



2022

Date: July 11 - 13, 2022
Venue: Port of Spain, Trinidad & Online

7th Conference of the Geological Society of Trinidad & Tobago

Geoscience of the Future: Adapt. Innovate. Evolve.



Conference Proceedings

A gateway into original, multi-disciplinary presentations covering core geoscience practices, the hydrocarbon industry, geoscience and the environment and geoscience of the future.

Editors: Jennifer James-Romano, Kim Gillezeau, Naila Haynes and Valini Kissoon

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7TH
CONFERENCE 2022
OF THE GEOLOGICAL SOCIETY OF TRINIDAD & TOBAGO

**GEOSCIENCE OF THE FUTURE:
ADAPT. INNOVATE. EVOLVE.**

JULY 11 - 13, 2022

HYATT REGENCY, TRINIDAD & ONLINE

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Photo courtesy Curtis Archie 2022

MESSAGE FROM THE CONFERENCE CHAIR & GSTT PRESIDENT

Welcome Note

The GSTT is pleased to welcome you to the 7th Geological Conference of the GSTT. Founded in 1976, the GSTT's main aim, to increase the general level of geological knowledge among members and the public, has remained unchanged. In the 46 years of existence the GSTT has fulfilled this mandate through technical sessions, short courses, lectures, field trips, publications, public outreach programmes and student career guidance.

In the year of this nation's independence, the Mighty Sparrow won the Calypso Monarch with one of his songs 'Our Model Nation'. He sang, "The revenue we make from oil and Pitch Lake is great, but wait, we got cocoa and copra, bananas and sugar, coconuts and citrus". The oil and gas industry has supported our economy for many years, but now more than ever we recognize that we are more than oil and gas. The society continues to be a network for individuals not only in the oil and gas industry, but for all fields in geoscience. The GSTT has recently been awarded NGO status which will ensure more non-taxable finances to fund programmes that align with our goals. The society has expanded its presence on social media (LinkedIn, Facebook and Instagram) and uses it as a platform for advertising seminars, talks, publications and public education. The GSTT continues to place emphasis on public education. This year, for example, the GSTT donated rocks and geological maps for display at the Tobago Museum. The collaboration with other technical societies such as AAPG and SPE, remains important to us and we continue to unify our efforts in seminars and talks. We have also worked with the NGO, Environment Tobago, to draft and submit a proposal to UNESCO for the Main Ridge in Tobago to be designated a Geopark (an area of geological significance).

Our 7th Geological Conference is a historical event for the society, marking our first in-person event in the nearly two years since the start of the Covid-19 pandemic. The conference theme '*Geoscience of the Future: Adapt. Innovate. Evolve*' is reflective of the changing energy landscape and is intended to address the energy transition in Trinidad and Tobago, whose economy has largely benefited from the production of hydrocarbon resources. What differentiates the 7th Geological Conference of the GSTT is the focus on both the science, the extractive industries and the changing energy mix. As the world transitions from predominantly fossil fuels to green energy, geological analyses are evolving from traditional techniques to new methodologies involving big data analytics, artificial intelligence, and data liberalization. This conference will therefore be a forum to showcase the latest developments in the discipline and to present a roadmap for the future.

The hybrid format of the conference with both in-person and virtual sessions demonstrates changes in the way we work. Like the rocks we study which have stood the test of time, it reflects our ability to be resilient in face of adversity in response to a global pandemic, instability in oil prices, reduction in geoscience roles and the effects of climate change. We have prepared a diverse range of topics covering both our traditional hydrocarbon-based themes while exploring new avenues for the geoscience community such as renewable resources, hydrology, data analytics, carbon sequestration, geohazards and coastal and marine research to name a few. Through this conference we are committed to providing a technical forum for geoscience knowledge-sharing, bringing together experts from the industry for feature presentations, panel discussions, technical talks, short courses, fields trips and poster sessions.

The success of this conference would not be possible without our generous sponsors who despite significant challenges over the last few years have committed both financially and intellectually. From feature speakers to individual technical talks, the society has received overwhelming support and we are eternally grateful. We would like to recognise those who have offered to run field trips, short courses, sit on panel discussions and moderate sessions. Lastly, I must recognise the individuals on the executive and conference committee who have given their time freely working long and hard hours to make this conference a reality.

The GSTT is committed to ensuring that our membership plays an integral part in the shaping the future energy needs of Trinidad and Tobago. We recognise that the geoscience roles we hold now will be vastly different in the next five years as we pivot through the energy transition. And while change is inevitable, we have provided a forum for knowledge-sharing and collaboration within the geoscience community in Trinidad and Tobago for the last 46 years and we will continue to do so. We hope that the technical programme presented will be insightful and thought-provoking while highlighting the benefit of continued technical collaboration. It is only through our shared experiences that we can truly achieve greatness and in the famous words of Henry Ford, "If everyone is moving together then success will take care of itself". It is only through collaborative sessions like this we can truly become better geoscientists.

Thank you for being part of the 7th Geological Conference of the GSTT. Please enjoy all that we have to offer as part of the programme and we look forward to your future participation.

Adrian K. Tuitt

Dr. Adrian Tuitt
GSTT President

Ann Ramsook

Ms. Ann Ramsook
Chairperson, 7th Geological Conference Committee

CONFERENCE COMMITTEE

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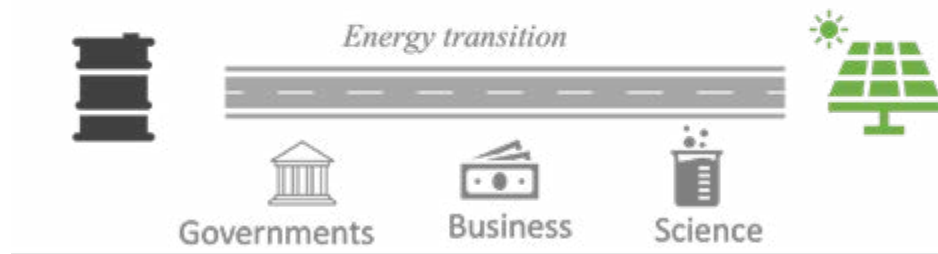
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PREFACE

Geoscience of the Future; Adapt, Innovate, Evolve



The 7th Geological Conference of the Geological Society of Trinidad & Tobago (GSTT) is themed 'Geoscience of the Future: Adapt, Innovate & Evolve'. This hybrid conference will be held from July 11th to 13th 2022, with the first day in-person at the Hyatt Regency Hotel, Trinidad and the following two days being held virtually. The conference will be officially opened by the Prime Minister of Trinidad & Tobago, the Honourable Dr. Keith Rowley.

This conference provides a forum for geoscientists to showcase their recent work under the following conference themes:

1. CORE GEOSCIENCE PRACTICES: Stratigraphic & Sedimentological Principles, Structure & Tectonics around the Caribbean, Geotechnical Engineering, Hydrology around the Caribbean, Biostratigraphy, Seismology & Volcanology, Rock Mechanics & Petrophysical Methods, and Aggregate Resources
2. THE HYDROCARBON INDUSTRY: Circum-Caribbean & Atlantic Basins Exploration, Field Appraisal Case Studies, Brownfield Development, Enhanced Oil Recovery, Revitalizing Mature Provinces, Petroleum Systems & Geochemistry, and Advanced Geophysical Methods
3. GEOSCIENCE & THE ENVIRONMENT: Carbon Sequestration & Storage, Geohazards & Slope Stability, and Coastal & Marine Research
4. THE FUTURE OF GEOSCIENCE: Unconventional & Alternative Resources, Geological Applications & Workflows, Geophysical Techniques, Big Data, Careers in the Geoscience and Business Initiatives

All abstracts are published in this conference proceedings volume. The views expressed reflect the authors' own views and will hopefully stimulate scientific discussion & broaden our understanding of the future energy mix. As the world transitions from predominantly fossil fuels to green energy, geological analyses are evolving from traditional techniques to new methodologies involving big data analytics, artificial intelligence, and data liberalization. Application of these adaptive technologies is important in optimizing existing opportunities and in the search for and the mining of silicon, copper or alumina for computer chips, in the utilization of geothermal energy, developing renewables, and carbon sequestration.

This year fifty five (55) abstracts were received, of these forty three (43) papers & four (4) posters will be presented over a three day period. Six (6) keynote speakers have been invited to speak on topics such as The Business of Petroleum, Energy Management, Innovation in Oil & Gas Development and Big Data.

There are nine (9) Panel Discussions, an overview of the topics to be discussed & the names of the panelists are included in the conference proceedings.

Overviews of the four (4) Field trips & four (4) Short Courses have been included in these conference proceedings.

We sincerely thank all our Reviewers, Publication Committee, Program Committee, Field Trip Committee, and Short Course Committee members who have reviewed abstracts, invited feature speakers & panelists, organized short courses & field trips. Finally, we would like to thank the conference chairmen, the members of all the organizing committees and the financial support from the conference sponsors that made this conference possible.



Jennifer James-Romano,
Publications Sub-Committee

SPECIAL FEATURES & EVENTS

**7TH GEOLOGICAL CONFERENCE
JULY 11 - 13, 2022**

Opening Session
KEYNOTE SPEAKERS

Date: July 11, 2022
Time: 7:55am - 9:30am
Venue: Hyatt Regency, Trinidad & Online



The Honourable
Dr. Keith Rowley,
Prime Minister of
Trinidad & Tobago



Mr. Eugene Okpere,
Shell VP & Country Chair



Dr. Adrian Tuitt,
GSTT President



Mrs. Ann Ramscook,
Conference Chair

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**7TH GEOLOGICAL CONFERENCE
JULY 11 - 13, 2022**

Featured Session
THE BUSINESS OF PETROLEUM



Ms. Verlier Quan Vie
VP Commercial, NGC



Penelope Bradshaw-Niles
Permanent Secretary,
Ministry of Energy and Energy Industries

Date: July 11, 2022
Time: 10am - 11am
Venue: Online

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**7TH GEOLOGICAL CONFERENCE
JULY 11 - 13, 2022**

Featured Session
THE MANAGEMENT OF ENERGY



The Honourable Stuart Young
Minister of Energy &
Energy Industries



Mr. Mark Loquan
President NGC



Mr. NJ Ayuk
Chairman African
Energy Chamber

Date: July 12, 2022
Time: 8am - 9:30am
Venue: Online

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**7TH GEOLOGICAL CONFERENCE
JULY 11 - 13, 2022**

Featured Session
BIG DATA



Joseph Nicholson
COO Osokey

Date: July 13, 2022
Time: 8am - 8:30am
Venue: Online

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Geoscience of the Future: Adapt. Innovate. Evolve

