ended during the Miocene. (After Ferrer et al., 2012)

The Late Cretaceous (Campanian) marks the first compressive movements related to the subduction of the Iberian plate beneath the European plate. The Eocene Pyrenean and Miocene Alpine orogenies (Figure 2) generated a shortening of approximately 80-100km (Biteau et al., 2006), where the Pyrenees were upthrust and flanked by opposing verging fold and thrust belts. The foreland received limited shortening relative to the hinterland as the underlying salt structures were able to absorb much of the movement (Ferrer et al., 2012) – despite these salt ridges within the study area still show evidence of inversion along previously extensional fault hinges.

## Review & QC Appraisal of Dataset

A VDR data package was used for the offshore Archachon Bay area (Aquitaine Maritime block) which included 4 wells. A small but vital amount of data has also been acquired from the literature including 2D line extension and onshore type well stratigraphy depths. Below is a review of the important data used in assessing the exploration potential in the area.

### *Seismic Data*

The seismic data provided consists of a 3D survey approximately 475 km$^2$ (length of inline: 24101.44 m, length of crossline: 18974.67 m) that was shot with a line spacing of 25m (760 in lines, 965 cross lines). The data quality of the survey is good and clear. The vertical resolution has been calculated for the intervals at different depths (Figure 4).

## Seismic Interpretation

The seismic interpretation performed at this stage was aimed at producing a good representation of key megasequences and structural configuration in the area, with a focus on considering possible hydrocarbon plays and prospects. More care was taken to accurately map the key structures in the block.

### *Seismic Well Ties and Well Tops*

Before the well tie process can be undertaken, a QC of the checkshots is done to check if any checkshots have extreme velocities, which can skew the time-depth relationship. A sonic de-spiking and resampling tool is used to generate a new, smooth sonic log and correct for the extreme spikes caused by cycle skipping.

Calibrated sonic logs were produced (Figure 5), and knee points made at checkshots. This was set as the TDR as no density log was run in wells within seismic so decision was made to produce density log by using the Gardner equation on the sonic log, which would be unreliable and may create a false TDR. Thus, no synthetic seismic sections could be produced. The seabed was used to determine the polarity of the wavelet, and thus determine if an increase in acoustic impedance response (hard kick) will show up as a positive or negative amplitude response on the seismic section. The wavelet extracted for the Bellatrix Basin is of normal polarity, due to the seabed appearing as a peak (hard kick), therefore increases in acoustic impedance responses will show up as a positive amplitude (red), using the European convention. Since no density log was run for the wells, changes in interval velocity taken from the sonic log can be used to suggest acoustic impedance changes. The seismic section was interpreted using tectono-stratigraphy alongside the sonic log, in order to more accurately pick key surfaces.

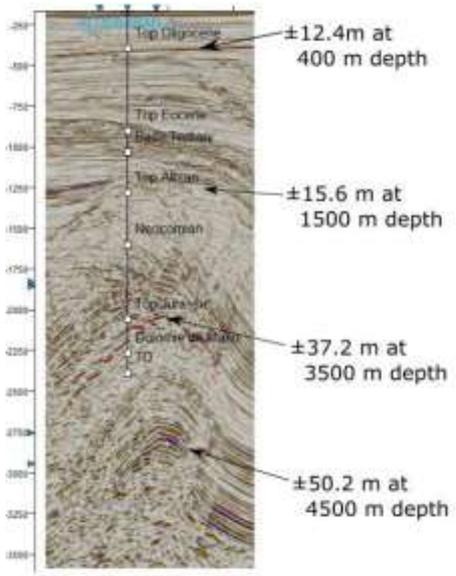

**Figure 4:** Vertical resolution calculated at different depth intervals

### *Velocity Model and Time-Depth Conversion*

Sonic logs were generated in a well section window, and exported into a spread sheet in order to graphically plot the formation velocities, to determine if there is a change in velocity throughout the formation, or whether the velocity remains constant throughout. These were constructed by measuring the sonic velocities at the top and base of the formations, and then plotting these velocities on a scatter graph (Figure 6). Scatter graphs were generated for the Aldebaran-1 well.

To account for these inconsistencies, several velocity models were constructed and ran in order to allow visual determination of the most appropriate model with regard to the resulting residuals and the overall visual look of the depth converted model. The model that was chosen for the final velocity conversion used a V0-K increasing velocity for the Top Oligocene to Base Tertiary, a constant velocity for the Base Tertiary to Top Albian, and a V0-K increasing velocity for the Top Albian to TD (modelled as one continuous layer) (Figure 6). These velocity models were calibrated to the seabed depth of 32m, with a velocity of 1500ms.

This model chosen resulted in the lowest overall residual errors, with a difference in highest and lowest residual amounts of ±86m (the uncertainty). This model generated the best depth converted top reservoir surface of all the models (Figure 7), and only had few pull up structures under faults, which were corrected by re-picking horizons around these major faults. The final depth converted surfaces can then be used to extract RMS and other surface attribute maps to identify leads or areas of interest.

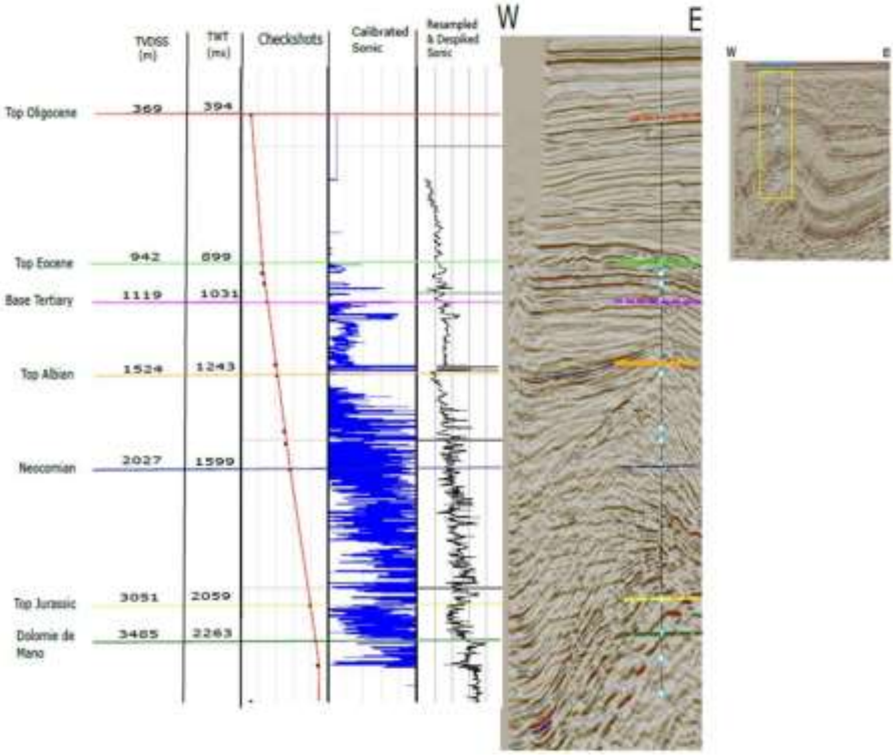

**Figure 5:** Sonic log calibration, showing time-depth relationship and corresponding surface markers on seismic section alongside resampled and de-spiked sonic log

