Understanding the divergent (central) and the strike-slip (equatorial) margins of the South Atlantic by sandbox experiments

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Abstract

Lateral displacements are basic elements of plate kinematics. The San Andreas Fault, for example, transfers the divergence between the Mexican mainland and the peninsula of Baja California into the North American continent. The same combination of kinematic regimes occurs at the Red Sea, where the Gulf of Aqabapropagated into the Arabian Plate,coalescing with the Sinai Strike-Slip Shear Belt. These examples demonstrate that combination of divergent and strike slip movements are often keys to continental fragmentation, and define tectonic plates.

In this work, scaled sandbox experiments were used to investigate the early phases of rupture during the synchronous activity of divergent and strike-slip plate limits during the Late-Jurassic/Early Cretaceous rifting of the central and equatorial segments of the South Atlantic Ocean.The experiments showed that in the divergent regimes, since the early stages fault bounded depocentersmigrated basinward with variable degrees of distributed deformation. Along the strike-slip margin, however, deformation proceededdifferently: sharp linear *en echelon* ruptures formed with small displacements and inexpressive subsidence. With increasing displacement rupture interactions developed hard and soft fault linkages, which evolved into release bendsmarked by pronounced local subsidence.

Although the same amount of displacement was applied simultaneously to both margins of the experiment, on the divergent limit, depocenters formed since the very beginning, whereas along the transform margin substantial subsidence was achieved only after large displacements. The infilling sediments are crucial to demonstrate the chronology of deformation; in kinematic regimes with strong lateral displacements,accommodation spaces are formed later compared to those developed along divergent boundaries of the same age. Thus,even though they are synchronous, divergent and strike-slip plate limits can have apparently diachronic infilling histories.

Rift zones underlying the continental margin offshore central Labrador, Canada

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Abstract

New 2D seismic reflection data across the Labrador margin provides us with an improved image of its deep basement structure and further insight into the evolution of non-volcanic margins globally. Over the last several decades a number of studies have investigated the nature of the continent-ocean transition zone on this margin, as well as on its conjugate, off West Greenland. We describe some of the new seismic data and related potential field data, in relation to earlier studies which include a deep velocity profile.

The seismic data crosses three major structural and compositional zones defined by earlier studies as: 1) extended continental crust, including a hyper-extended region, partly underlain by serpentinised mantle; 2) exhumed and serpentinised continental mantle; and 3) oceanic crust. In this study, we extend these zones laterally to over 200 km along the margin.

The continental crust is hyper-extended over tens of kilometres landward of the breakup location, where normal faults and possible low angle detachment surfaces are present. Some of these are near or at the base of the crust. Further seaward, a zone of serpentinised mantle underlies the sediments and the seismic character of these rocks is very different from that of continental crust.

Within the oceanic zone we define a further sub-division into a 'proto- oceanic' domain with thin, variable oceanic crust and ages of about 70-65 Ma (magnetic chrons 27 to 31) and a steady-state sea floor spreading region further seaward.

We compare these results to earlier studies of the West Greenland conjugate margin and to other well-studied magma-poor margins and find they are remarkably similar to those off Iberia and Newfoundland.

A late rift to post-rift shoreline clinoform and shelf-edge model for the offshore Labrador margin, Canada

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Abstract

TheLabrador Sea and Baffin Bay evolved through extension between North America and Greenland commencing in theEarly Cretaceous,withseafloor spreading beginning by Chron 27 time (Selandian). During the late-rift to post-rift phase of the Late Cretaceous through Cenozoic, the succession along the Labrador margin can be linked tomargin subsidence, global sea level fluctuations, and more localized factors.

In the Hopedale Basin on the southern Labrador margin, we have mapped Late Cretaceous and Cenozoic shoreline clinoforms and shelf-edge breaksby integrating our revised paleoenvironmental and biostratigraphic analyses with the seismic reflection interpretation.The Coniacian–Maastrichtianshoreline clinoform sandstones and correlative deep-water shales of theMarkland Formationreflectsag-basin subsidence. The overlying Gudrid Formation represents a major Selandian to basal Ypresian regression. During ensuing subsidence and transgression,sea level stillstand formed alowerYpresian shoreline clinoform near the basement hinge. Renewed progradation was initially slow, but was followed by Bartonianregression andformation of subdued Leif Member (Kenamu Formation) shoreline clinoforms andthe earliest true shelf-edge break.