Cocktail Reception

JULY
11

6pm - 9pm
Hyatt Regency Hotel,
1 Wrightson Road,
Port of Spain, Trinidad

PROGRAMME

Thursday July 7, 2022		Short Course: South American - Caribbean - Central Atlantic Plate Boundary, Tectonic Evolution, Basin Architecture and Petroleum Systems - Dr. Tricia Alvarez and Prof. Paul Mann			
Friday July 8, 2022		Short Course: Fault Kinematics - Randy Partap			
Saturday July 9, 2022		Short Course: Sustainable Energy Solutions for Small Island Developing States, Trinidad and Tobago and the Caribbean - Dr. Adolfo Mejia Montero			
Monday July 11, 2022		PRESENTATION ROOM #1 (Hyatt Regency, Trinidad)		PRESENTATION ROOM #2 (Hyatt Regency, Trinidad)	
07:55 - 8:35	Opening Ceremony	National Anthem; Welcome remarks (Ann Ramsook, Conference Chair) / Remarks on the GSTT (Adrian Tuitt, GSTT President)			
08:35 - 8:55		Greetings from Eugene Okpere (Shell VP & Country Chair)			
09:00 - 9:30		Feature Speaker (Dr. The Honourable Keith Rowley, Prime Minister of Trinidad & Tobago)			
09:30 - 10:00		Penelope Bradshaw-Niles (Permanent Secretary, Ministry of Energy and Energy Industries)			
10:00 - 10:30	Morning Coffee Break				
10:30 - 11:00	The Business of Petroleum	Verlier Quan Vie (VP Commercial, NGC)			
11:00-12:00	Panel discussion (Innovation in Oil & Gas Exploration and Development) - Rodney Hosein, Kiran Sankar, Kun Jiang, Richard Burgess, Keith Bally (moderator)				
12:00 -13:00	Luncheon Talk - Unlocking Subsurface Complexity - Khaled Abdelaziz (Schlumberger)				
13:00-13:30	Field Appraisal Case Studies	Aphrodite - An Integrated Approach to Accelerated Prospect Maturation - Maneesha Maharaj		Structure & Tectonics around the Caribbean	Constraints on Tectonic Processes and Crustal Deformation within the Subduction to Strike Slip Transition at the Southeastern Caribbean Plate Boundary Zone - Tricia Alvarez
13:30-14:00		Fault Transmissibility in Gas Reservoirs - Randy Partap			New Structural Styles in the Deep Columbus Basin; Observations from 3D Nodal Seismic Data - Avinash Ramroosingh
14:00-14:30		Focus on Value Competitiveness for Aphrodite Well towards an Accelerated First Gas Development - Gabriella Kokaram			
14:30-15:00	Biostratigraphy	Integration of Micro- and Nannofossil data for High Resolution Biostratigraphy in the onshore Southern Basin of Trinidad - Ashleigh Costelloe (Pre rec)		Rock Mechanics & Petrophy.	Petrofacies: A new petrophysical approach to facies description in the Columbus Basin, Trinidad - Samantha Jaipaulsingh
15:00-15:30	Afternoon Coffee Break				
15:30-16:00	Stratigraphic & Sedimentological principles	Reservoir Depositional Element (RDE) Mapping: Adding detail to the regional picture - Tracy Gunness		Geophysical Techniques	Capturing Bulk Rock Volume (BRV) Uncertainty- A workflow incorporating seismic (pre-stack and post stack data) and well data - Abigail Maxwell
16:00-16:30		Moving away from simplistic reservoir models; mixed - process marginal marine reservoir analogues from Trinidad - Saeed Khan			A Whirlwind Tour of Shell Seismic Technologies Employed in the NCMA Basin - Analiese Ferreira
16:30-17:00		Outcrops and exotic boulders of Miocene - Cretaceous reservoirs and their exploration implications - Curtis Archie			Angelin fault seal analysis: A case study on the A Sand hanging- wall trap anomaly in FB4 - Kareem James, Nirala Boodoo
17:00-17:30		Columbus Basin Upper Slope: Modern Depositional Environments from Seismic - Nadeer Khan			Qualitative and Quantitative Geophysical Data Integration for Better-Informed Decisions - Matthew Miller
Awards Ceremony & Cocktail Reception					

Tuesday July 12, 2022		PRESENTATION ROOM #1 (Virtual)	PRESENTATION ROOM #2 (Virtual)	
08:00 - 09:30	Feature Session -The Management of Energy	NJ Ayuk, Chairman, African Energy Chamber		
		Mark Loquan, President, NGC		
		The Honorable Stuart Young, Minister of Energy & Energy Industries		
09:30 - 10:00	Morning Coffee Break			
10:00 - 10:30	Carbon Sequestration & Storage	An assessment of some geological challenges in the implementation of a Carbon Capture, Utilization & Sequestration (CCS) and Carbon Dioxide Enhanced Oil Recovery (CO2 EOR) project in Trinidad - Clement Ramroop	Panel Discussion (Revitalizing Hydrocarbon Production in Mature Fields) - - Lynn Anderson, James Walker, Anderson Arjoon, Rajesh Rajpaulsingh, Javed Razack (moderator)	
10:30 - 11:00				
11:00 - 11:30	Panel Discussion (Renewable Energy Targets in the Caribbean) - Francisco Vozza, Siana Teelucksingh, Navin Boodhai, Adolfo Mejias-Montero, Brendon James (Moderator)		Brownfield Dev./ Field Appraisal Studies	Maximizing Opportunity, Managing Risk: Integrated decision-based modelling for the value optimization of production - Rashad Ramjohn & Elizabeth Sookal (PreRec)
11:30 - 12:00				A history of the appraisal and development of Shell's Block 5c acreage - Joel Dowlath (PreRec)
12:00 -13:00	Lunch			
13:00-13:30	Alternative Energy sources	A mission for Sustainable Energy - harnessing the energy of the sun - Graeme Jones	Circum-Carib. Exploration	Accessing the Pre-Negoene Play Potential of the Tobago Trough - Thomas Hansen
13:30-14:00		The Exploration of the Role and Benefits of Solar Photovoltaic Energy Production in the Diversification of Jamaica's Energy Mix - Kamiruu Clark		Age & Provenance of the Scotland Formation, Onshore Barbados - Catherine Belgarde
14:00-14:30	Panel discussion (Climate Change and its Impact on Small Island Developing States) - Kishan Kumarsingh, Raquel Moses, Dr. Colin Young, Akil Callender, Stephen Jagdeo (moderator)		Sedimentology & Stratigraphy	Understanding the Net Sand Distribution of the Pliocene Forest Formation Topsets, Southern Basin, Trinidad - Christie Carr
14:30-15:00				Variability of Secondary Pay in the Columbus Basin - Martin Wells
15:00-15:30	Afternoon Coffee Break			
15:30-16:00	Alternative Energy sources	Investigation and Analysis of Hot Water Generation using a modified Parabolic Solar Dish - Stephen Jagdeo	Structure & Tectonics	* POSTER - Structural Geology and Cenozoic Deformation: Western Northern Range, Trinidad - Abigail Clark
			Sedimentology & Stratigraphy	* POSTER - Deciphering the depositional history of the Lower Forest Formation using outcrop and well log facies analysis to examine reservoir quality, continuity, and connectivity - POSTER -Daniel Joseph
16:00-16:30	Vetiver grass and the Vetiver System (VS) as a Green Infrastructure Tool - Jonathan Barcant	Reservoir Architecture of Deep-Water Deposits in the Northern Trinidad Region - Rene Winter (PreRec)		
16:30-17:00		A proposal for the introduction of the Central Range Structural Complex into the stratigraphy of Trinidad - Clement Ramroop		
17:00-17:30	Geoscience & the Environment/ Geohazards	Historic and recent mud volcano eruptions in Trinidad, impacts on surrounding communities - Curtis Archie		New Seismic + Old Concepts - Case Study from the Columbus Basin, offshore Trinidad - Rene Winter (PreRec)

Wednesday July 13, 2022		PRESENTATION ROOM #1 (Virtual)	PRESENTATION ROOM #2 (Virtual)
08:00 - 08:30	Feature session (Big Data)	Featured Speaker: Joseph Nicholson, (COO, Osokey)	
08:30 - 9:30	Panel Discussion (Data Management and Architecture and its link to Machine Learning and Artificial Intelligence: The Impact on the Energy Sectors) - Roeland van Gilst, Julian Moreno, Catalina Herrera, Krishna Persad, Stanley Wharton (moderator)		
09:30 - 10:00	Morning Coffee Break		
10:00 - 10:30	Big Data/ Machine Learning	Overcoming Governance Issues: Making Data Freely Available in Trinidad and Tobago - Helena Inniss	Panel discussion (Changing Tides: Coastal Erosion & Protection Measures Around the Caribbean) - Hamish Asmath, Dr. George Sammy, Frank Teelucksingh, Don Rambarran, Dr. Charmaine O'Brien-Delpesh (Moderator)
10:30 - 11:00		Integrated Machine Learning Unsupervised Log Facies and Seismic Facies Workflows to delineate stratigraphic traps for field developments - Stanley Wharton	
11:00-11:30	Panel Discussion (Earthquakes & Volcanoes in the Caribbean; Past Events, Current Threats & Preparedness) - Professor Richard Robertson, Dr. Omar Bello, Dr. Ilias Papadopoulos, Michelle Forbes		Field Appraisal
11:30 - 12:00			The Evolution of the Angelin Field Fault Framework, northern Columbus Basin, Trinidad - Alicia Bertie (PreRec) Reservoir Depositional Element (RDE) Maps – Anchored or Exploring the range – A Case Study - Tracy Guinness
12:00 -13:00	Luncheon Talk -The Impact of Regime and Tectonics on the Orinoco's Second Clastic Wedge's Architecture, Trinidad - Ariana Osman		
13:00-13:30	Panel Discussion (Leveraging groundwater: Tapping the Potential of Traditional & Bedrock Aquifers to Securing Water Supply) - Dr. Roland Hoag, Kambiri Cox, Marilyn Crichlow, Geoffrey Marshall, Sara-Jade Govia (moderator)		Well Planning/ EOR
13:30-14:00			
14:00-14:30	Hydrogeology around the Caribbean	Groundwater Supply: The role of geology in determining distribution and exploration techniques for target optimization of wells - Dana Marie Jacob	Pilot EOR feasibility study in deltaic channel sands -Jillian George & Dwarak Uhayashankar
14:30-15:00	Afternoon Coffee Break		
15:00-15:30	Panel Discussion (Geoscientists and Careers) Sean Cardinez, Sandra Chapman, Kalain Hosein, Hayden Romano, Akil Callender, Celine Gooljar (moderator)		Geohazards
15:30-16:00			Small island developing states (SIDS) in the Zone Tropical and Plate Boundary Vulnerabilities risk multiple hazards: Jamaican case study - Rafi Ahmad
16:00-16:30	Geohazards / Field Mapping	Use of satellite imagery, drones and 3D models, as an aid to geological field mapping - Curtis Archie	Geophysical Techniques
16:30-17:00			Structure & Tectonics
		Trinidad & Tobago potential unveiled by high repeat offshore satellite oil seeps - Clément Blaziot	Using 2-dimensional seismic modelling to support observed DHIs the Columbus Basin, Trinidad - Akkel Paul * POSTER - 2D multicomponent adaptive focused beam migration - Chao Chen (PreRec) * POSTER - Squeezing every drop out of a new OBN dataset (Columbus Basin, Trinidad & Tobago) - Avinash Ramroopsingh * POSTER - Provenance of the Northern Range, Trinidad using Detrital Zircon U-Pb Geochronology: Implications for northern South American River System paleogeography * POSTER - A tale of two tufas
July 14 - 15, 2022		Short Course: Reservoir Model Design - How to make a good Reservoir Model - Dr. Mark Bentley	

Poster

Pre-recorded

Panel discussion

PANEL DISCUSSIONS

Innovations in Oil and Gas Exploration and Development

Monday 11th July, 11:00am – 12:00pm (In-person)

Changes are occurring in the oil and gas industry in the areas of technology, efficiency, safety, and smart solutions. Companies are continuously seeking innovative ways to remain competitive as they solve complex sub-surface challenges. We are seeing more projects utilizing artificial intelligence, automated solutions, advanced robotics, and novel data management practices to help accelerate processing times, increase safety, and reduce human labour. This panel discussion will share the ideas, research, strategies, and experiences of operating companies.

