

# **Fourth EAGE Workshop on Pre-Salt Reservoir 2024**

Rio de Janeiro, Brazil  
17-19 September 2024

ISBN: 979-8-3313-0832-2

**Printed from e-media with permission by:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571



**Some format issues inherent in the e-media version may also appear in this print version.**

Copyright© (2024) by the European Association of Geoscientists & Engineers (EAGE)  
All rights reserved.

Printed with permission by Curran Associates, Inc. (2024)

For permission requests, please contact by the European Association of Geoscientists & Engineers (EAGE)  
at the address below.

European Association of Geoscientists & Engineers (EAGE)  
PO Box 59  
3990 DB Houten  
The Netherlands

Phone: +31 88 995 5055  
Fax: +31 30 634 3524

[eage@eage.org](mailto:eage@eage.org)

**Additional copies of this publication are available from:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: 845-758-0400  
Fax: 845-758-2633  
Email: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

## TABLE OF CONTENTS

### **SESSION I - EXPLORATION IN PRE-SALT PLAYS (PART I)**

The Tupinambá High and Its Control on the Deposition of the Pre-Salt Sequence, South-Central Santos Basin .....	1
<i>M. D. Carvalho, D. Domingues, C. Aristizabal, K. Cardozo, L. Halfen, A. Guimarães, L. Magnavita, F. Gonçalves</i>	
CO2 Induced Fluid Compositional Changes; Lessons Learned from the Tres Marias-1 Well .....	7
<i>R. Norelis, D. Boyarko</i>	

### **SESSION II - EXPLORATION IN PRE-SALT PLAYS (PART II)**

South Campos Well Results Corroborate Two Distinct Early Cretaceous Rifting Stages in the Outboard Region .....	11
<i>N. Kuhle, D. Green, A. Kahn, V. Heesakkers, D. Erickson</i>	
Controls of Carbonate Petrofabrics on the Occurrence of Silicified Intervals in the Pre-Salt, Santos Basin, Brazil .....	15
<i>P. W. Santana, G. Pires, P. Dal'Bó, M. Arena, L. Borghi</i>	

### **SESSION III - OPTIMIZING RESERVOIR CHARACTERIZATION, FIELD DEVELOPMENT STRATEGIES, AND RECOVERY (PART I)**

Integrating Vp/Vs and AI Data from Nodes Seismic into the Búzios Pre-Salt Geological Model.....	20
<i>B. E. M. Lima, L. M. T. Silva, D. L. D. P. Faria, J. C. Guerrero, S. P. Guimarães, L. M. A. Ribeiro, E. B. Silva, V. G. M. D. R. Silva, T. C. Oliveira, V. P. L. Dutra</i>	
Excess K Cumulative Curve Prediction in Pre-Salt Carbonates Reservoir.....	25
<i>A. Belila, P. Bitencourt, E. Teran, K. Klein, K. Juk</i>	
Pre-Salt Carbonates Relative Permeability Characterization: 3D Digital Workflow for Numerical Interpretation .....	29
<i>S. Drexler, A. Fadili, Y. Wang, T. Yeh, B. Roussenac, S. Berg</i>	

### **SESSION IV- EXPLORATION IN PRE-SALT PLAYS (PART III)**

Insights into Reservoir & Source Rock Presence on Hyper-Extended Crust, Outboard Santos Basin.....	35
<i>R. Dvoretzky, D. Erickson, J. Greene</i>	
An Unusual and Innovative Prospect Amidst the Pre-Salt Polygon: An Albian Atoll, New Data, New Interpretation.....	38
<i>M. Cvetkovic, P. Zalan, A. Hartwig, H. Houllevigue, K. Reuber</i>	

## **SESSION V - OPTIMIZING RESERVOIR CHARACTERIZATION, FIELD DEVELOPMENT STRATEGIES, AND RECOVERY (PART II)**

Core-To-Log Data Integration to Detect Relations Between Silicification and Excess-k Intervals in Pre-salt Carbonate Reservoirs .....	43
<i>L. Brelaz, P. Bitencourt, B. Rodrigues, L. Drehmer, K. Juk</i>	
Hybrid Time Lapse Seismic Monitoring to Explore Subsurface Concepts in a Presalt Carbonate Reservoir, Offshore Brazil.....	47
<i>R. Hodgson</i>	