Middle to late Bartonian transgression marksthe base of the Mokami Formation, and was followed by progradation and aggradation of a thick upper Bartonian to Rupelian successionwith minor intervening transgressions. Prominent mid-Oligocene and mid-Miocene regressions formed two Saglek Formation shelf-edge deltaswith an intervening transgression. Followingtransgression of the second clinoform and deposition of an aggradational wedge, Pleistocene glaciation producedtheyoungestshelf-edge clinoform.

Understanding transgressive-regressive cycles along the Labrador margin provides a predictive model for the stratigraphy of adjacent and conjugate marginswhere data is more limited, such as Orphan Basin to the south and the Baffin Bay margin to the north.

Multi-parameter geophysical analysis and structural architecture of Paraíba and Natal Platform basins, Northeastern Brazilian margin

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Abstract

The Paraíba and Natal Platform encompass the set of basins located at Northeasternmost Brazilian margin. They were formed during the last stage of separation between South American and African plates in the Upper Cretaceous. The continental breakup in the region occurred probab y during the Upper Albian (~102Ma). The structural framework of basement crustal blocks is dominated by large shear zones and they present ages varying since Archean to Neoproterozoic. Considering the basement structural controls and rift propagation, we present a regional investigation using gravimetric, magnetic and seismic data. The potential field maps and seismic interpretation indicate that this region represents a basement high with regional (ENE-WSW) orientation of the tectonic structures, which is orthogonal to the structures developed during the opening processes of the Paraíba and Natal Platform basins (NNE-SSW and NNW-SSE). The continental basement forms a narrow platform with a thin sedimentary cover (0.8-2.5km) and an abrupt shelf break, creating a large bypass zone towards the slope. The analysis of a deep seismic section revealed that extended continental crust occupies a narrow zone and that the continental-oceanic boundary (COB) is located approximately 100 km to the east of the present coastline, at Paraíba Basin, and 70 km, at Natal Platform Basin. 2D forward modeling of free-air anomalies constrained by seismic data suggests that this region is characterized by an abrupt thinning of continental crust, with an expressive rise of the Moho. At distal region of the extended crust, there are indications for the existence of a zone of extremely thinned continental crust, which was interpreted as hyper-extended crust. Our findings suggest that the NE Brazilian margin shows similarities to non-volcanic or magma-poor rifted margins.

Interpretation of depth to the magnetic basement in the Pernambuco Plateau, Northeastern Brazilian margin

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Abstract

The study region encompass the Pernambuco Plateau (PP), located in distal domain of Pernambuco Basin. The tectonic evolution of the PP is related to separation between South America and African plates during Upper Cretaceous. The continental breakup in this region occurred probably during the Upper Albian (~102 m.y). The tectonic and magmatic evolution of the Pernambuco Basin was influenced by oblique rifting (~ 35° to rift axis) and a thermal anomaly probably caused by the Santa Helena hotspot, where the PP was developed over an extended continental crust. The objective of this work is to present a first-order interpretation of sedimentary thickness distribution and analyze the structural patterns of magnetic solutions along of the PP. In this way, we applied depth estimation techniques based in magnetic derivatives (3D Standard Euler Deconvolution and Local Wavenumber) to calculate the depths to the magnetic basement. We also use the bathymetric data compiled from Etopo1 dataset. The interpretation of the sedimentary thickness map (obtained by subtraction between magnetic basement depths and seafloor depths) shows thickness varying from 4.5 km (at main depocentres) to 0.5 km (at structural highs). These information were constrained to seismic basement and one stratigraphic well, where they show a good correlation (mainly in regions with occurrence of structural lows or in areas with low concentration of high magnetic susceptibility rocks related to magmatic and intra-basement magnetic sources). The magnetic solutions highlighted depocentres oriented on NNW-SSE and structural highs. The structural highs shows circular (forming cluster solutions) and elongated shape (NNW-SSE), where they presents internally magnetic solutions trending ENE-WSW. The results obtained concerning structural framework, shows positive correlation with features delineated through gravimetric and seismic interpretation.