7TH GEOLOGICAL CONFERENCE
JULY 11 - 13, 2022

Meet our panelists for
**INNOVATION IN OIL AND GAS
EXPLORATION AND DEVELOPMENT**

Rodney Hosein Richard Burgess Kiran Sankar Kun Jiang

Date: July 11, 2022
Time: 11am - 12pm
Venue: Hyatt Regency, Trinidad & Online

Moderated by
Keith Bally

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Revitalizing Hydrocarbon Production in Mature Fields

Tuesday 12th July, 10:00am - 11:00am (Virtual)

With most of the world's oil and gas fields in a mature stage of development, it is becoming increasingly challenging and costly to sustain production. Extending the life of these fields now rely on novel innovations in engineering, geophysics, economics and policy framework fuelled by ongoing research. Many opportunities may still exist "behind casing", within attic reservoirs or through improved technology. Efforts to mitigate the natural

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JULY 11 - 13, 2022

Meet our panelists for
**REVITALIZING HYDROCARBON
PRODUCTION IN MATURE FIELDS**

Lynn Anderson James Walker Anderson Arjoon Rajesh Rajpaulsingh

Date: July 12, 2022
Time: 10am - 11am
Venue: Online

Moderated by
Javed Razuck

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production decline of mature fields can be truly remarkable, requiring the total synergy between various disciplines.

7TH GEOLOGICAL CONFERENCE
JULY 11 - 13, 2022

Meet our panelists for
**RENEWABLE ENERGY TARGETS
IN THE CARIBBEAN**

Francisco Vozza Siana Teelucksingh Navin Boodhai Adolfo Mejias-Montero

Date: July 12, 2022
Time: 11am - 12pm
Venue: Online

Moderated by
Brendon James

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Renewable Energy Targets in the Caribbean

Tuesday 12th July, 11:00am – 12:00pm (Virtual)

Once known as a disruptive resource and technology, renewable energy has grown measurably in the last few years becoming a defining feature of the global energy landscape. This is spurred by ambitious growth targets worldwide with Caricom’s target of 47 per cent renewable energy contribution to total electricity generation in the region by 2027, to adapt to the profound changes in the world’s energy system. In response, the world has seen a diversification of energy sources such to solar, wind, geothermal, biomass and others. Throughout the world, wind energy and solar PV installations have recorded unparalleled growth over the past decade. While the absolute growth has been impressive, the RE growth has been less tardy and reactive. This discussion will focus on challenges to the renewable energy uptake in the region, identifying barriers to entry, providing micro- & macroeconomics perspectives, technological solutions, and discussing the vital role of policy, with input from technological, economic, and bureaucratic experts.

Climate Change and its Impact on Small Island Developing States

Tuesday 12th July, 2:00pm - 3:00pm (Virtual)

The upward trend in the average daily surface temperature of the Earth is expected to continue well into the 21st century if all signatory nations to the 2016 Paris Accord do not actively pursue long term renewable and sustainable energy measures to in the renewable energy space and policy initiatives that mitigate this effect, although the world continues to rely on fossil fuels to meet its primary energy needs.

Caricom nations have pledged towards the United Nations Framework Convention on Climate Change (UNFCCC 2021) by being amongst the first to itemize Nationally Determined Contributions or NDCs. This is a particularly vulnerable group that is most affected by climate change including sea-level rise, coastal erosion, flooding and drought leading to unpredictable socio-economic pressures and a new term – climate refugees. Only a multi-tiered approach with support from all stakeholders will enable Trinidad and Tobago and other nations to not just meet international mandates but to be exemplars in affecting climate change.

7TH GEOLOGICAL CONFERENCE
JULY 11 - 13, 2022

Meet our panelists for
**CLIMATE CHANGE AND ITS IMPACT ON
SMALL ISLAND DEVELOPING STATES**

Kishan Kumarsingh
Racquel Moses
Dr. Colin Young
Akil Callender

Date: July 12, 2022
Time: 2pm - 3pm
Venue: Online

Moderated by
Stephen Jagdeo

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Meet our panelists for
**DATA MANAGEMENT, ARCHITECTURE & ITS LINK TO
MACHINE LEARNING & ARTIFICIAL INTELLIGENCE:
THE IMPACT ON THE ENERGY SECTORS**



Roeland van Gilst Julian Moreno Catalina Herrera Dr. Krishna Persad

Date: July 13, 2022
Time: 8:30am - 9:30am
Venue: Online



Moderated by
Stanley Wharton

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Data Management and Architecture and its Link to Machine Learning and Artificial Intelligence: The Impact on the Energy Sectors

Wednesday 13th July, 8:30am - 9:30am (Virtual)

Organizations are continuously seeking innovative ways to remain competitive as they solve complex challenges using artificial intelligence, automated solutions and novel data management practices. This panel discussion will underscore the importance of data management and architecture which are the building blocks of ML and AI, to business innovation and practices. Its focus is on the different sectors of energy, including alternatives, though the concepts discussed could be applied across various entities. Any industry which analyses copious amounts of data can tune in and learn from our distinguished panellists who are all experts in different aspects of data applications.



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JULY 11 - 13, 2022

Meet our panelists for
**CHANGING TIDES: COASTAL EROSION &
PROTECTION MEASURES AROUND THE CARIBBEAN**



Hamish Asmath Dr. George Sammy Frank Teelucksingh Don Rambarran

Date: July 13, 2022
Time: 10am - 11am
Venue: Online



Moderated by
Dr. Charmaine
O'Brien-Delpesh

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Changing Tides: Coastal Erosion and Protection Measures Around the Caribbean

Wednesday 13th July, 10:00am to 11:00am (Virtual)

The Caribbean islands rely heavily on its natural capital in coastal regions for eco-tourism,

fishing and other recreational and commercial activities. Communities are however becoming increasingly susceptible to the effects of rising sea level and coastal erosion, often linked to the changing climate and or local tectonics. Caribbean territories have embarked on several projects to understand and mitigate against the impacts of coastal erosion, threats of sea level rise, storms and hurricanes. This discussion explores the experience of Caribbean territories in managing coastal affairs. It will explore the physical science, policy framework, use of technology and practices of the coastal management community.

Earthquakes & Volcanoes in the Caribbean, Past Events, Current Threats & Preparedness

Wednesday 13th July, 11:00am - 12:00pm
(Virtual)

Natural geological disasters in the Caribbean is topical given recent events such as the 2010 Haitian earthquake and the 2021 Soufriere volcanic eruption in St. Vincent. These events have had a considerable impact on livelihoods and economies within Caribbean states; earthquakes and volcanic eruptions are the two most impactful geological phenomena among several Caribbean territories. This panel discussion will explore the science behind these natural disasters, the regions preparedness for their occurrence, areas of vulnerability and the policy framework for education, recovery and global engagement.

The poster features a light blue and white background with a wavy pattern. At the top left, there are logos for the Geological Society of Jamaica and the 7th Geological Conference 2022. The top right text reads '7TH GEOLOGICAL CONFERENCE JULY 11 - 13, 2022'. The central text says 'Meet our panelists for EARTHQUAKES & VOLCANOES IN THE CARIBBEAN: PAST EVENTS, CURRENT THREATS & PREPAREDNESS'. Below this are four circular portraits of the panelists: Prof. Richard Robertson, Dr. Omar Bello, Dr. Ilias Papadopoulos, and Michelle Forbes. At the bottom left, it states 'Date: July 13, 2022', 'Time: 11am - 12pm', and 'Venue: Online'. At the bottom right, it says 'Moderated by Dr. Erouscilla Joseph' next to her portrait. The footer contains the website '7THGSTTCONFERENCE.VFAIRS.COM', a 'REGISTER NOW' button, and social media icons for Facebook, Instagram, and LinkedIn.



7TH GEOLOGICAL CONFERENCE
JULY 11 - 13, 2022

Meet our panelists for
**LEVERAGING GROUNDWATER: TAPPING THE
POTENTIAL OF TRADITIONAL & BEDROCK AQUIFERS
TO SECURING WATER SUPPLY**



Dr. Roland
Hoag



Kambiri
Cox



Marilyn
Crichlow



Geoffrey
Marshall

Date: July 13, 2022
Time: 1pm - 2pm
Venue: Online



Moderated by
Sara-Jade Govia

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Leveraging Groundwater: Tapping the Potential of Traditional & Bedrock Aquifers to Secure Water Supply

Wednesday 13th July, 1:00pm - 2:00pm (Virtual)

Many Caribbean countries continue to be challenged by depleting water resources which are forecasted to worsen as a result of climate change. Bedrock aquifer exploration has proven successful in islands such as Tobago and Nevis where it has been demonstrated they can provide a reliable and sustainable supply of groundwater in a small island developing state (SIDS). For example, following a 1999/2000 study undertaken by the Water and Sewerage Authority (WASA) of Trinidad and Tobago, the utility was able to source considerable volumes of additional groundwater that has the potential to significantly alleviate the water quantity and quality challenges posed by traditional sources.

This discussion will explore how bedrock aquifers can solve the water scarcity and water quality problems that SIDS face as a result of over exploitation of traditional aquifers. It will explore the physical science, policy framework and experiences from the global community on available water resources.