## **SESSION VI - OPTIMIZING RESERVOIR CHARACTERIZATION, FIELD DEVELOPMENT STRATEGIES, AND RECOVERY (PART III)**

Atapú Integrated Reservoir Modelling – an Integrated & Iterative Concept-Driven and Multi-Scenario Modelling Novel Application .....	52
<i>R. Micheli Clavier, M. Bolton, A. Kellock, N. Gardner, R. Vaughan, A. Cook, M. Salles</i>	
Ultra-Deep Water 4D Monitoring: 10 Years of Ocean Bottom Nodes Acquisitions in Santos Basin .....	57
<i>D. Scapin, E. Saragoussi, S. Trezzi, F. Perez Ortega, J. F. Espinoza, Y. P. Kristomo, T. Da Silva Sales</i>	
Petrophysical Characterization of Low Energy Sediments in a Pre-Salt Succession. ....	62
<i>I. De Jesus, A. P. Soares, H. S. Yamasaki, M. Blauth, G. J. S. Terra, A. França, G. V. Bueno, S. Fontes, A. Guimarães</i>	

## **SESSION VII- GETTING THE MOST FROM OUR DATA; DIGITAL INNOVATION, IMAGING ADVANCEMENTS, AND EMERGING TECHNOLOGIES (PART I)**

Improved Target Illumination Using High-Frequency Elastic FWI for Santos Basin OBN Surveys .....	67
<i>N. Casado, M. Carneiro, C. Parekh, P. Barros, J. Igarashi, C. Castro</i>	
Revealing Complex Geology in the Presalt with Elastic FWI Imaging .....	72
<i>E. Cavalcanti, G. Pacheco, A. Araujo, D. Costa, K. Pereira, L. Cypriano</i>	
Low-Impact Seismic Sources for Brazilian Pre-Salt Imaging.....	77
<i>F. Capuzzo, M. Cetale, S. Grandi, J. Lopez, S. L. Da Silva, F. Costa, R. Moreira</i>	

## **SESSION VIII - GETTING THE MOST FROM OUR DATA; DIGITAL INNOVATION, IMAGING ADVANCEMENTS, AND EMERGING TECHNOLOGIES (PART II)**

Innovative Approaches to Surface Multiple Attenuation: 3D Iterative Strategies Applied in Offshore Brazil Context.....	82
<i>F. Sokolowski, T. Sales, F. Xavier De Melo, J. Monteiro, S. Attia, D. Skorinski, M. Ghazey, A. Schuartz Ferreira, E. Sperandio, M. Rapini Braga, M. De Souza Bezerra, T. Nobre Costa</i>	
Shear-Noise Attenuation Using Fourier-curvelet Thresholding for Ultradeepwater Ocean-bottom-Nodes Data from Santos Basin, Brazil .....	88
<i>F. Perez-Ortega, E. Saragoussi, D. Scapin, S. Trezzi, R. Kumar, C. Bagaini, Y. Izzeldin, K. Amin</i>	

Illuminating the Subsurface for Advanced Reservoir Understanding – Pre-Stack LSRTM Campos Basin Case Study .....	93
<i>M. Shadrina, M. C. Cavalca, E. Saragoussi, J. Monteiro, B. Pereira Dias, E. Feller Sperandio, M. Rapini Braga, M. De Souza Bezerra, T. Nobre Costa</i>	

## **SESSION IX - GETTING THE MOST FROM OUR DATA; DIGITAL INNOVATION, IMAGING ADVANCEMENTS, AND EMERGING TECHNOLOGIES (PART III)**

Enhancing Turnaround Time and Data Quality in Santos Basin OBN Processing: A Case Study .....	98
<i>S. Trezzi, E. Saragoussi, D. Scapin, A. H. Ruiz Lozano, J. R. Ruiz Torres, W. Barragan, C. L. Perdigao Castro, F. Perez Ortega</i>	
Seismic Imaging Using a Circular Shot OBN Geometry: Experiences and Lessons Learned .....	103
<i>S. L. Da Silva, F. Costa, A. Karsou, F. Capuzzo, R. Moreira, J. Lopez, M. Cetale</i>	
Earth Model Building in the Campos Basin Using FWI and Full-Azimuth Tomography with OBN Seismic Data.....	108
<i>N. Casado, C. Parekh, P. Barros, J. Monteiro, E. Sperandio, F. Jardim, M. Braga, M. Bezerra</i>	

## **SESSION X- OPTIMIZING RESERVOIR CHARACTERIZATION, FIELD DEVELOPMENT STRATEGIES, AND RECOVERY (PART IV)**

Mitigating Potential Solids Production Utilizing Modelling and Experiments for a Carbonate Pre-Salt Development Offshore Brazil.....	113
<i>N. Hummel, B. Verberne, J. Wheeler, I. Foo, E. Rice-Birchall, L. Ribeiro</i>	
Excess Permeability in Carbonate Reservoirs: Machine Learning Prediction Tool .....	118
<i>B. Honorio, A. Chandler, D. W. Hunt, L. E. Gomis, O. P. Wennberg, E. Time, A. P. Penha, M. Axelsson, U. Lazouski, T. M. Ballestad</i>	
Comprehensive Analysis of Mud Invasion Geotypes Using CT-Scan Data of Pre-Salt Carbonate Reservoirs.....	123
<i>G. Fernandes Matheus, L. Mendes, D. Hunt, H. Long-Sanouiller, M. Zeller, O. P. Wennberg, A. Chandler, J. Matias, A. Campane Vidal</i>	