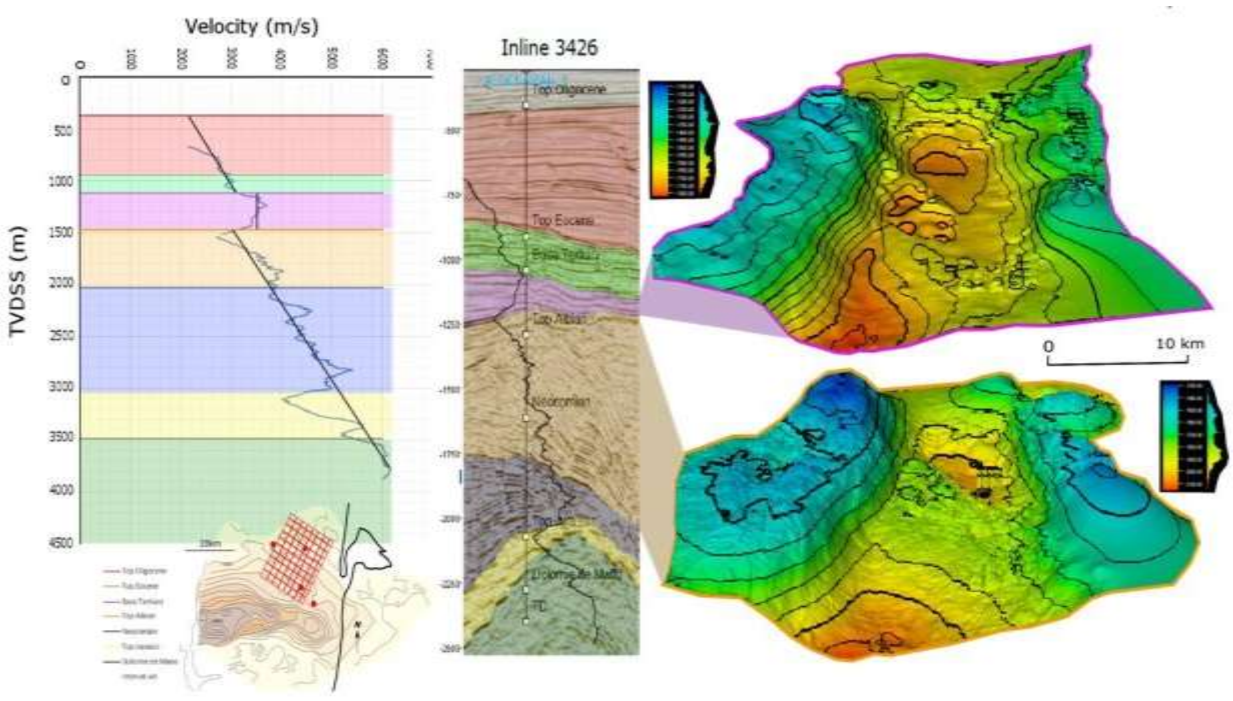

**Figure 6:** On left - Final velocity model with exported sonic log overlain, displaying V0-K and constant velocity relationships from Top Oligocene to total depth (TD). On right – Seismic section with velocity model overprinted to show TDR, as well as final depth converted key surfaces (Base Tertiary and Top Albian)