Geophysical signature of the Abrolhos Magmatic Complex, Brazilian Margin

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Abstract

The Abrolhos Magmatic Complex (AMC) is an igneous complex formed on the Espírito Santo segment of the Brazilian margin in the lower Cenozoic, approximately 60 Ma after continental breakup of Gondwana. Our objective is to determine whether the AMC is underlain by oceanic or continental crust, and to understand how the AMC was formed.

This work investigates the crustal structure underneath the AMC based on seismic mapping, and gravity and magnetic anomaly analysis. We focus on the characterization of the Abrolhos Formation, identifying associated seismofacies and magmatic rocks. The seismic data, in association with crustal thickness from gravity inversion, enables the identification of crustal tectonic domains and to infer on the presence of continental or oceanic crust underlying the AMC.

We identify two seismic facies in the AMC with distinctive seismic textures: 1) a massive seismic texture of low amplitude chaotic reflectors; 2) an interspersed seismic texture formed by both chaotic reflectors and high amplitudes continuous reflectors. The first seismic facies is interpreted as a discordant intrusive body of igneous rock, younger than the sedimentary sequences. The second is truncated by a regional discordance, forming a large erosional surface. We propose that it represents an event of subaerial magmatism interbedded with sedimentary rocks. The associated tectono-stratigraphic architecture of overlying sedimentary sequences suggests early Cenozoic uplift followed by subsidence to the present day.

We interpret 3 distinct crustal domains consisting of a crustal necking zone, distal hyperextended continental crust and oceanic crust beneath the AMC. The oceanic domain is isostatically flexured by igneous loading and, along with the hyperextended domain, shows evidence of polyphase magmatism.

Early Cretaceous Tectonostratigraphic Evolution in Congo and Gabon

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Abstract

The continental margins of Congo and Gabon are prolific petroleum provinces where key observations can be made to enhance our understanding of the early stages in the evolution of the South Atlantic passive margins. Active rifting and coeval deposition of fluvial and lacustrine clastic sediments dominated up to Middle Barremian, at which time an unconformity marks the end of significant rifting in the inner rift systems of Congo and Gabon. Middle Barremian lacustrine shales with world class source rock potential were deposited on top of this unconformity. As the water depth increased in the lakes pre-existing rift-related highs were onlapped and commonly completely covered by lacustrine shales.

A pronounced shift in regional subsidence towards the outboard region of the margin occurred towards the end of the Barremian stage. A lacustrine delta system was established, prograding westward into the rapidly subsiding outboard region of the Congo-Gabon margin. Observations from gravity, seismic and well data indicate that this Early Aptian delta system was at least 800 km long, 100 km wide and with a thickness in the order of 3 km or more. The rapid subsidence and sediment infill in the outboard region generated a flexural forebulge, uplift and erosion in the inboard region. The end of this dynamic deltaic depositional system is represented by a regional unconformity, subsequently onlapped by the fluvial and marginal marine sandstones of the Gamba- and Chela Formations. This is interpreted as a transgressive unit deposited under influence of marine incursions. As the influx of seawater increased a thick salt layer was deposited in Late Aptian, followed by deposition of shallow marine Albian carbonates.

Differences between conjugate margins of the Equatorial South Atlantic explained by intracontinental deformation

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Abstract

Intracontinental dextral strike slip structureshave been described for the early rifting stages of the Equatorial South Atlantic during the Early Cretaceous, accounting for the onshore structural framework of its Brazilian and African conjugate marginscomposed of asymmetric half-grabens limited by basements highs and/or transfer zones. The offshore continuation of these basins is divided into rift-dominated and shear-dominated segments.

Here we show through seismic interpretation of intrabasinal geometryin theCeará Basin (NW Brazil) and its African conjugate, the Benin Basin, that the rift-dominated segmentis directly related to the interaction of the Romanche FZ with theTransbrasiliano/Kandi Lineament, both of which probably acted as intracontinental transfer zones prior tothe implantation of the Equatorial Dextral Transform Plate boundary.