Geoscientists and Careers

Wednesday 13th July, 3:00 pm – 4:00pm
(Virtual)

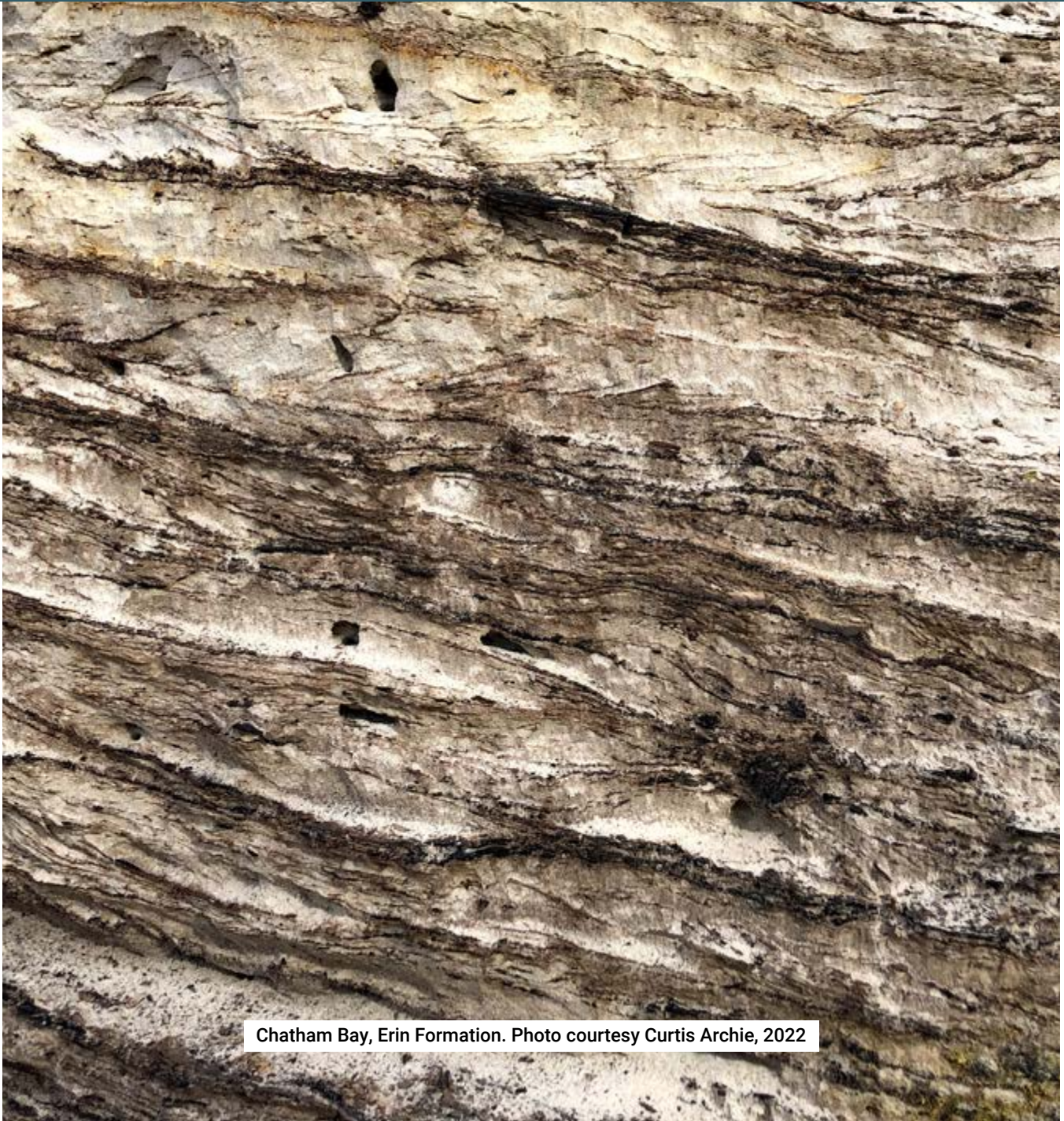
The oil and gas sector has been a primary employer for geoscience graduates in Trinidad and Tobago as in many other countries and today, there are generations of professionals that have devoted their careers to this industry. Other traditional employers of the geoscience field include aggregate resources, water, coastal management and civil engineering. Local graduates today are faced with a changing work environment coupled with shifts in global industry and academic focus in response to environmental initiatives that encourage alternative forms of energy and sustainable use of resources. This session will explore some of the questions faced by new graduates or existing professionals as they enter or manoeuvre the changing professional landscape.

The graphic is a promotional poster for a virtual session. At the top left, it features the logos for the 7th Geological Conference 2022 and the Trinidad and Tobago Geoscientists' Association. The main title '7TH GEOLOGICAL CONFERENCE JULY 11 - 13, 2022' is in the top right. Below this, it says 'Meet our panelists for GEOSCIENTISTS AND CAREERS'. Five circular headshots of the panelists are shown in a row, with their names listed below: Sean Cardinez, Sandra Chapman, Kalain Hosein, Hayden Romano, and Akil Callender. A separate circular headshot of the moderator, Celine Gooljar, is shown below the panelists. To the left of the moderator's photo, the session details are listed: 'Date: July 13, 2022', 'Time: 3pm - 4pm', and 'Venue: Online'. At the bottom, there is a red banner with the website '7THGSTTCONFERENCE.VFAIRS.COM', a yellow 'REGISTER NOW' button, and social media icons for Facebook, Instagram, and LinkedIn.



ABSTRACTS

CORE GEOSCIENCE



Chatham Bay, Erin Formation. Photo courtesy Curtis Archie, 2022

A Proposal for the Introduction of the Central Range Structural Complex into the Stratigraphy of Trinidad

Author: ¹Clement Ramroop

¹clement.ramroop@gmail.com - Presenter, Wellbore Limited, Trinidad and Tobago

Theme: CG: Stratigraphic and sedimentological principles

Key Words: central range, stratigraphy, melange

This paper intends to review the historical development of the stratigraphy of Trinidad with special reference to the Central Range Structural Complex, which was described by Ramroop (2017). The use of biostratigraphic methods to define lithostratigraphic units has been historically applied to the development of Trinidadian stratigraphy since the beginning of the 20th century.

Modern concepts on stratigraphic framework and nomenclature as espoused by the North American Stratigraphic Code (2005) has led Ramroop(2017) to review the stratigraphy of Trinidad with a view to determine whether the stratigraphic units are still valid. He has interpreted the majority of the rock units to consist of structural complexes. This paper reviews the Central Range Structural Complex with a view of introducing it into the stratigraphic record of Trinidad. The recent characterization of parts of Trinidad's stratigraphy as mélanges or tectonostratigraphic units invokes possible tectonic influence on the sedimentary record. The wide array of lithological units which cannot be correlated at the scale of geological mapping and the erratic surface structural dips infer that a non- stratiform body of rock is present and would lead to the interpretation of a structural complex.

This paper intends to evaluate the reasons for the amalgamation of the Brasso and Tamana formations of Kugler (2001) into the Central Range Structural Complex and to introduce it into the stratigraphic record of Trinidad.

Age & Provenance of the Scotland Formation, Onshore Barbados

Author: ¹Catherine Belgrade, Drew Carlock, Emily McGinnis, and Jens Schmieder
¹catherine.belgrade@bhp.com - Presenter, BHP Trinidad and Tobago

Theme: CG: Structure and tectonics around the Caribbean margin

Key Words: Caribbean Plate Tectonics, Scotland Formation, provenance, detrital zircon

The Cenozoic dextral-oblique collision of the Caribbean and South American tectonic plates has progressively deformed, exhumed, and eroded the northern South American margin from Venezuela to Trinidad. Although sediment shed off the South American continent into the foredeep and accretionary prism ahead of the eastward-advancing Caribbean Plate provides a record of the timing and magnitude of collision, subsequent deformation and erosion limits preservation and the early history of the collision remains uncertain.

Paleogene deepwater turbidite deposits exposed in the Scotlands District of eastern Barbados (Scotland Group) provide a unique opportunity to constrain the early Cenozoic evolution of the South American-Caribbean Plate Boundary. Although the Scotland Group has been studied since at least 1940, the age, provenance, and nature of its relationship to the overlying Oceanics Formation remain the subject of much debate.

In 2017, BHP conducted a comprehensive field and analytical program targeting Paleogene sediments exposed onshore Barbados with the purpose of constraining depositional age, provenance, and tectonic history through field observation, biostratigraphy, heavy minerals analysis, detrital geochronology, and thermochronology. Our results definitively constrain the age of the Scotland Group to Eocene, with a most likely age of Early Eocene. Interbedded carbonates, shales, and sandstones of the Oceanics Formation are both age-equivalent and younger than the Scotland Group. Detrital geochronology, thermochronology, and heavy minerals analysis support a shared provenance from the Andes, Caribbean Mountains, and the southwestern Guyana shield for the Scotland Group and Oceanics Formation.

We conclude that the Scotland Group and Oceanics Formation record continuous deepwater sedimentation in the foredeep and accretionary prism ahead of the advancing Caribbean Plate from Early Eocene time. Furthermore, Early Eocene deepwater turbidites of the Scotland Group are likely down-dip equivalents of the Misoa Delta of the Maracaibo foreland basin and have since been transported eastward over 1000 km to their present-day location.

A Tale of Two Tufas

Author: ¹Abigail Miller, Dr. John Weber, Dr. Ian Winkelstern, Grand Valley State University
¹milleab1@mail.gvsu.edu

Theme: Other

Keywords: tufa, Trinidad, geochemistry, calcite

Tufas are calcium-carbonate deposits that form when conditions in calcium and carbon dioxide saturated waters change abruptly, such as when there is a decrease in water temperature. These changes allow carbon dioxide to escape from the water or calcium to change its reactivity, which can then trigger the precipitation of calcium carbonate. This project aims to analyze and compare two tufa deposits from Northern and Southern Trinidad. In South Trinidad the Salt Springs tufas form in a warm, saline, and crude oil-bearing spring. In contrast, the Turure tufas in Trinidad's Northern mountain range form in a pristine freshwater stream. The Northern Range, far removed from the oil and gas deposits of South Trinidad, is covered in relatively pristine rain forest held up by metamorphic rock. We will apply oxygen and carbon stable isotope geochemistry to understand the temperatures and hydrologic conditions of the carbonate formation, also potentially using thin tufa layers to evaluate cyclicity of precipitation of tufa. X-ray diffraction analysis will be applied to identify the mineralogical composition of each of the two tufas. Different carbonates form under different geochemical conditions, so having a precise understanding of mineralogy is important. Differences between the two tufa locations are expected to be the result of differences in local geology, and the application of these techniques will help determine the specific origin and formation of these tufas.

Columbus Basin Upper Slope: Modern Depositional Environments from Seismic

Author: ¹Nadeer Khan

¹Nadeer.Khan@shell.com - Presenter, Shell Trinidad and Tobago

Theme: CG: Stratigraphic and sedimentological principles

Key Words: slope, reservoir, seismic

Plio-Pleistocene deposition within the Columbus Basin foredeep is dominated by the massive proto-Orinoco delta system. The eastward-prograding drainage system has deposited over 30,000 ft of sediment within the last 5 million years. With new advances in seismic imaging and drilling capability, there is now opportunity to push exploration deeper below known shelf discoveries. This talk aims to use observations of seismic geomorphology within the most recent upper slope depositional sequence as an analogue for potential upper slope reservoirs that can then be applied to the deepest sections below the shelf.

From detailed seismic mapping and using attributes such as spectral decomposition, it is observed that upper slope deposition is dominated by mass transport complexes (MTCs) and slumping, with narrow, straight channels hinting at mostly sand by-pass onto the lower slope and basin floor. However, although far less common, some potentially attractive reservoirs can be recognized in the form of channel belts, slope aprons and channel levee complexes.