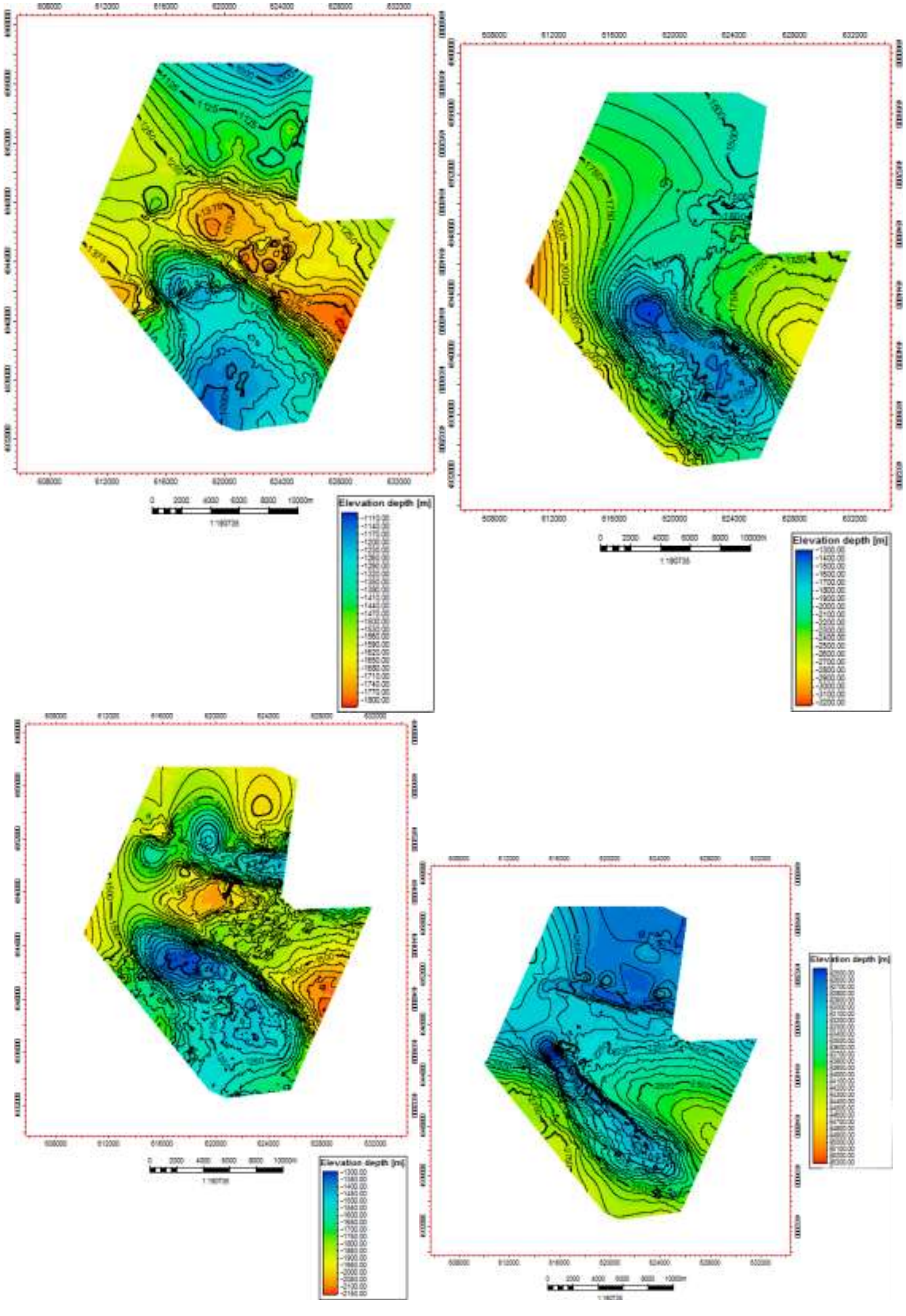

**Figure 7:** Final depth converted surface maps for Base Tertiary (top left), Albian Unconformity (top right), Top Albian (bottom left), Dolomie de Mano (bottom right)

### *Horizon Picking*

Based on seismic stratigraphy, nine horizons were interpreted. They are – Top Oligocene, Top Eocene, Base Tertiary, Top Albian, Albian Unconformity, Neocomian, Top Jurassic/Dolomie De Mano, Upper Kimmeridgian, and Base Jurassic-Top Salt (Table 1).

Manual picking is carried out as most of the interpreted horizons are reflection termination boundaries and later compared with our well tops which corresponded consistently. Criterion for each of the horizons are given in Table 1. Some are more difficult than the other therefore uncertainty increases interpreting them.

The two major types of angular unconformities were observed in Top Eocene, Base Tertiary, Top Albian, Albian Unconformity and Neocomian. Base Jurassic are interpreted to be a nonconformity.

Type-1 unconformity is identified and commonly related to tectonic events. It has truncated steeply-dipping deformed reflection and gently-dipping reflections onlapping the unconformity (Figure 8). This is referred to the Albian Unconformity and Top Albian. They may related to the post-rift thermal subsidence and Late Cretaceous convergence.

Type-2 unconformity is identified and commonly associated to changes in sea level, which probably related to the Pyrenean Orogeny. It has truncated gently-dipping reflections and gently dipping reflections onlapping the unconformity (Figure 9). This is referred to as the Base Tertiary and Top Eocene.

**Table 1:** Horizons with its Characteristics and Interpretation Constraints

| Horizon | Reflector Type | Seismic Character |
|---|---|---|
| **Top Oligocene** | Peak (Red) | - Continuous horizon<br>• - Strong amplitude<br>• - Highly continuous<br>• - Mapped 100% |
| **Top Eocene** | Peak (Red) | - Unconformity<br>- Continuous but challenging to determine across the folded topographical highs as there are a number of reflection terminations converge in the same manner<br>• - Mapped 75% |
| **Base Tertiary** | Peak (Red) | - Unconformity<br>- Hard to constrain when it occurs between rock of similar composition<br>- Very erosive in character towards N, hard to determine its continuity across erosive events<br>- Mapped 70% |
| **Top Albian** | Blue (Trough) | - Unconformity<br>- Merges into Albian Unconformity at anticlinal highs<br>- Separates prograding reflections underneath from overlying horizontal Reflections<br>- Challenging to determine as there are a number of reflection terminations converge in the same manner<br>- Mapped 100% |
| **Albian Unconformity** | Peak (Red) | - Unconformity<br>- Boundary between steeply-dipping deformed reflections and overlaid by gently-onlapping reflections<br>- Hard to constrain when it occurs between rock of similar composition<br>- Mapped 100% |
| **Neocomian** | Reflection termination boundary | - Boundary between high amplitude, low angle progradation clinoform and overlaid low amplitude, high angle progradation clinoform<br>- No definite reflection – no distinct density-velocity contrast<br>- Mapped 60% |
| **Top Jurassic/ Dolomie De Mano** | Peak (Red) | - Strong amplitude<br>- Difficult to follow across the large scale fault-propagate fold<br>- Mapped 75% |
| **Base Jurassic** | Peak (Red) | - Non-conformity<br>- Mapped 65%<br>- Difficult to determine across the large scale fault propagate fold<br>- Difficult to distinguish the real horizon from salt-weld affected zones |

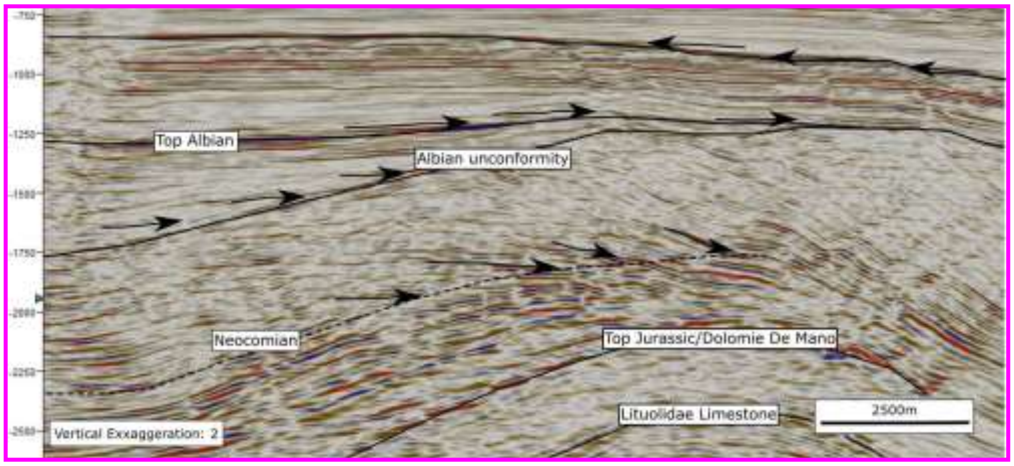

**Figure 8**: Tectonic-Related Unconformities – Truncated steeply-dipping deformed reflection and gently-dipping reflections onlapping the Albian Unconformity and Top Albian