Seismic interpretation, stratigraphic and structural analysis show thatthe main faults along the Ceará Basin strike mainly E-W, with subsidiaryNE-SW/NNW-SSE transtensional and transpressionalsegments located between the Romanche FZ and the border fault (parallel with the present shoreline). Therefore we interpreta much more compressional domain to the west of the basin, near the Romanche FZ. On the African side, the border fault zone of the Benin Basin is oblique relative to the Romanche FZ (inferred, despite the sparse seismic coverage), but displaysnormal rift-like evolution. Thus the Benin Basin portion of the margin is much more rift-dominated than that of the Ceará Basin.

Combining these elements we can affirm that the Ceará and Benin basins were parts of the same system during the early stages of their evolution. The first probably nucleated near the intracontinental transform and the second along release bends or oversteps of not yet connected fault segments.

Salt-related Structural Styles and Sequential Generation of Allochthonous Salt Sheets on the Conjugate Margins of Nova Scotia and Morocco

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Abstract

Salt tectonics is an important control on the structural configuration of many passive margins around the world that influences syn-deformational sedimentation and stratigraphic architecture and has a significant impact on reservoir distribution, migration pathways and trap formation. This study adopts an integrated seismic stratigraphic interpretation and forward modeling approach, combining regional 2D seismic data and Discrete-Element Modeling to compare the style and evolution of salt tectonics on the Nova Scotia and Morocco conjugate margins and to, ultimately, assess the influence of pre-salt topography and sedimentation styles on salt-related deformation and its influence on basin topography and sediment distribution. Both margins display significant along-strike variation of structural styles associated with changes in pre-salt topography and salt thickness. Timing of salt deposition is interpreted to be syn-rift to early post rift, with inherent variability in salt thickness between graben depocentres and depo-minima on fault block crests. Later deformation was also controlled by the timing, distribution and thickness of post salt sedimentation. The widespread occurrence of tear-drop and squeezed diapirs on the Moroccan margin suggest a greater degree of shortening and steepening related to the translation of tectonic stress associated with the Alpine orogeny and the presence of an early seaward buttress formed by Triassic volcanoes. This early buttressing effect explains why the Moroccan salt basin demonstrates only 15-20km of basinward translation. In Nova Scotia, without the presence of a buttress, the early seaward fold belt is absent and translation was more than 100km. This study shows that the origin, evolution and distribution of allochthonous salt tongues and sheets along both margins are remarkably different due to different timing of sediment input and regional basin structural configuration.

Salt-detached Ramp Syncline Basins on the Brazilian and Angolan Margins

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Abstract

A salt-detached ramp-syncline basin (RSB) forms where a cover sequence, sliding basinward over a salt layer, moves over a basinward dipping ramp in the base of salt. Ramp-syncline basins are characterized by an asymmetric depocentre defined by a basinward-dipping axial trace and occur in both sides of South Atlantic conjugate margins, (Angola and Brazil). Existing publications have documented the existence of RSBs in the Kwanza margin of Angola, and describe their overall 2D development, but hitherto, the existence of RSBs in Brazil has not been documented, and nothing has been published about their 3D geometry. We combine high-resolution 3D seismic data from the São Paulo Plateau, offshore Brazil, numerical forward modelling and 2D lines and restorations of the Kwanza Basin to understand ramp-syncline basin evolution and distribution along both margins, comparing translation rates, timing, salt thickness, stratigraphic architecture and interactions with diapiric structures. These minibasins are commonly bounded below by an onlap surface, and above by an erosional unconformity, both of which are diachronous and get progressively younger landward. Internal strata expand and dip landward, are gently folded, and contain numerous intra-formational unconformities. Ramp-syncline basins are important because they provide a continuous record of the rate and amount of downdip translation of the overburden. Furthermore, identifying RSB structures in the supra-salt section provides a method of identifying pre-salt structures in regions where the subsalt is poorly imaged or masked by velocity effects, which is extremely relevant in the context of pre-salt hydrocarbon exploration.