## **SESSION XI - OPTIMIZING RESERVOIR CHARACTERIZATION, FIELD DEVELOPMENT STRATEGIES, AND RECOVERY (PART V)**

Geological Forward Modeling Parameters Adapted for Fast-Track Model - Pre-Salt Examples in Santos Basin, Brazilian Offshore.....	128
<i>D. Faria, P. Benac, A. Maul</i>	
An Integrated Workflow to Condition Reservoir Model Properties with Elastic Inversion Constraints, Pre-Salt Santos Basin, Brazil.....	133
<i>J. Pape, K. Miller, A. Scribner, P. Prakash, A. Khattab, E. Hixon, G. Medma</i>	
Enhancing Drilling Strategies with FWI Imaging: A Case Study from the Santos Basin Pre-Salt.....	137
<i>F. S. F. Coelho, N. M. S. M. D. Cruz, J. S. Paegle, D. H. L. D. Moura, C. H. V. Araujo</i>	
Integrated 3D/4D Seismic Interpretation and Inversion Workflow for Carbonate Reservoirs Applied to the Tupi Field .....	144
<i>M. Maleki, T. Buratto Rebelo, F. B. Mesquita Da Silva, S. Danaei, M. Correia, D. José Schiozer, A. Davolio</i>	

## **SESSION XII -OPTIMIZING RESERVOIR CHARACTERIZATION, FIELD DEVELOPMENT STRATEGIES, AND RECOVERY (PART VI)**

Water-Based EOR Methods for a Diverse R&D Portfolio in Brazil.....	149
<i>W. Godoy, C. De Lima, V. Rios, L. Arinelli, R. Wat</i>	
Case Studies of Petro-Elastic Modeling to Support Interpretation of a 4D Hybrid Field Data .....	154
<i>E. Da Silva, M. Salgado, M. Izeli, F. Makino, M. Grochau</i>	
Hybrid 4D Seismic in a Pre-Salt Field, Santos Basin, Brazil: Gains from Monitoring Early Production Effects .....	159
<i>M. Izeli, M. Grochau, F. Makino, E. Da Silva, M. Salgado, A. P. Lima, J. P. Olivito, A. C. Bizotto, J. Diniz</i>	

## **POSTER SESSION I**

Advanced Reservoir Characterization in the Iara Cluster: Integrating Self-Organizing Maps with Formation Evaluation Techniques .....	164
<i>B. L. De Oliveira, G. De Oliveira, T. C. Da Silva, G. C. Stael</i>	
Computational Petrophysics Applied to Aptian Carbonate Rocks from the Barra Velha Formation, Santos Basin, Brazil.....	169
<i>L. Mansini, M. Basso, G. Chinelatto, J. Souza, E. Feitoza, A. Vidal</i>	
Fracture Networks in Fault Zones: Insights from Core and Well Log Data of the Pre-Salt Reservoirs .....	175
<i>L. Mendes, G. Matheus, O. Wennberg, D. Hunt, M. Zeller, H. Long-Sanouiller, A. Chandler, J. Matias, A. Vidal</i>	
Seismic Interpretation on OBN and Streamer Datasets - Implications for Quantitative Analysis and Structural Models .....	180
<i>N. Mattos, F. Nepomuceno, F. Neves, C. Ribeiro, G. Raitz, M. Arena, L. Borghi</i>	

A New Electrofacies Approach: SGR and Velocity-Density Models Applied for Characterization of a Pre-salt Carbonate Reservoir .....	185
<i>M. Molina Camargo, B. Seyfang, A. S. Chandler, B. Honório, J. L. De Lima Matias, M. Basso, G. Furlan Chinelatto, A. Campane Vidal</i>	

Detecting Water Injection Effects in Brazilian Pre-Salt Reservoirs Using a Circular Shot OBN Survey.....	190
<i>F. T. Costa, S. L. Da Silva, F. Capuzzo, A. Karsou, R. Moreira, J. Lopez, M. Cetale</i>	