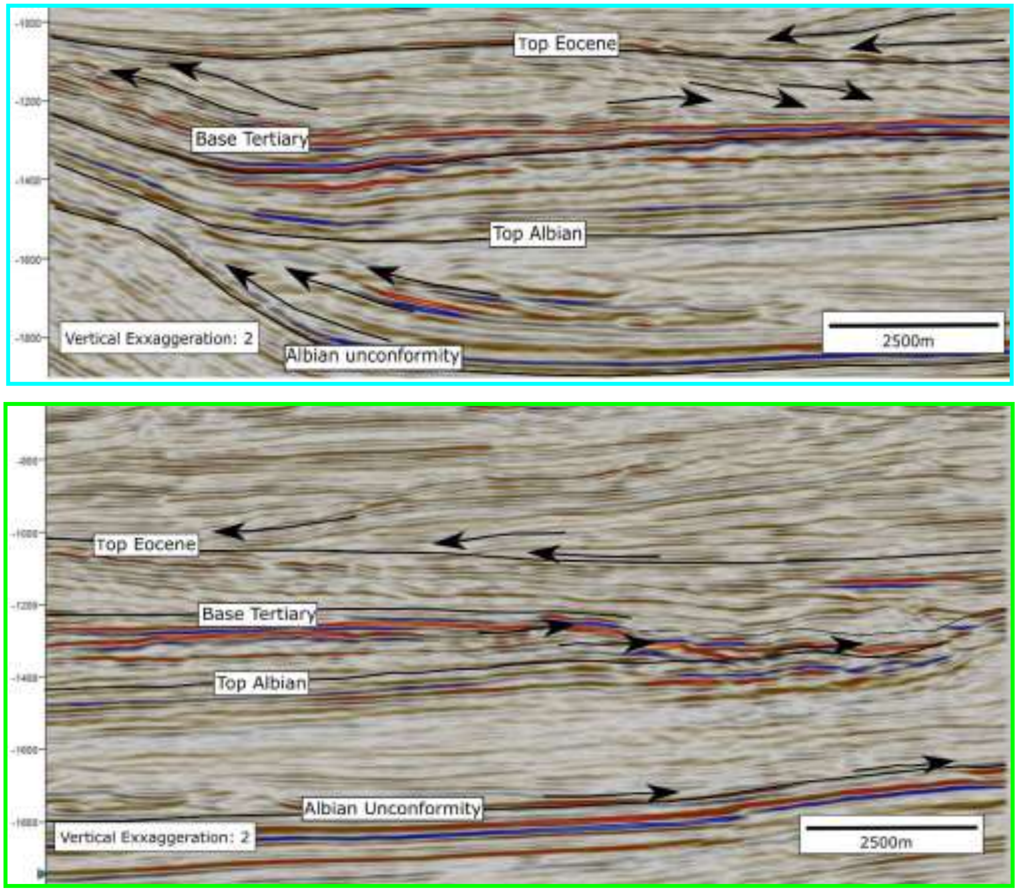

**Figure 9: (A) and (B):** Reflection Termination Boundaries with Respect to Horizons Interpreted

### *Megasequences*

Combining seismic interpretation and information from the literature, we propose five megasequences for the study area; Paleozoic Basement and Triassic Salt, Pre-Rift (Pre-Cretaceous), Syn-Rift (Early Cretaceous), Post-Rift (Albian unconformity), Inversion (Paleocene-Eocene) and Prograding Shelf megasequence.

**Table 2:** Megasequences and Its Respective Sequences' Descriptions

| **(A) Paleozoic Basement** |
|---|
| Seismic character is poorly imaged by low amplitude reflections observed at depth of about 3.8s TWT (Line 3426) (Figure 10). It has layered, horizontal reflectors and made up of metasediments. The reflections are discontinuous suggesting they have been largely broken up by substantial |

amount of stretching. The basement is believed to have been faulted by rifting. It is overlaid by Triassic salt by km-scale detachment fault. Due to salt-weld effects and various geometries of salt, picking top of basement is difficult. The basement shallows northwards suggesting it is nearing the basin margin.

### (B) Triassic Salt

There are a few areas with chaotic reflections which has been interpreted as salt bodies. They are observed to occur where overburden is thinnest. It fills up the core of WNW trending anticlines near Aldebaran and Castor wells as accommodating structures above the detachment fault.

## PRE-RIFT (PRE-CRETACEOUS)

The megasequence is isopachous and represented by low frequency layered reflections bounded by reflections with higher amplitude that approximately inferred to be Lituolidae Limestone and Top Jurassic/Dolomie De Mano horizons.

### (C) Base Jurassic to Lituolidae Limestone sequence

This sequence has high amplitude, continuous reflections especially at the lower part. It could be that the sequence goes from carbonate facies with cycles of evaporites (stable platform) at the lower part to a more homogeneous deposition of limestone and dolomites in an outer shelf environment (Biteau, 2006).

### (D) Lituolidae Limestone to Top Jurassic/Dolomie De Mano sequence

This sequence distinctively has weaker to almost transparent, shorter reflections all through-out. It has very low density and velocity contrast. The sequence comprised of the same composition as the upper part of Base Jurassic to Lituolidae Limestone sequence – limestone and dolomites but with less heterogeneity. Biteau (2006) reported Dolomie De Dolomite is a fractured dolomitized formation. Fractured zones are difficult to identify which may be due to poor seismic imagery or they are sub-seismic resolution.

## SYN-RIFT (EARLY CRETACEOUS)

The megasequence is thick and shows reflections with lesser amplitude than Pre-Rift. It has an overall variation in thickness which thickens towards the SW, where deposition infill the accommodation space created by the movement of Ibis Fault. The megasequence is subdivided into two sequences by the Neocomian horizon which represents a reflection termination boundary.

### (E) Top Jurassic/Dolomie De Mano to Neocomiansequence

This sequence has high amplitude, low-angle progradationclinoform at the paleo-footwall highs and towards the NE it behaves more horizontally. Progradational reflectors are inferred to be an evidence of the end of regression. Amplitude is observed to be stronger down-slope of the progradation reflectors. The strong reflectors may be due to transition from sandstone-rich to mud-rich. This inferred to be Purbeckianclastics deposited with intraformational Wealden shales which may act as a reservoir-seal pair. Towards the NE there is lateral facies change to a more distal, shaley part of the succession which could potentially act as a barrier to underlying reservoir rock.