Integrating matched filters and derivatives of potential field data: insights about structural geometries in Pernambuco Plateau, Northeastern Brazilian margin

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Abstract

The study region encompasses the outer part of Pernambuco Basin, dominated by the Pernambuco Plateau (PP). The PP represents the extended continental crust domain of Pernambuco Basin and your tectonic evolution is related to separation between South America and African plates during Upper Cretaceous. The continental breakup in this part of Northeast Brazilian rifted margin occurred probably during the Upper Albian (~102 m.y). The structural framework of basement rocks is dominated by large Precambrian shear zones oriented with E-W and NE-SW strikes. The tectonic and magmatic evolution of the Pernambuco Basin was influenced by oblique rifting (~ 35° to rift axis) and a thermal anomaly probably caused by the Santa Helena hotspot. In this study we present a regional interpretation of structural geometries, focused on basement controls in the PP formation. The analysis was based on the interpretation of gravity and aeromagnetic data. A set of filters was applied in the Space and Wavenumber domains (Reduce to the Magnetic Pole, Conventional and Normalized Derivatives and Matched Filtering) to produced a series of maps that were integrated for interpretation. The results (mainly the residual information: depth slices above 8.0 km in Matched filtering and Derivatives) showed that the PP presents main depocentres trending NNW-SSE, and structural-marginal highs with circular and elongated shapes trending NNW-SSE. Observation of internal magnetic anomalies in these structural highs shows that they are trending ENE-WSW. Our findings suggests that the oblique rifting process promoted by crustal thinning and the magmatic activity in the PP produced an anastomosing pattern between the two sets of shear zones (NE-SW, E-W and NW-SE) and a series of rhomb-shaped structures (lozenges) formed by intersection between them.

Structural framework of the SubSaharian Western African Margins in regard to potential fields methods

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Abstract

The validation of the structural framework is an important step in the study and interpretation of a rifted margin. In this paper, the structural framework of the SubSaharian Western African Margins comprising magma-rich, magma-poor and transform margins, was analyzed by using gravity and magnetometric data and their derivative signatures. This data provides elements to help defining the major structural features individualized by reflection seismic data. Our study shows that gravity maps of total horizontal gradient of Bouguer anomaly, total horizontal gradient of Bouguer Anomaly presented with a cutoff at 5.019E and tilt derivative Bouguer anomaly are useful to constrain the limits of the oceanic domain along all these margins. In the region of the Namibe Basin, regional maps of the tilt derivative of the Bouguer anomaly, the total magnetic field and the first derivative of the total magnetic field support the interpretation that the Outer Domain of the magma-rich margin could continue northward from the Walvis Ridge features. This fact may introduce some implications in how the lithospheric breakup happened in this region. Moreover, the residual Bouguer anomaly map together with the total magnetic field and its first vertical derivative suggest that some region in the Oceanic Domain appear characteristics that regard the continental crust. These observations suggest the presence of microcontinents. Gravity profiles modeling across the transition zone between distinct margin types (magma-rich, magma-poor and transform) suggests different mantle regions with density values that may be associated with the occurrence of changing mechanisms of rifting (e.g. extraction processes of magma) or may be related to inherited structures as indicated by onshore geological observations.

A model of the continent-ocean transition across the NE Nova Scotian margin from coincident dense wide-angle refractionand long-streamer reflection profiles

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Abstract

We present anew 2-D velocity model of the 405-km-long OETR profile collected across the northeastern Nova Scotia margin. This model wasformed by re-analysisof data from 78 ocean bottom seismometerssupported bya reflection image from the coincident9-km-long streamer profile GXT-2000 and nearby boreholes P-52 and D-76. Three crustal zones are recognized: continental, transitional and oceanic. Full-thickness (~30 km) continental crust thinsdramatically on the shelf by a fault that forms a large 12-km deep basin beneath a carbonate platform, resultingin a low-velocity zone above the tilted crustal fault blocks.Further seaward, thinning continues more gradually beneath the riseuntil80 km from the carbonateswhere the continental crustis replaced by a transitional zone that hasvelocity characteristics which cannot be explained by either continental or oceanic crust.This region contains a ~1.5-km thick upper “crust” of very low velocityand gradient,a < 5-km thick lower layer of very high velocity and gradient, and a <4-km thick interpreted serpentinized mantle layer (velocity=7.1–8.0 km/s) above normal mantle. As the serpentinized mantle layer pinches out seaward 145 km from the shelf break, elevated basement of a ~5-km thick oceanic crust with velocities consistent with Layers 2 and 3 is modelled. The modelled structure of the margin indicates that extension was amagmatic, with no evidence for significant syn-rift volcanismandwith the seaward occurrence of mantle serpentinization beneath thin crust, similar to that found on the adjacent SMART-1 profile. Velocity structures are highly asymmetrical across a conjugate profile offshore Morocco (MIRROR-1), such as sediment thickness, width of thinned continental crust, basement depth, and character of the transition zone and oceanic crust.