Individual, long-lived, erosionally confined channel belts that are likely to be more sand prone can be recognized, with lengths greater than 20 Km and 5-7 Km wide. These align with sediment entry points into the upper slope that are controlled by the tip points of syn depositional normal faults along the edge of the shelf depositional system. Channel levee complexes and slope aprons are seen to develop where there are subtle, localized changes in slope gradient, often associated with MTC topography or structural deformation related to strike slip faulting. Some complexes can develop as large as 20 km long and 5 km wide with multiple depositional sequences compensationally stacked together.

Constraints on Tectonic Processes and Crustal Deformation within the Subduction to Strike Slip Transition at the Southeastern Caribbean Plate Boundary Zone

Author: ¹Tricia Alvarez, Paul Mann, Carlos A. Vargas, Lesli Wood

¹talvarez@utexas.edu - Presenter, Heritage Petroleum Company Limited, Trinidad and Tobago

Theme: CG: Structure and tectonics around the Caribbean margin

Key Words: Southeastern Caribbean, STEP fault, Contractional tectonics, transitional plate boundary

The southeastern Caribbean margin is a location where active subduction and strike-slip tectonic styles transition along a strongly curved and seismogenic plate boundary. We use an integrated dataset which comprises 2-D seismic reflection, well, seismic tomographic, gravity, magnetic, earthquake focal mechanisms, and global positioning system (GPS) data to analyze the transitions of geologic structures and sedimentary basins at the subduction to strike-slip transition.

The evolution of the margin includes oblique collision between the arcuate southeastern margin of the Caribbean plate and the South American margin; propagation of the Subduction-Transform-Edge-Propagator fault; and north-to-northwest flexure of transitional South American lithosphere to the south of the west-dipping segment of the slab that sinks into the mantle beneath the Caribbean plate.

Pre-existing structures such as northwest–southeast-oriented Atlantic oceanic fracture zones and lithospheric transitional boundaries are a significant control on the evolution of the margin including the location and orientations of STEP faults, slab rollback, detachment, and tearing. Lithospheric deformation associated with STEP tearing and slab detachment influences the position, orientation, and evolution of crustal plate boundary structures and sedimentary basins.

The multiphase deformational history that includes oblique collision, Subduction-Transform-Edge-Propagator faulting, and subducted slab dynamics, influence the spatially and temporally complex uplift and subsidence patterns observed in sedimentary basins and structures within the southeastern Caribbean subduction-to-strike-slip transition.

Deciphering the Depositional History of the Lower Forest Formation Using Outcrop and Well Log Facies Analysis to Examine Reservoir Quality, Continuity, and Connectivity

Author: Daniel Joseph

danieljoseph54321@hotmail.com - Presenter, UWI, St. Augustine, Trinidad and Tobago

Theme: CG: Stratigraphic and sedimentological principles

Key Words: stratigraphy

The applicability of well logs and well log facies analysis to depositional environment interpretations in areas with limited geological data was assessed. A gross depositional environment (GDE) was interpreted for the lowermost Forest Formation from the Panoo Trace outcrop. The depositional environment interpreted from the outcrop was used as a baseline to interpret a depositional environment from well logs. Well-log facies analysis was conducted using 13 wells across the Southern Basin. Depositional environment interpretations from outcrop and well log data were compared and discussed as it relates to quality, continuity, and connectivity. The Panoo Trace outcrop was logged. Facies analysis and process probability were used to aid in classification of the deposits as a deltaic system and interpret a possible depositional environment. Gamma ray and spontaneous potential (SP) well logs were used to correlate the Forest Formation. Well log signatures were also used to subdivide the Forest Formation into three packages. Well log signatures were characterized based on the depositional environments identified for the outcrop. This was summarized in a well log facies catalogue. The well log facies were then colour blocked along several cross-sections and interpreted. A 3D fence diagram was constructed and used to generate a GDE. The outcrop facies and process probability analysis depicted a tide-dominated environment that was fluvial influenced and wave affected - Tfw. This translated to tidal/fluvial channels, barrier bars, tidal/mud flats, and floodplains. A similar depositional environment was interpreted from the well log facies analysis. The interpreted barrier island environment and GDE suggests good reservoir quality, continuity, and connectivity. This study showed that the use of well logs to interpret depositional environments in areas with limited data proved to be valid. This suggest that the method used in this report can be utilized in future geological studies in areas with limited data.

Groundwater Supply: The Role of Geology in Determining Groundwater Distribution and Exploration Techniques for Target Optimization of Wells

Author/ presenter: ¹Dana Marie Jacob

¹danamariej@gmail.com, Water and Sewerage Authority, Trinidad and Tobago

Theme: CG: Hydrogeology around the Caribbean

Key Words: hydrogeology, aquifers

Subsurface rocks are reservoirs, not only for oil and gas, but can accommodate large quantities of water. These aquifers are the source of twenty percent (20%) of all potable water in Trinidad and Tobago. In Tobago most groundwater is derived from bedrock (igneous and metamorphic rock), while some wells produce from alluvium and sedimentary aquifers. Conversely, Trinidad a large proportion of groundwater in Trinidad is derived from alluvium and sedimentary rock with minor contributions from bedrock.

Structural features and stratigraphy have played a major role in the distribution of groundwater across the islands. Lineaments, for example, channel rainwater through bedrock to aquifers. Water chemistry is affected by the rock formation, the residence time within a reservoir, elevation of recharge and saltwater intrusion. Exploration techniques are similar to the processes employed in the oil & gas industry and are used to evaluate a site's suitability for drilling a water well. This includes taking an inventory of existing water resources, assessment of structural features and the review of available lithological, geophysical, and electrical logs.

Field visits are also important to record observations on vegetation, topography, and land use. Should information derived from analyses of available hydrogeological data and fieldwork be insufficient, additional geophysical exploration is necessary. Geophysical survey methods include resistivity and magnetics. Wells are drilled to a depth of less than 1,500 ft, with coastal wells being shallower to avoid the fresh water-sea water interface. In the dry season, coastal wells may be affected by sea water influx due to a decrease in the freshwater hydrostatic head. If sea water influx occurs, the well is shut-in for some time before resuming production to ensure a retreat of the sea water interface. Exploration techniques facilitate an understanding of geology and has ensured the replenishment of the groundwater well stock.

Integration of Micro- and Nannofossil Data for High Resolution Biostratigraphy in the Onshore Southern Basin of Trinidad

Author: ¹ Ashleigh Costelloe, Tamara de Nobriga, Marina Ciommelli, David Rutledge, John Gregory

¹ashleigh.costelloe@biostratjv.com - Presenter, Biostrat JV Ltd., Trinidad and Tobago

Theme: CG: Biostratigraphy

Keywords: Biostratigraphy, nannofossils, microfossils, Trinidad, stratigraphy, southern basin

Calcareous nannofossils are important biostratigraphic tools, having a global presence in open marine settings at low and high latitudes. They are widely-preserved and abundant in sediments ranging in age from Pleistocene back to Late Triassic, and include many key marker taxa used for global correlation of the geologic record. Recent refinements of biostratigraphic schemes further add to their utility.

This case study integrates nanno- and microfossil (foraminifera) data sets from an onshore well drilled in the Central Block of the Southern Basin, Trinidad. The study was conducted by Biostrat JV Ltd to demonstrate the practicality of using nannofossils in the Southern Basin and improved biostratigraphic resolution when integrated with microfossil data.

Traditionally, microfossil data has been exclusively used in exploration onshore Trinidad, whereas both micro- and nannofossil disciplines are typically used together offshore Trinidad. In the Central Block (Trinidad), well-preserved and abundant nannofossils are observed, including key markers which are used to interpret the Middle to Late Miocene succession.

Nannofossils provide better resolution compared to foraminifera alone; however, integration of both disciplines enables even higher resolution and confidence and – just as offshore - would be recommended whenever real-time biostratigraphic picks are required to assist drilling decisions.

Moving away from Simplistic Reservoir Models; Mixed Process Marginal - Marine Analogues from Trinidad

Author: Saeed Khan

saeedkhan_0903@live.com - Presenter, UWI, St. Augustine, Trinidad and Tobago

Theme: CG: Stratigraphic and sedimentological principles

Key Words: marginal-marine systems, modern analogues, Trinidad

Marginal-marine deposits constitute a significant fraction of hydrocarbon reservoirs. Deltaic deposits alone account for ~ 30% of the world's oil, gas, and coal accumulations. Reservoirs are a product of their depositional history. Deposition models are an interpretation of process controls on sedimentation. Deposition in the marginal-marine environment is controlled by the interaction of basinal (wave, tide, storm, and littoral currents) and fluvial processes. This process interaction determines the size, geometry, and heterogeneity of reservoirs. Until recently, much of our depositional models have been built from traditional, descriptive classification schemes that focus on end-member classifications (e.g., river, wave or tide dominated).

Modern, semi-quantitative and quantitative classification methods have recognized that the application of traditional classification schemes leads to an oversimplification of depositional processes. Quantitative classification schemes focus on the spatio-temporal interaction of basinal processes and their impact on complex sedimentations patterns distribution and stacking.

This paper applies qualitative, semi-quantitative and quantitative classification methods on Trinidad's modern marginal-marine depositional systems. It documents the variety of Trinidad's previously undocumented coastal systems, and the impact of mixed processes on their morphology, distribution, and internal sedimentary architecture. Sixteen modern marginal-marine depositional systems were classified along Trinidad's east, south, and west coasts and comprises deltas, estuaries, coastal lagoons, barrier island complexes, beaches, strandplains, and tidal flats.

Two quantitative classification methods were compared when applied to geomorphological and stratigraphic data. Trinidad's modern coastal depositional systems, here characterized as naturally occurring flume experiments, are considered as modern analogues to ancient deposits based on the concept of fractals in Geology. Trinidad's marginal-marine systems demonstrate the geomorphological and stratigraphic complexity imparted by mixed processes on a "micro" scale, and provides a framework for better understanding their ancient counterparts. This Trinidad dataset provides an excellent opportunity to assess larger-scale reservoir models at various scales of observation.

New Structural Styles in the Deep Columbus Basin: Observations from 3D Nodal Seismic Data

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Theme: CG: Structure and tectonics around the Caribbean margin

Key Words: Structure, Columbus Basin, Deep, Pliocene, Pleistocene

The Columbus Basin is a foredeep basin, between the Caribbean Plate deformation front to North and South American continent to South. The major tectonic regime does from extension – strike slip – compression as you move from West to East. The continued interaction of the leading edge of the Caribbean plate with the extended continental crust of South America expresses itself in a series of (younging to the Southeast) anticlinal folds that trend NE to SW, set up in the overlying Plio-Pleistocene sediments.

Deep imaging in the Columbus basin, (Dolphin/Barracuda areas) has been challenged due to attenuation of seismic signal within the thick, rapidly deposited Plio-Pleistocene Orinoco deltaic succession, making the deep cores of these anticlinal structures poorly understood.

An OBN dataset that straddles the edge of the shelf system (beyond the Deltaic shelf depocenter, on the transition from extensional to shear dominated tectonics) offers insight to the early nature and relative position of these anticlinal trends and gives a clue to the distribution of the Regional Growth fault system controlling deposition in the youngest section of the basin.