### (F) Neocomian to Albian Unconformity sequence

This sequence has low amplitude, high-angle progradation clinoform at the paleo-footwall highs and towards the NE it behaves more horizontally. Towards the NE there is lateral facies change to a more distal, shaley part of the succession. The top of this sequence is erosive especially near the paleo-footwall highs. This area could also be a fractured zone as the inherited faults are being reactivated during syn-rift phase. Therefore, this sequence could potentially be a reservoir rock.

## POST-RIFT (ALBIAN UNCONFORMITY TO LATE CRETACEOUS)

### (G) Albian Unconformity to Top Albian

Albian Unconformity marks the end of rifting and onset of salt movement which formed the WNW trending anticline (Aldebaran-Cephee ridge). This sequence unconformablyonlap and infill the depression caused by post-rift thermal subsidence. They have great lateral variation in thickness and irregularly distributed which might be due to variation in rate of subsidence. There is high amplitude accumulation at the progradational reflectors just after the paleo-footwall highs. This could potentially be sand accumulations eroded from the paleo-topography-highs. This high amplitude accumulation is shown to be encased and draped over by low amplitude reflectors which may reflect intraformational shale layers which could act as seal to the localized high amplitude accumulation.

### (H) Top Albian to Base Tertiary sequence

This sequence captures the folding event which is amplified by the Late Cretaceous convergence which is aided by the salt structures.

## INVERSION (LATE CRETACEOUS TO EOCENE)

### (I) Base Tertiary to Top Eocene

This inversion package is imaged by high amplitude reflections and it outlines channel and progradation deposits. This package captures a lot of erosion and incision which is due to the emergence of the entire chain by Pyrenean Orogeny. The fold and thrust belt is said to be fully developed during this event. Towards the NE, the lower section in fills a severely eroded Base Tertiary unconformity.

## PROGRADING SHELF (EOCENE TO OLIGOCENE)

### (J) Top Eocene to Top Oligocene sequence

This sequence is largely made up of progradingclastic and carbonate sequence that came from the north. The upper section of this sequence is largely continental derived from the eroded topographical highs emerged due to Pyrenean Orogeny.