OBN Seismic Applications for a Pre-Salt Carbonate Field Development: A Case Study of Bacalhau Field.....	195
<i>Y. Camargo, P. Roberto Barros Dos Santos, D. Chiossi, E. Porto Schwedersky, C. Hess, C. Almeida, K. Virmond Juk, L. Heitor Drehmer</i>	

Dolomitization on the Barra Velha Formation, Sururu Field, Santos Basin, Brazil. ....	200
<i>J. T. F. Oste, L. F. De Ros, L. Borghi</i>	

## **POSTER SESSION II**

Seismic Facies Classification and Refinement Using Convolutional Neural Networks.....	206
<i>L. Bomfim, M. Soares, O. Cunha, S. Aurelio, E. Santos, L. Godoi, E. Villamizar, M. Caldas, M. Avansi, H. Pedrini, A. Vidal</i>	

Exploring the Sedimentological and Petrophysical Significance of Erosive Unconformities in the Pre-Salt Strata.....	211
<i>M. Soares, L. Bomfim, M. Avansi, O. Cunha, S. Aurelio, L. Godoi, E. Villamizar, E. Santos, M. Caldas, A. Vidal</i>	
Fracture Characterization from Borehole Acoustic Image Log Analysis of a Pre-Salt Carbonate Reservoir, Santos Basin.....	216
<i>E. Villamizar, E. Santos, M. Soares, L. Bomfim, O. Cunha, L. Godoi, S. Aurelio, M. Caldas, M. Avansi, A. Vidal</i>	
Impact of CNN Variations in the Low-Frequency Extrapolation in Synthetic Seismic Data .....	221
<i>R. Figueiredo, J. Maciel, M. Oliveira, A. Wyzykowski, C. Leão, O. Mojica</i>	
Exploring Low-Frequency Extrapolation: A Comparative Study of U-Nets with ResNet Encoders Considering Overfitting Challenges in Geophysical-Data .....	226
<i>C. Leão, M. Oliveira, O. Mojica, A. Wyzykowski, J. Maciel, R. Figueiredo</i>	
Topological Characterization of Faults and Fractures in Pre-Salt Reservoirs: Identifying Zones of Enhanced Intensity, Density, Connectivity.....	231
<i>E. C. Santos, E. J. P. Villamizar, M. V. T. Soares, O. R. Cunha, S. Aurelio, L. F. Godoi, L. D. S. Bomfim, M. V. P. Caldas, M. C. Kuroda Avansi, A. C. Vidal</i>	
Pre-Salt Rock and Fluid Properties: Considerations for Field Development and Beyond .....	236
<i>C. De Lima, R. Wat, O. Karoussi, M. Naumann, L. Brelaz</i>	

### **POSTER SESSION III**

Lithology Identification with Well Logs Using Machine Learning: A Case Study in Brazilian Pre Salt.....	241
<i>G. Raitz Jr; N. Mattos, C. Ribeiro, M. Arena, J. Favoretto, J. Santos, H. Santos, F. Neves, L. Borghi</i>	
Exploring Geological Controls on Flow Efficiency: A Study of Hydraulic Flow Units and Acoustic Facies.....	246
<i>L. Godoi, M. V. T. Soares, M. C. K. Avansi, E. J. P. Villamizar, E. C. Santos, O. R. Cunha, S. Aurelio, L. D. S. Bomfim, M. V. P. Caldas, A. C. Vidal</i>	
Facies and Depositional Insights from Barra Velha Formation in Mero Field, Santos Basin, Brazil .....	251
<i>A. P. D. Castro, J. T. F. Oste, L. Borghi</i>	
Karst-Related Features and Porosity Implications in the Barra Velha Formation, Santos Basin.....	256
<i>L. Ferreira, M. Neves, M. Arena, L. Borghi</i>	
Depositional, Diagenetic, and Tectonic Setting of Aptian Pre-Salt Carbonate Reservoir in the Santos Basin, Brazil.....	261
<i>M. Menezes, P. Dal' Bó, J. Smith, N. Mattos, C. Ribeiro, M. Arena, L. Borghi</i>	
Facies and Facies Succession, Barra Velha Formation, Aptian, Sururu field, Santos Basin.....	267
<i>R. De Negri, A. Ribeiro, S. Terra</i>	
An Integration Approach to Early Pre-Salt Reservoir Detection: Case Study in Bacalhau Field, Offshore Brazil .....	272
<i>R. Cremonini Baptista, K. Glitz, K. Sandler Klein, L. Hector De Miranda</i>	
Characterization of Dolomite Crystals in a Well Core from Sururu Field, Pre Salt, Santos Basin.....	278
<i>R. Fricks Sayão, J. T. F. Oste, A. Ribeiro, J. Santos</i>	

### **Author Index**