Observations including fold tightening and synclinal inversion sitting below the shallow anticlinal structures offer a key to the likely early nature of the deeper systems.

Fluidized mud escape (in some cases to seabed) within overall dilated zones are also noted on trend with the Deeper water Transpressional highs with mud cored characteristics.

Seismic Structural interpretation, and map-based techniques give insight into the interplay of accommodation and deposition as well as the changing nature of dominant structural regime as a function of inherited dip/strike. Observations from near Cretaceous levels to seabed are investigated, which have an impact on trap style and syn-depositional accommodation in the uncalibrated section.

Significant image uncertainty remains an issue in this deeper seismic picture upon which these observations are established.

Petrofacies: A New Petrophysical Approach to Facies Description in the Columbus Basin, Trinidad

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Theme: CG: Rock mechanics & petrophysical methods

Key Words: petrophysics, petrofacies, Columbus Basin

A comprehensive petrophysical refresh on the gas fields in the Columbus Basin was carried out in 2009 to provide consistency and continuity in petrophysical interpretations for conventional reservoirs. As many of the conventional reservoirs become depleted, attention has shifted towards lower net-to-gross, thinly-bedded or shaly sand reservoirs (Secondary Pay). In 2017, a core was acquired and was interpreted to be a reworked laminated system, with heavy bioturbation, resulting in a shaly sand with high dispersed clay content. A new petrophysical model, addressing net, permeability and water saturation, was needed to account for the dispersed clays in the reservoir. Analogous regions such as West Nile Delta and Angola successfully adopted petrophysical models that group facies types based on their log response and character called “petrofacies”.

For the Columbus Basin, five petrofacies were identified from core, ranging from conventional sands to shale-prone heterolithics, with a direct link to a decrease in grain size and increase in clay content. To propagate away from cored intervals and apply to all wells in the basin, an automated log blocking technique driven by Vshale, bed thickness, resistivity and neutron-density separation criteria was determined and the predictive power tested against the core.

This approach has resulted in a more robust petrophysical model which accounts for reservoir variability, and produces more refined concatenated near-wellbore permeability and corresponding saturation height function curves. These outputs lead to more technically sound rate and reserves prediction, with data-driven uncertainty ranges. Petrofacies has been integrated into depositional environment maps, recovery factor and completion design, and has become the common language spoken within the multi-disciplinary team.

Provenance of the Northern Range, Trinidad Using Detrital Zircon U-Pb Geochronology: Implications for Northern South American River System Paleogeography

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Theme: G: Geophysical techniques

Keywords: Trinidad, South America, Geochronology, U-Pb Dating, Zircon

The Northern Range of Trinidad is located in a key area for evaluating the Mesozoic-Cenozoic evolution of the Caribbean and South American plates. Here, we present detrital zircon U-Pb geochronology for 2391 grains from ten samples collected from metasedimentary rocks of the Northern Range. These data bracket the maximum depositional age of the fossil-poor metasedimentary rocks from the Northern Range and to investigate the provenance of their sedimentary protoliths. Detrital zircon ages range between 3136.5 ± 22.9 Ma and 139.0 ± 5.4 Ma, reflecting apparent contribution from a variety of crustal affinities; however, since the youngest ages are 199.5 ± 7.4 Ma to 139.0 ± 5.4 Ma, it is unlikely that sediments were sourced from the Caribbean Plate, which is ca. 88 Ma. Samples from the western Northern Range exhibit significant peaks clustering around 1.0 Ga, suggesting a prominent Grenville basement sediment source. In contrast, samples from the eastern Northern Range have bimodal peaks at ca. 1.4 Ga and 1.75 Ga, which overlap with Central Amazonian crustal ages. Central Northern Range rocks exhibit a single, well-constrained peak at ca. 2.0 Ga, which may be associated with Eburnean-West African to Northern-Central Amazonian terranes. While all samples show significant contributions from the South American craton, suggesting this was their primary sedimentological source, potential source area changes were explored because samples were collected from different structural horizons. These results are among the first to quantify the maximum depositional age of the metasedimentary rock and indicate that the youngest Northern Range clastic sediments were deposited in the Early Cretaceous (Valanginian). Based on the high frequency of detrital zircons from the western interior of South America, our data suggest that the proto-Orinoco River may have begun draining to the northeast coast of South America earlier than previous research suggests.

Reservoir Architecture of Deep-Water Deposits in the Northern Trinidad Region

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Theme: CG:Stratigraphic and sedimentological principles

Key Words: sedimentology. stratigraphy. deepwater reservoirs

Over the last decade, renewed activity in the Trinidad deep-water region has resulted in the drilling of several new exploration wells. As part of this activity, over 450ft of conventional cores were acquired over multiple subsurface reservoir intervals in the basin, providing for the first time a detailed view of the depositional architecture of reservoirs in the region.

Four facies associations (FAs) have been interpreted based on lithotype abundance and vertical assemblage trends. They include: FA1: meter-scale amalgamated, structureless, high-density turbidites, with occasional dewatering structures, parallel lamination and siderite clasts; FA2: centimeter-scale mudclast conglomeratic zones in association with sharp/erosive boundaries; FA3: decimeter-scale low-density turbidites, commonly in association with linked debrites; and FA:4 meter-scale, bioturbated, deformed and poorly sorted mudstones with floating quartz granules.

These FAs represent the building blocks of the sedimentary system, from which three architectural elements can be interpreted. FA1 is most abundant, and is predictably overlain and underlain by FA3, interpreted to represent the initiation, build, and abandonment phases of sandstone-prone lobes. The transition from these lobes to sub-seismic, poorly confined channel elements are interpreted to occur via the presence of FA2, overlain by FA1, which represent erosive/bypass channel bases overlain by high-sedimentation channel fill respectively. The background non-reservoir sedimentation is dominated by FA4, interpreted to represent mudstone-prone debrites and mass transport deposits, similar to reported fine-grained deposits characterized in shallow drop-cores in the region.

The presence and character of these sedimentary deposits and resultant architectural elements indicate a depositional system closely controlled by syn-kinematic tectonic conditions, common in the region at the plate boundary zone between the Caribbean and Atlantic plates. Slope instability triggers MTDs, which shape the seafloor topography and control the spatial and temporal development of the reservoir-prone channels and lobes.

Reservoir Depositional Element (RDE) Mapping: Adding Detail to the Regional Picture

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Theme: CG: Stratigraphic and sedimentological principles

Key Words: depositional environment, sedimentology, stratigraphy, workflow, integration, mapping

Standard exploration products that are used to understand reservoir presence include Gross Depositional Environment (GDE) maps. These maps generally include major fairways (e.g. delta plain, delta front, slope), location of shelf edges and active faults for a single depositional sequence (100s ft thick). Such maps are generally insufficient to portray intra-sequence variability, which may impact reservoir deliverability and consequently field development and management decisions. Reservoir Depositional Element (RDE) maps are based on thinner stratigraphic intervals (10s ft thick) and a broader range of depositional settings (e.g. distributary channel, mouth bar, axial-, medial-, distal-delta lobe, upper and lower shoreface). They can be constructed for multiple intervals within a particular depositional sequence and used to highlight vertical and lateral variability. This presentation describes an RDE mapping workflow with illustrated examples.

The workflow begins with data gathering, before setting regional stratigraphic and structural context. Core and well logs are interpreted using sequence stratigraphic principles to define time equivalent intervals. Syn-depositional faults, that may influence sediment input points and depocenters, are mapped using seismic calibrated to well data. Depositional elements are interpreted from core, well logs and seismic. Illumination of the depositional elements on seismic has been made possible via improved imaging from Ocean Bottom Cable/Node (OBC/OBN) data and resultant attributes like spectral decomposition. Finally, analogs and conceptual models are used to assist interpreting the inter-well space and draw a range of RDE maps.

The detail depicted on RDE maps adds value at various phases of field development. In exploration, the maps facilitate prediction of reservoir presence, depositional setting and associated petrophysical ranges for a prospect. In field development and management, petrophysical trend directions, reservoir quality, reservoir connectivity, aquifer strength and size, that inform static volumes and dynamic behavior can be postulated. It is an integrated tool intended to inform technical and business decisions.

Reservoir Depositional Element (RDE) Maps – Anchored or Exploring the Range – A Case Study

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Theme: CG: Stratigraphic and sedimentological principles

Key Words: depositional environment, sedimentology, stratigraphy, structural

Reservoir Depositional Element (RDE) maps are a key product in understanding variability within a field or prospect, informing exploration activity or field development/management . These maps are generated from integration of a range of observed and modelled data. Data quality, availability, utilization, anchoring and bias all impact the maps being generated. As such, it is important to explore alternative scenarios to capture the range of uncertainty and better assess risk. This presentation uses a case study to illustrate how additional seismic attributes and a deeper investigation of structural controls on sedimentation were used to generate an alternative scenario for an existing RDE map.

The existing RDE map, depicting a deltaic shelf with a channelized system to the south, and its inputs were first reviewed. Data gaps and uncertainty were focused on; what and how data was utilized, what data exists that were not integrated and potential gaps in the regional framework. The workplan was developed from this foundation to investigate alternative scenarios. Aspects of the workplan include investigating depositional controls, generating additional seismic attributes, focusing on observations and potential alternate interpretations and a reassessment of analogues.

One area that was identified as potentially influential to the depositional environment, but not previously analyzed or integrated, was the structural framework, particularly syn-depositional faulting. Faults control where accommodation space is created, the location of depocenters, how stress is distributed and instabilities, created through fault linkage zones between similar and differently oriented faults and inherited fabrics. The findings from this work, integrated with seismic observations, and analogue studies led to the realization of a slump model as an alternative.

RDE interpretation impacts the way we view uncertainty and influences how we analyze risk for a target. Assessing alternative cases helps us explore the range of possibilities and make more informed business decisions.

Structural Geology and Cenozoic Deformation: Western Northern Range, Trinidad

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Theme: CG: Structure and tectonics around the Caribbean margin

Key Words: Caribbean, Trinidad, structural geology, seismicity, tectonics

The Northern Range, Trinidad underwent deformation due to oblique collision of Caribbean plate with northern South America, which was then followed by transform plate motion. Deformation began in the late Miocene when sedimentary protoliths were ductility deformed and metamorphosed to greenschist facies; this event and subsequent transform deformation drove exhumation of these rocks to the surface and created their high topography.

This project provides constraints of the structural history of the western Northern Range where bedrock mapping and structural analyses are most complete. Initial geologic mapping of the Northern Range, which continued from the 1950s, 1960s, and 1990s, focused on attempting to establish and map a protolith stratigraphy. Our new approach has been to simply map the observed metamorphic rock types. We supplement our new map with abundant mesoscopic structural fabric measurements collected from roadcut, streambed, and quarry exposures. We synthesized the new map and all structural data into a GIS geodatabase.