Meso-Cenozoic tectonic evolution of SE Brazilian continental margin: petrographic, kinematic and dynamic analysis of the onshore Araruama Lagoon Fault system

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Abstract

The Ararauama Lagoon Fault System composes one of the most prominent set of lineaments of the SE Brazilian continental margin. It is located onshore in a key tectonic domain, where the basement inheritance rule is not followed. This fault system is consisted by ENE-WSW silicified tectonic breccias and cataclasites showing evidences of recurrent tectonic reactivations in its outcrops. Based on field work, microtectonic, kinematic and dynamic analysis, we reconstructed the paleostresses in the region and propose a sequence of three brittle deformational phases accountable for these reactivations: 1) NE-SW dextral transcurrence; 2) NNW-SSE dextral oblique extension evolved to NNW-SSE "pure" extension; and 3) ENE-WSW dextral oblique extension. These phases are reasonably correlated with the tectonic events responsible for the onset and evolution of the SE onshore rift basins, between the Neocretaceous and the Holocene. However, based on petrographic studies and supported by regional geological correlations, we assume that the origin of this fault system is older, related to the Early Cretaceous South Atlantic rifting. This study provides significant information about one of the main structural trends of the SE Brazilian continental margin and the tectonic events that controlled its segmentation, since the Gondwana rifting, and compartmentalization of its onshore sedimentary deposits during the Cenozoic.

Depositional Evolution of the Cretaceous Deep-Water Turbidite System in the Barreirinhas Basin

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Abstract

The Brazilian Equatorial Margin has become a focus for oil and gas exploration in an attempt to replicate the success of the West African conjugate margin. BG acquired 10 blocks in the Barreirinhas Basin through ANP Round 11 in 2013 (now operated by Shell). As part of the initial exploration phase, a 14,500Km2 3D seismic survey was acquired. This dataset spectacularly imaged a well-developed Cretaceous deep-water turbidite system. The Creteaceous section presents distinct chances in depositional styles that can be divided in 5 Mega-sequences:

1- Albian? to Turonian?: Dominated by a thick, chaotic section interpreted to be made of a large mass transport complex (MTC). MTCs create subtle topography that is gradually smoothed by subsequent deposition.

2-Turonian? to Santonian?: Potential Source rocks. Characterized continuous, parallel and low frequency reflectors and MTC's. Top of the sequence is represented by a condensed section.

3-Santonian?: Marks transition from small scale MTC features to potentially ponded turbidite sands. Large lobes/aprons are favourably oriented relative to the regional dip with regards to potential for up-dip pinch-out.

4-Campanian: Main reservoir section. Seismic geometries indicate a well-developed Late Cretaceous turbidite depositional system. Characterized by channel-levee geometries associated with high-amplitude reflection packets (HARP) and large asymmetric mud-prone levees.

5-Maastrichtian: Depositional system steps outward and begins to bypass sand to the distal low of the previous section. Sequence is comprised of sheet-like seismic facies (lobes &HARPS) intercalated with small MTCs and/or mudrocks.

The interpretation on the new 3D survey has provided a better understanding of the evolution of the Cretaceous depositional sequence through the identification of reservoir-prone intervals. These results have been used to better understand the prospectivity in this frontier basin.

Flexural uplift and underplating anomaly for a profile at 43.5°S on the Argentine Continental margin

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Abstract

Magmatic underplating could be defined as "the addition of mafic magma to the lower crust and uppermost mantle around the Moho" and could be included in a wide range of processes, which appear in compressional and extensional tectonic environment as continental margins.

We have modelled the magmatic underplating effect using Process Oriented Gravity Modelling (POGM) instead of conventional "static" modelling, where the density structure is determined that best explains the gravity anomaly. This approach has been useful in determining the physical properties of the crust and mantle in continental margin regions. However, POGM is an innovative modelling that can distinguish the contribution that different geological processes make to the observed gravity. In the POGM the gravity anomaly is composed by the rift anomaly, the sedimentation anomaly and the underplating anomaly.