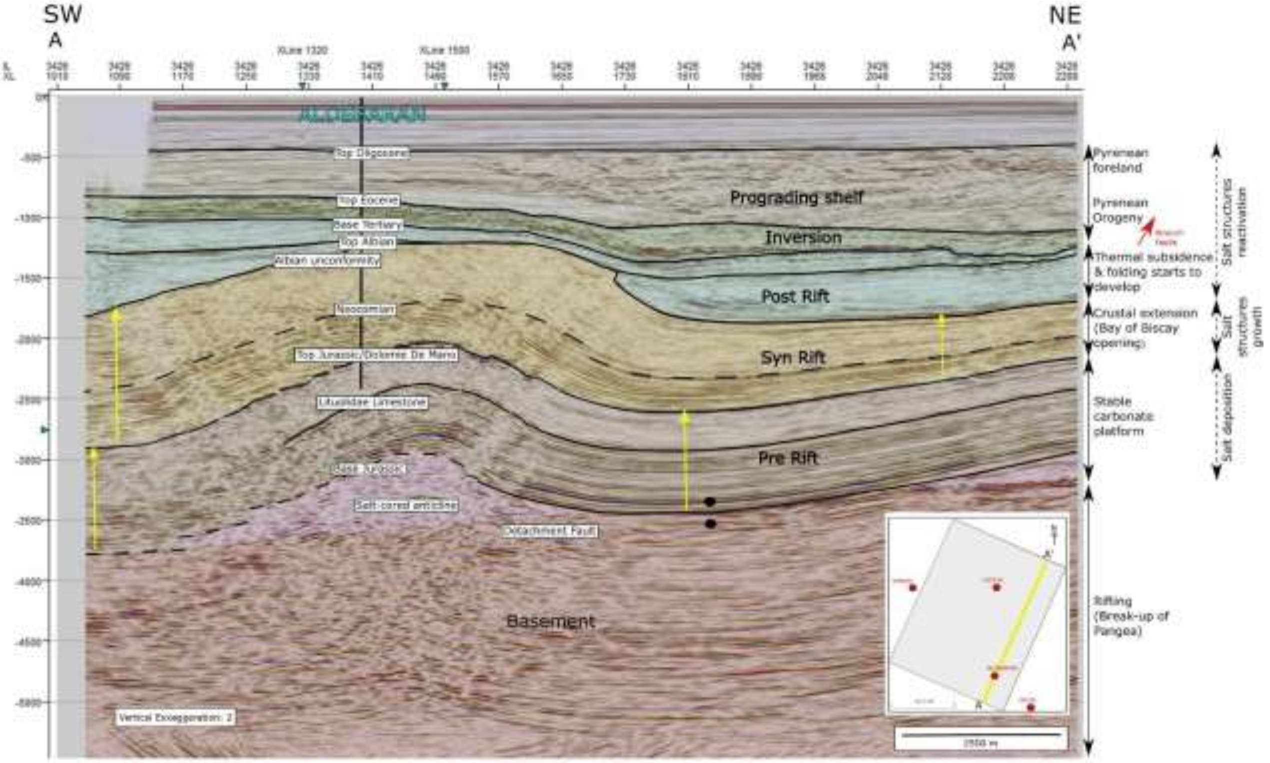

**Figure 10**: Megasequences and their Major Tectonic Events- line 3426

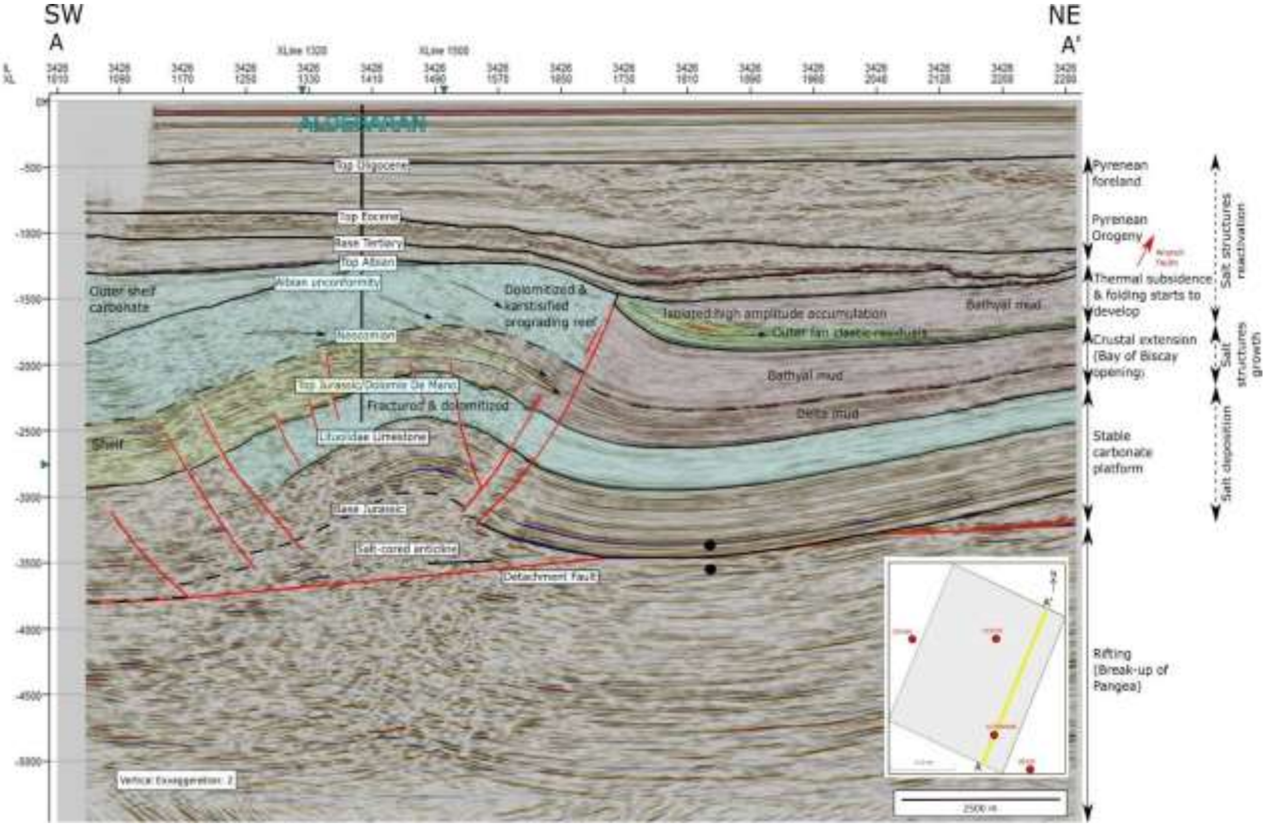

**Figure 11:** Gross depositional environment for sequences of interest

### *Fault-Structural Interpretation*

This process was carried out in order to interpret large-scale faults throughout seismic section, which trend NW-SE (Figure 11). Fault densities are high around the crests of the main anticlinal structures, and have a normal sense of movement. These faults penetrate from the Dolomie de Mano formation up to the Neocomian surface (Figure 12). Several large scale thrust faults were interpreted, and can be attributed to Late Cretaceous-Tertiary inversion producing NW-SE trending anticlinal fault propagation folds. These faults initiate below the Base Jurassic, and extend into Top Albian. Biteau et al. 2006 suggests that these thrust fault decollement zones are along the Triassic salt. A select few of the faults pass through the Top Albian seal, however fault seal analysis suggests that due to the high content of shale, sealing potential is still high. Faults could have been interpreted beyond the seismic section and into the basement, however there is high uncertainty with poorer data quality and thus these were not interpreted.

### *Gross Depositional Environments*

Principle components of the Parentis petroleum system exist in the intervals between Top Jurassic and Top Albian as these are shown to be where the primary producing intervals occur in the basin. Regional geological models in conjunction with seismic and well log interpretation have been used to assess the gross depositional environment (GDE) of each of the potential reservoir intervals within the study area. A variety of seismic attributes were used to distinguish these environments at the scale of the 3D seismic block. In a similar manner to the regional Jurassic GDE, the Jurassic Dolomie de Mano is considered to be deposited under broad open marine conditions which are undifferentiated within the study area and the GDE can be considered to operate parallel to the regional scale.

### *Neocomian (Purbeckian) Sands*

The Purbeckian sandstones were deposited as massive sand bodies in a series of fluvio-deltaic sequences as a result of underlying salt movement producing syn-sedimentary relief on the northern basin margin (Mathieu 1986). We see a progressive decrease in the clastic sedimentation as we move north through the study area which is concordant with the depositional model which identifies a more dominantly shale facies associated with the Wealden on the northern basin margin. RMS amplitude confirms a higher volume of clastic sedimentation in the south-west of the study area (Figure 13).

### *Barremian Carbonate Shelf*

The Barremian interval can be sub-divided into zones which comprise a series of transgressive-regressive carbonate sequences. The HSTs of these Lower Cretaceous sequences upwards from lime mudstones into the limestone shelf which gets progressively thicker in the SW part of the study area. This is thought to represent the transition zone between regressive sedimentation of carbonate facies in the south of the basin contrasting the northern edge which saw an influx of fluvial clastic and predominantly marl facies throughout the Barremian and into the Aptian. RMS amplitude confirms the presence of carbonate facies coming in from the south towards a progressively poorer quality bathyal mudstone (Figure 14).

### *Albian Turbidite Clastics*

The Albian interval which contains clastic material is up 500m thick in places and contains ~200m of channelized turbidites and debris flows. The fining upward channel sequences are ~30-50m thick and can potentially be recognised on electrical logs (Bessaguet and Martin 1977), although unfortunately there is no well control between the structural highs where these sands are thought to exist within the study area. They typically contain five lithofacies comprised of parallel laminated quartz-rich sandstones and massive pebbly conglomerates with chaotically bedded mudstones. The channels are generally oriented NNE-SSW, orthogonal to the underlying structure. At least one submarine fan has been identified within the study area which appears to be sourced from the N-W flowing around the carbonate highs. This is confirmed by seismic RMS amplitude maps for the corresponding Albian section. There appears to be a lobate structure approximately $5km^2$ in area (Figure 15).