The data were used to construct cross-sections and stereonet along a continuous N-S transect across the entire western Northern Range. Our analyses highlight three major phases of deformation in the western Northern Range. D1 (Early Miocene) produced a S1 foliation that completely transposed the original stratigraphy and dips south at an azimuth between 150-220°. D2 folded S1 into asymmetric trains of south-verging m- to dm-scale mesoscopic folds. D3 produced conjugate sets of NE-SW- and NW-SE-trending f3 folds. The timing of D2 is not well constrained. D3 is probably associated with Pliocene extension related to the local development of pull-apart basins.

Our cross-section highlights: 1) range front domains of upright NW-SE trending folds, and 2) the range-bounding Arima Fault zone, a ~100m wide zone of young, but inactive (Plio-Pleistocene), ~E-W trending, sub-vertical (both N- and S-dipping), predominantly dip-slip, normal sense, faulting.

The Impact of Regime and Tectonics on the Orinoco's Second Clastic Wedge's Architecture, Trinidad

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Theme: CG: Stratigraphic and sedimentological principles

Keywords: Orinoco, Clinoform, Growth Faults, Regime Change

The Pliocene aged, 3rd order, second clastic wedge (the Forest/ Moruga/ Mayaro formations) records the first entrant of Orinoco sands into the Columbus Basin. Linking these formations' strata across Trinidad and offshore is challenging as it is strongly segmented by both syn-depositional growth faults, and syn- and post- transpressional events associated with the eastward migration of the Caribbean plate. 130 wells and outcrop exposures were integrated to define 11, 4th order, clinoform topsets (F10 - F110) and reconstruct a sub-regional dip correlation across the shelf margin of the Southern and Columbus basins. The oldest sub-wedge (Forest-Gros Morne sands: F10 – F40) shows the development of at least four topset clinoforms and records some of the fastest progradation rates for the Trinidad Orinoco wedges (up to 25 m/ ky), that were likely driven by tectonic uplift, reduced dynamic subsidence, basin geometry and eustatic sea-level fall. On the outer shelf, this sub-wedge shows an overall fluvial dominance of the delta, identified by coarsening upward successions of well-developed mouth bar sands and hyperpycnal flows. Its strong fluvial character may have been controlled by the active southward growing thrust on the margin, which created an embayment and hindered reworking by waves. However, the fluvial nature of the deltas created focused sedimentation on the outer-shelf, that initiated growth faults resulting in impressive over-thickening of these topsets across the margin, from 600 to 1500 ft on the inner- to mid-shelf, and > 7,500 ft towards the shelf edge. The younger topsets (F50-F110) show a mixed fluvial-wave influence and the development of double clinoforms on the mid-shelf. However, as the delta lobes prograded across active growth faults on the shelf margin, the increased accommodation not only resulted in a reduction of their forward growth but also led to a longer period of wave reworking on the delta.

Understanding the Net Sand Distribution of the Pliocene Forest Formation Topsets, Southern Basin, Trinidad

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Theme: CG: Stratigraphic and sedimentological principles

Key Words: Forest Formation, Deltaic Setting, Sequence Stratigraphy

This study investigates the net sand distribution of the Pliocene Forest Formation topsets of the Orinoco Delta within a section of the Southern Basin, Trinidad. The primary objectives were to understand the Forest Formation sand distribution and determine its deltaic setting by utilizing well log facies to create gross depositional environments (GDE) for three units of interest, as well as assess the value of this study.

Using 50 scanned wells, a 1D analysis was created to understand periods of regression and transgression. From this, 20 wells with the best data were used for the project where units were picked. For three selected units, sand maps were made, and deltaic regime was interpreted based on the geometry. Facies distribution maps were then created using the distribution of well log facies within each selected unit. This was represented by pie charts and was plotted onto a base map. Distinct patterns and features such as estuaries were now visible throughout the study area since each of the facies were linked to an associated depositional environment.

GDEs were created and a sequence stratigraphy interpretation was done to justify the presence of estuary networks by illustrating down cut regions and comparing it to the facies distribution maps.

Finally, the value of this study is such that it can be useful for future projects in terms of understanding reservoir geometry and quality since the facies analysis method gave a more detailed and defined resolution. This is essential when placing a well since despite the net sand map showing obvious thicknesses, it does not consider regime and the presence of estuaries which can affect flow because of there being stacked sequence boundaries. This study has the potential for further development as it can assist in accurately modeling GDEs and reservoir geometry for well placement.

Variability Of Secondary Pay In The Columbus Basin

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Theme: CG: Structure and tectonics around the Caribbean margin

Keywords: Thin bed pay, secondary pay, sedimentology, stratigraphy, bioturbation

Most of the actively producing hydrocarbon reservoirs in the Columbus Basin are thick (100s ft), amalgamated sandstones deposited in a proximal delta front to shoreface continuum as part of the palaeo-Orinoco Delta. Various types of Secondary Pay, not developed by primary completions, are recognised. The concept of thinly bedded pay is well established but not all Secondary Pay types are thinly bedded. Thick successions of intensely bioturbated silty sandstones can also make viable reservoirs. This presentation illustrates how regional stratigraphic and depositional context can explain Secondary Pay types, allowing for appropriate field development planning. Previous descriptions of thinly bedded pay in the Columbus Basin tend to come from the distal delta front. Low clay content sandstones with low-angle lamination to hummocky cross stratification are interbedded with non-net mudstones, which are typically fluid muds. Bioturbation intensity and diversity are low, reflecting high physio-chemical stress. Both laterally extensive sheets and confined chutes or channels are observed at outcrop. This Secondary Pay type is most common during delta advance (regression) and in areas down-dip from sediment entry points (delta distributaries). It reflects 'on-axis' but distal sedimentation associated with active delta lobes.

Thick, intensely bioturbated silty sandstones have a higher clay content and sedimentary structures are largely destroyed. Intense, relatively diverse bioturbation indicates lower physio-chemical stress. Laterally extensive sheets are observed at outcrop. This Secondary Pay type is most common during delta retreat (transgression) and in areas laterally offset from delta distributaries. It reflects 'off-axis' distal sedimentation associated with wave-reworked portions of the delta.

A third Secondary Pay type, comprising channelised thin beds associated with tidally-influenced delta plain sedimentation is observed at outcrop but has to date remained unrecognised in the subsurface. It represents a further potential habitat for the next phase of Columbus Basin hydrocarbon production.

HYDROCARBON INDUSTRY



Pumping unit in the Moruga West Field, producing oil from Herrera reservoirs. Photo courtesy Curtis Archie, 2022

A History of the Appraisal and Development of Shell's Block 5c Acreage

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Theme: HR: Hydrocarbon field appraisal case studies

Key Words: appraisal, development, shell, 5c, bounty, endeavour

Shell's Block 5c off the east coast of Trinidad contains the Bounty and Endeavour gas fields. Following their discovery 2008/9, a comprehensive appraisal campaign was conducted, including seismic and a well. This led to development drilling in 2020 and first gas from the block in 2021. The exploration wells were drilled based on legacy streamer seismic acquired in 1999. This was followed by another survey in 2012, and ocean bottom seismic in 2018. With each successive survey, improvements in acquisition and processing technology gave greater insights into the structure and fluid fill of the traps.

Full waveform inversion was applied in 2016, helping to improve the image through the complex overburden consisting of shallow gas and faults with significant velocity contrasts. The ocean bottom seismic increased the offsets and gave wide azimuthal coverage, improving control on anisotropy. The reservoir is moderately faulted, creating multiple compartments with different gas water contacts.

Formation pressures acquired from the exploration and appraisal wells were critical in understanding the plumbing of the reservoir. Fault seal analysis was conducted to understand the potential baffling within the structures, and informed the development planning. In addition to shallow gas and faulting, the overburden contains multiple pressure ramps and regressions created by disequilibrium compaction.

The combinations of complex pressures and faults meant that careful consideration needed to be placed on the location and trajectory of the development wells. The complex overburden also created challenges for depth prediction. Variations in shallow gas and pressures resulted in significant uncertainty that needed to be incorporated in the development planning.

The safe and successful development of these fields demonstrated the value of applying technology and integrating across disciplines to account for multiple factors and uncertainty.

Accessing the Pre-Neogene Play Potential of the Tobago Trough

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Theme: HR: Circum Caribbean / Atlantic Basin Exploration

Key Words: Tobago Trough, Exploration, QI attribute analysis

The Tobago Trough is a fore-arc basin related to the Lesser Antilles Arc, which divides the Caribbean Sea and Atlantic Ocean. Although a frontier basin, existing discoveries adjacent to the Tobago Trough have targeted shallow biogenic/thermogenic gas and condensate accumulations. Extrapolating the trend of these Tertiary discoveries into the Tobago Trough and comparing AVO responses, has helped to determine the potential of deeper, untested plays in the pre-Neogene.

The study was performed on 2,448km of broadband multisensor PGS GeoStreamer™ MC2D depth data comprising sub-surface interpretation and amplitude analysis. Areas of interest for the AVO analysis were identified through seismic interpretation where favorable clastic and carbonate facies were delineated as potential exploration targets. The AVO signatures were validated using existing nearby dry wells and gas discoveries (Orchid, Iris and Sancoche) to improve the accuracy of the results and de-risk the leads. The identified leads within the Tobago Trough are estimated to range from Late Cretaceous – Pliocene, displaying similar responses to the nearby gas discoveries. Additionally, some AVO results below the Mid Miocene unconformity show a different signature to the typical local gas response, further supporting the model for a Cretaceous oil-prone source rock – a realistic scenario when considering source rock analogues in the neighboring basins of Barbados, Trinidad, Venezuela and Guyana.

Sharing a number of petroleum system elements with neighboring basins that have experienced recent exploration success, puts the Tobago Trough in a favorable position. The leads and features identified are characteristic of hydrocarbon accumulations within clastic units, visibly constrained to stratigraphic sequences and often brightening up-dip. The untested stratigraphic-structural combination traps in the pre-Neogene provide a host of exciting leads to pursue in the upcoming license round.

Aphrodite Lead – An Integrated Approach to Accelerated Prospect Maturation

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Theme: HR: Brownfield development

Key Words: Aphrodite; Maturation

The shallow Pleistocene Columbus Basin, currently the biogenic gas hub of Shell Trinidad, has seen a quicker than expected production decline from existing fields. One mitigation to alleviate the projected shortfall is a 2-well Near Field Exploration (NFE) campaign. However, after maturation of the second well was suspended, the team had to quickly find a replacement, the Aphrodite Lead, to complete the planned drilling campaign. This required accelerated maturation to fit the execution timeline.

The prospect ultimately benefited from an integrated approach to drill-worthy assurance with a multi-disciplinary team comprising exploration geoscience, structural geology, petrophysics and qualitative interpretation practitioners. This approach minimized the need for iterations across the disciplines, with inputs and findings being immediately integrated to successfully pass final assurance in just over four months. The strategy implemented focused solely on defining the key risks and uncertainties and de-risking each of those elements. These key risks and uncertainties were trap definition – specifically the nature of the stratigraphic edge, lateral seal capacity, reservoir presence and extent, and likely fluid fill. Upon completion, Aphrodite was defined as a combination trap within an early Pleistocene middle/outer shelf deltaic reservoir.