The interest of this work is focusing in the flexural uplift produced by the magmatic underplating and its associated gravity anomaly rarely investigated in actual profiles due to the refraction seismic data are generally unavailable. Particularly it had not been calculated in the volcanic sector of Argentine continental margin before this work.

The obtained results give a maximum flexural uplift associated with magmatic underplating, which is 276 m and 145 m for densities of the high-velocity body of 3050 kg/m^3 and 3150 kg/m^3, respectively and an average density of the sediment of 2300 kg/m^3. The increase of elastic thickness (Te=25km) to a minimum rms in comparison with the calculation without take into account the underplating (Te=20 km) is associated with the thickening of the crust. The underplating anomaly has opposite contribution to the typical free air gravity anomaly edge-effect for the Airy and flexural case.

Crustal domains in the South Atlantic Salt Basin and their implications for hydrocarbon systems

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Abstract

Continental margins have been the hunting ground of Oil and Gas companies for many decades, starting with deltaic plays in shallow water. The development of deepwater drilling technology and improvements in subsurface imaging have enabled industry to push activity to more and more distal settings. In such settings, the formation history of continental margins becomes more and more important for a working hydrocarbon system. An example of this is the South Atlantic Pre-Salt, where shelfal activity in the 1970's have made way for deep-water activity.

The academic community has proposed numerous rift scenarios to explain observations in distal settings. New terms and concepts have been introduced; morphological terms, domain names and terms referring to geological processes. Many of these terms refer to similar features or processes, but, the definitions of their boundaries are often not clearly described and the implications for Oil and Gas are not fully explained.

To underpin Shell's regional understanding, we have defined a number of key mapping criteria on deep seismic reflection profiles (ION SPAN data) and magnetic datasets that help define and differentiate various crustal domains. Plate Modeling software allowed us to analyze both sides of the Atlantic together and integrate all observations of the Pre-Salt basin into one interpretation.The result is a single crustal domain interpretation over the entire South Atlantic Salt Basin, based on clearly defined mapping criteria, which can subsequently be linked to elements of a working petroleum system, such as timing of structuration,heatflow history, expected stratigraphic sequence and depositional environment.

We will show how this work has highlighted similarities on different sides of the Atlantic and how it can underpin further exploration activity.

Trace elements, $^{40}Ar/^{39}Ar$ dating and Sr and Nd isotope analysis related to Trindade Plume evidences

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Abstract

We present here the results of chemical and isotopic composition of Sr and Nd from five seamounts (Montague, Jaseur, Davis, Dogaressa and Columbia) and the Martin Vaz main island, located in the offshore portion of southeastern Brazil. These alkaline intrusions were generated during the Plio-Pleistocene dated by the $^{40}Ar/^{39}Ar$ method with the oldest seamount yielded by this method of about 21 Ma and the youngest Martin Vaz Island of about 450 Ka. They are represented by sodic magmas of nephelinitic composition revealing a magmatic evolution process by fractional crystallization in Martin Vaz Island generating phonolites. The composition of the olivine phenocrysts in the seamounts and Martin Vaz indicates a disequilibrium liquid (assuming $Fe/Mg^{ol/liq}$ K_D ~ 0.30±0.03) probably associated with a prior crystallization process from an evolved magma. The greencores pyroxenes from Martin Vaz nephelinite lavas are characterized by a polybaric fractionation. The different chemical compositions in clinopyroxenes corroborate to a magma replenishing hypothesis. The $^{87}Sr/^{86}Sr$ (~ 0.703800) and $^{143}Nd/^{144}Nd$ (~ 0.512800) ratios of seamounts and Martin Vaz do not vary significantly reiterating a partial melting process from a homogeneous depleted source in comparison to the Bulk Silicate Earth (BSE). Non-modal partial melting models (Fractional Melting and Batch Melting) suggest that the source of the Vitoria-Trindade Ridge (VTR) magmatism is a mixing between the spinel and the garnet-lherzolite (75-90 Km) generated between 2.0-3,0GPawhich REE enrichment and chemical variability is due to small degree of partial melting (F = 0.02-0.07)generated by plume from a metasomatized mantlein an old thick lithosphere (~70-120Km).The VTR has a general W-E trend along 1000 Km and might suggest that, at least, during the last 21 My the South American Plate motion did not varyits path, along a steady linear W-E movement.