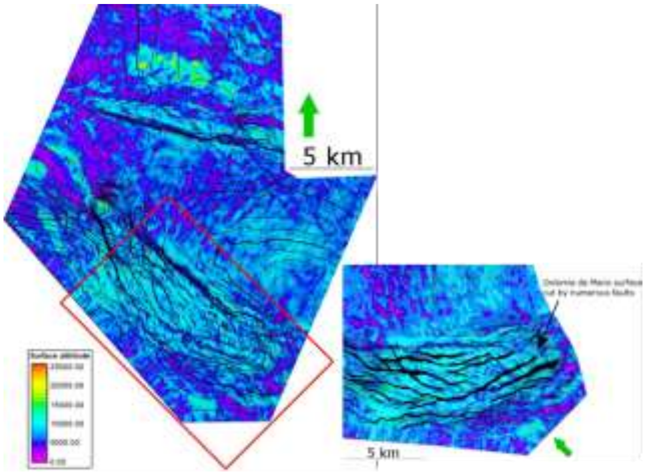

**Figure 12:** Above right – Variance attribute map displaying clear NW-SE structural trends. Below – RMS surface *attribute maps for Dolomie de Mano showing high density of faults around crest of anticlinal structure*

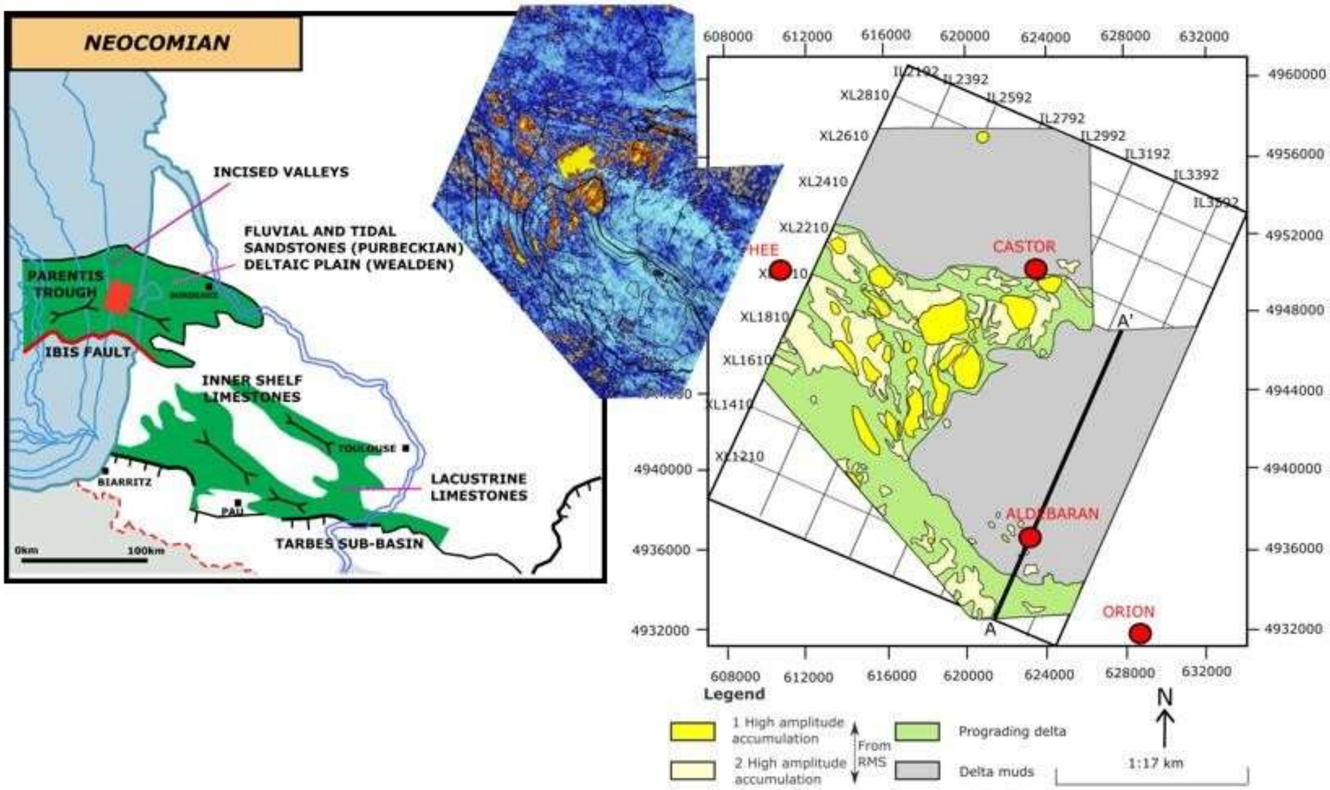

**Figure 13:** Regional Gross Depositional Environment with location of study area. Inset with RMS amplitude for Neocomian interval. Interpreted GDE from seismic showing decrease in Purbeckian clastic interval moving north through study area into bathyal muds of Wealden

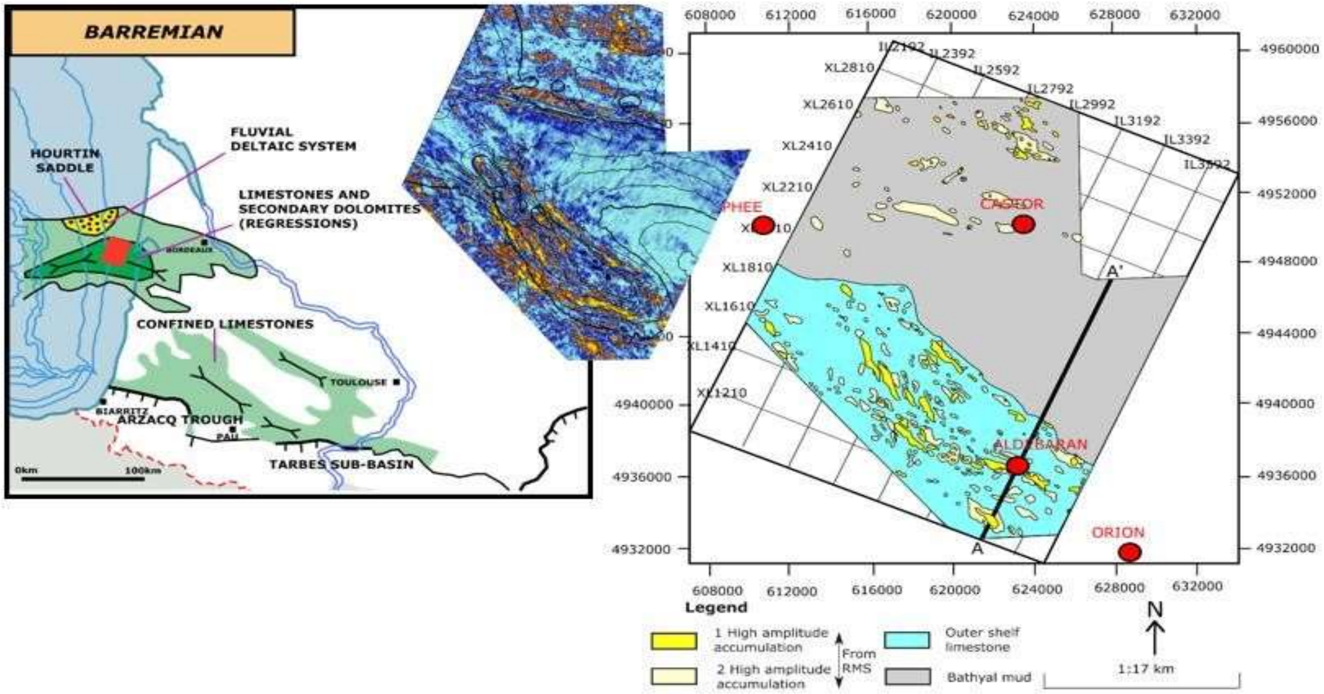

**Figure 14:** Regional Gross Depositional Environment with location of study area. Inset with RMS amplitude for Barremian interval. Interpreted GDE from seismic showing decrease in carbonate shelf moving north into study area into bathyal muds

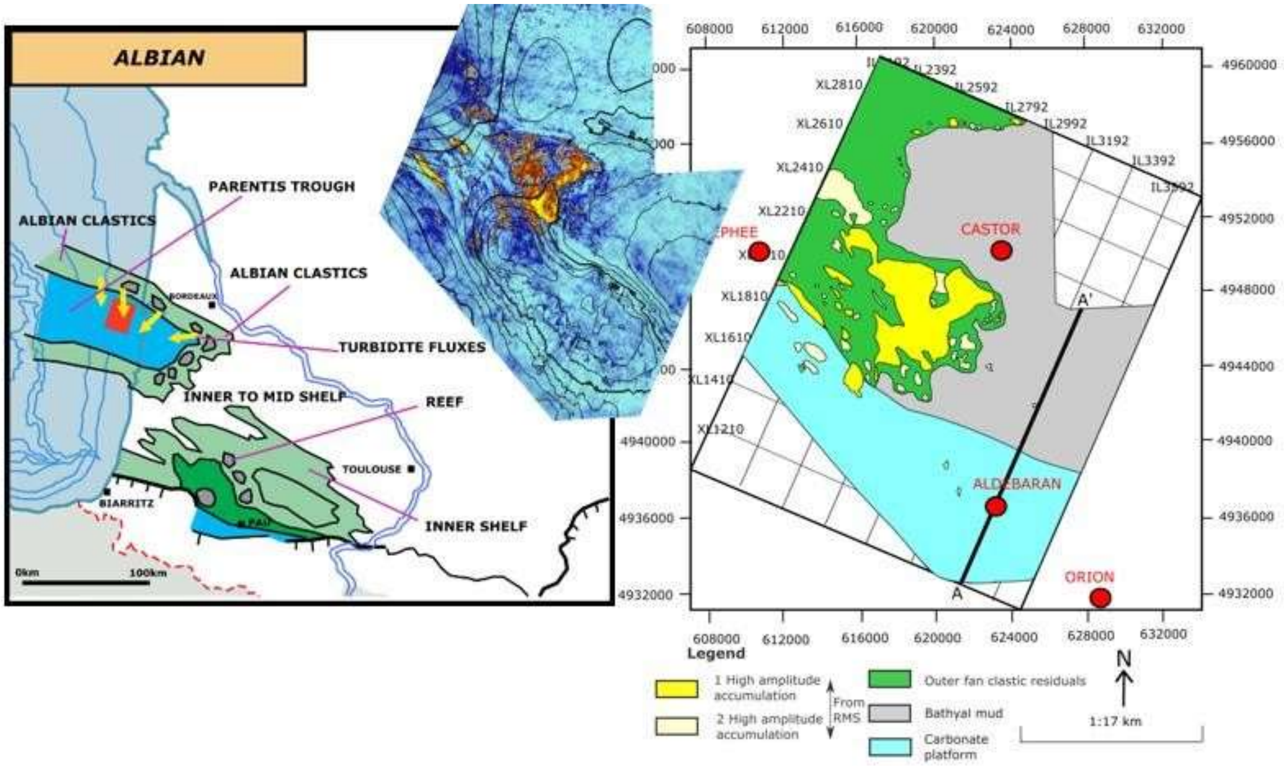

**Figure 15:** Regional Gross Depositional Environment with location of study area. Inset with RMS amplitude for Albian interval. Interpreted GDE from seismic turbidite deposition between carbonate highs on the basin floor. Best quality reservoir interpreted at centre of fan with residual clastics at margins and within tail

## Recommendations

Since the Purbeckian sandstone, which is a known reservoir rock in the adjacent Parentis sub-basin (Biteau et al., 2006) has its presence in the stratigraphy of the study area of Bellatrix basin as a thick fluvio-deltaic sequence there is an obvious potential for the accumulation of HC in the study area. The presence of the halokinetic structures and numbers of wrench faults makes it suitable of potential unconventional traps. So, further explorations in search of the HC reservoirs and trapping mechanisms are strongly recommended.

## Conclusion

The reservoir potential of different formations in Bellatrix Basin was studied using 3D Seismic Data. Based on evaluating the formations nine horizons were picked up and three different depositional settings were identified. The Purbeckian sandstones were deposited as massive sand bodies in a series of fluvio-deltaic sequences as a result of underlying salt movement producing syn-sedimentary relief on the northern basin margin. RMS amplitude confirms a higher volume of clastic sedimentation in the south- west of the study area. The Barremian interval can be sub-divided into zones which comprise a series of transgressive-regressive carbonate sequences. The HSTs of these Lower Cretaceous sequences upwards from lime mudstones into the limestone shelf which gets progressively thicker in the SW part of the study area. RMS amplitude confirms the presence of carbonate facies coming in from the south towards a progressively poorer quality bathyal mudstone. The Albian interval which contains clastic material is up 500m thick in places and contains ~200m of channelized turbidites and debris flows. They typically contain five lithofacies comprised of parallel laminated quartz-rich sandstones and massive pebbly

conglomerates with chaotically bedded mudstones. The channels are generally oriented NNE-SSW, orthogonal to the underlying structure. At least one submarine fan has been identified within the study area which appears to be sourced from the N-W flowing around the carbonate highs. This is confirmed by the seismic RMS amplitude maps for the corresponding Albian section.

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