There were moderately conformable amplitudes and a Class III Amplitude vs Offset (AVO) anomaly, defining a Direct Hydrocarbon Indicator (DHI) interpreted to represent biogenic gas within the reservoir in a success case. The prospect probability of success (PoS) almost doubled with the applied Quantitative Interpretation (QI) uplift and volumes now surpassed the commercial threshold.

Aphrodite was successfully matured within the shortened timeline through strong integration and collaboration amongst the multi-disciplinary team and a similar approach will be favored for upcoming projects. It was deemed competitive against the existing portfolio and is carded for execution mid- 2022.

Capturing Bulk Rock Volume (BRV) Uncertainty - A Workflow Incorporating Seismic (Pre-Stack and Post-Stack Data) and Well Data

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Theme: HR: Advanced geophysical methods for oil & gas reservoirs

Key Words: bulk Rock Volume, depth uncertainty, seismic data, velocity uncertainty

In the Trinidad region, one of our biggest subsurface uncertainties and sensitivities in our original gas in place (OGIP) calculations is the bulk rock volume (BRV) of our reservoirs. This uncertainty is a result of the geological complexity of our fields due to the presence of shallow gas, the regional and counter-regional faults, stacked pay segments, and reservoirs with multiple flow units. Often, we have limited well control with one or two wells either located on the crest of the structure or on one flank of the structure.

Previous methods used to capture BRV ranges did not always incorporate all the data available. In this case study, we use a data-driven depth uncertainty workflow to assist us in ensuring that we have a robust geophysical interpretation and a more suitable range of BRVs for our reservoirs. This workflow captures velocity uncertainty by incorporating seismic data and the products created during the processing such as pre-stack data, the velocity model, gamma and reflectivity volumes.

Data quality control is an important step in the process allowing us to determine the reliability of our data and what methods can be used to produce technically sound structural variations. The residual moveout of the gathers can tell us about the validity of our velocity model and what areas of the model may require adjustments (either an increase or decrease in the velocities). The workflow also employs the pseudo point method in producing tied surfaces for the reservoirs, constrained by the observations from the velocity and gathers, to flex the structure. Lastly, the geophysical data and observations are integrated with non-geophysical data types (dynamic data and petrophysics) to help refine the range of BRVs. The combination of methods produces a range of plausible BRV scenarios that are defensible and supported by data.

Fault Transmissibility in Gas Reservoirs

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Key Words: Fault Transmissibility

Fault transmissibility reflects the ability of the fault rock texture to allow fluid to enter and flow from one side of the fault to the other. It is a function of the following: 1) Fault rock permeability 2) Fault zone thickness - 3) The fluid phases 4) Dynamic changes across the fault In the Columbus Basin shelf Trinidad and Tobago, the wall rocks are Pliocene and Pleistocene sand and shale deltaic reservoirs.

The typical fault rock found in the Columbus basin range from disaggregation zones, phyllosilicate framework rocks to both clay and shale smears. This study explores the transmissive behavior of faults within self-juxtaposed gas bearing reservoirs under production in the Columbus basin shelf. The study uses production, pressure data, reservoir engineering models and fault rock analysis, to determine fault transmissibility. These models showed gas systems with the weaker aquifer support are more transmissive across the faults for most of their life. It was found that stronger water drive systems are less transmissive through intra- reservoir faults.

This behavior is attributed to two reasons, one being pressure drawdown across the fault leading to breakdown of fault baffle and the other being the interactions of the aquifer and the fault zone, where the fault acts as a barrier to flow, and the aquifer is preferentially channeled up one side of the fault. These and other examples from the Columbus Basin support the hypothesis that drive mechanism in gas reservoirs significantly affect the transmissive behavior across faults. It also shows the importance of performing fault Qc, length vs throw and throw plots to understand faults and whether the faults can be split into smaller faults allowing for flow across and around them. Fault position with respect to the water leg is also thought to have an impact on fault transmissibility of gas.

Focus on Value Competitiveness for Aphrodite Well Towards an Accelerated First Gas Development

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Theme: HR: Revitalizing mature provinces

Key Words: near field development, AVO, project competitiveness, marginal

Aphrodite is the second well in a 2 well near field exploration campaign in Shell's operated Block 5a, East Coast Marine Area(ECMA), Columbus Basin. It is a combination stratigraphic-structural trap with expected biogenic gas. Cost competitiveness and accelerated development maturation are key success factors to unleash the full value chain of Aphrodite for T&T's gas supply needs. Not only will this realize gas to market in a reduced timeframe, it also potentially reveals additional stratigraphic trap potential in the basin. Aphrodite can further unlock stranded discovered volumes via new infrastructure.

The prospect represented an easier path to commercialization with a QI validated Class III AVO anomaly with fair amplitude conformance to structure. However, the limited GIP means there is a commercially established challenged scope unable to support an appraisal well or more than one development well. To ultimately deliver maximum value for project competitiveness, a 'One Subsurface' team was formed to accelerate development planning for an exploration success case. The alignment boosted productivity, and increased innovation as it reduced time by 25% with an estimated cost synergy using standardization SURF hardware, single rig sequence and SURF execution.

The key steps include: - Collaborative knowledge sharing of geological models, trap and volume assumptions - Overview of Value to Volumes data and geological inputs to quantify the distribution of GIIP across the possibly segmented structure and considering reservoir variability - Realistic, data-supported Scenario Generation to de-risk potential compartmentalization and amplitude data quality - VOI led data acquisition - Appraisal opportunities including pros and cons of an appraisal sidetrack - Development well concept to optimally access and drain resources. - Lessons learnt from global analogs.

This presentation will highlight the methodology that allows the unlocking of nearfield value in a low volume, high-cost scenario with time and budget constraints.

Geosteering for Success – Making Better Drilling Decisions with Cutting Edge Technology

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Theme: HR: Revitalizing mature provinces

Key Words: Geosteering, well planning, drilling, NCMA

The Trinidad and Tobago energy landscape has seen significant declines in gas production, with major players in the industry returning to negotiating tables to construct a revised framework for the future. The drive to boost production to meet the needs of domestic markets and for foreign exchange, placed a strong responsibility on Subsurface disciplines to bring feasible field developments to fruition.

In March 2020, Shell Trinidad and Tobago Ltd., in partnership with Heritage Petroleum Ltd., announced the Final Investment Decision (FID) for the Colibri Project. This 4 well subsea campaign would connect the Cassra and Orchid fields, situated in Block 22 and NCMA-4 (NCMA), to the domestic and ALNG pipelines. In anticipation of a Q4 2020 spud, the operation to target 3 reservoir intervals, via long, 1500ft horizontal completions, took shape with little room for error.

For success, several challenges needed to be overcome. From the seismic and offset well data, it was clear that these fields presented two stark contrasts: a benign, geologically uneventful overburden, paired with thin, high variability reservoirs. The benign overburden meant that depth calibration could be difficult and solutions to overcome this needed to be sought. At the reservoir, accurate well positioning via well-timed directional decisions would be key to landing and steering each well in an optimal manner. For the first time in T&T, Schlumberger's GeoSphere and GeoSphere HD tools were employed, providing real-time reservoir mapping outputs to inform steering decisions.

A deep, integrated working relationship between the Shell Subsurface team and Schlumberger's Well Placement team, allowed the right experience levels to be leveraged to ensure successful application. Finally, execution would take place under the ominous umbrella of COVID-19, requiring a strong, hybrid arrangement between onsite and now fully remote delivery teams, to ensure no gaps existed and no missteps in decision making took place.

Groundwater Supply: The Role of Geology in Determining Groundwater Distribution and Exploration Techniques for Target Optimization of Wells

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Theme: CG: Hydrogeology around the Caribbean

Key Words: hydrogeology, aquifers

Subsurface rocks are reservoirs, not only for oil and gas, but can accommodate large quantities of water. These aquifers are the source of twenty percent (20%) of all potable water in Trinidad and Tobago. In Tobago most groundwater is derived from bedrock (igneous and metamorphic rock), while some wells produce from alluvium and sedimentary aquifers. Conversely, Trinidad a large proportion of groundwater in Trinidad is derived from alluvium and sedimentary rock with minor contributions from bedrock.

Structural features and stratigraphy have played a major role in the distribution of groundwater across the islands. Lineaments, for example, channel rainwater through bedrock to aquifers. Water chemistry is affected by the rock formation, the residence time within a reservoir, elevation of recharge and saltwater intrusion. Exploration techniques are similar to the processes employed in the oil & gas industry and are used to evaluate a site's suitability for drilling a water well. This includes taking an inventory of existing water resources, assessment of structural features and the review of available lithological, geophysical, and electrical logs.

Field visits are also important to record observations on vegetation, topography, and land use. Should information derived from analyses of available hydrogeological data and fieldwork be insufficient, additional geophysical exploration is necessary. Geophysical survey methods include resistivity and magnetics. Wells are drilled to a depth of less than 1,500 ft, with coastal wells being shallower to avoid the fresh water-sea water interface. In the dry season, coastal wells may be affected by sea water influx due to a decrease in the freshwater hydrostatic head. If sea water influx occurs, the well is shut-in for some time before resuming production to ensure a retreat of the sea water interface. Exploration techniques facilitate an understanding of geology and has ensured the replenishment of the groundwater well stock.

Maximizing Opportunity, Managing Risk: Integrated Decision-Based Modelling for the Value Optimization of Production

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Theme: HR: Brownfield development

Key Words: Integration, Decision-based Modeling

Early in the production life of a single well development, it became apparent the reservoir behaviour was outside of expectation based on the observed reduction in bottom hole flowing pressure. Pressure transient analysis suggested that either there were faults very close to the well or there was a significant deterioration in reservoir quality away from the well.

There were no indications of crossing faults while drilling and no faults observed on seismic at the time. There is a known gas water contact approximately 130ft below the well and as the geological model did not support the observed behaviour, there was an increased risk of Early Water Breakthrough. An opportunity arose to ramp up the well to capitalize on the gas market price adding value across the Integrated Gas Value chain. Due to the concern that increasing the rate could accelerate water coning and the low confidence in the current model predictability, a reverse engineering approach was attempted where geological scenarios were replicated dynamically in simplified reservoir models.

Scenarios included lower gas in place, a more homogeneous reservoir, reduced vertical and lateral connectivity and enhanced vertical connectivity. These scenarios allowed the team to differentiate the sensitivity and impact in terms of water breakthrough and ultimate recovery. Although the different realizations showed a wide range in ultimate recovery as expected, the analysis illustrated that there was low sensitivity to the actual well offtake rates within the same realization and as a result that a higher rate would give a higher life cycle value. This approach helped the team to differentiate decision related impacts (controllable action) from the uncertainty of the subsurface realizations (it is what it is) and facilitated the subsequent informed decision.

New Seismic + Old Concepts – Derisking Exploration and Appraisal in a Mature Hydrocarbon Basin. Case Study from the Columbus Basin, Offshore Trinidad

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Theme: HR: Revitalizing mature provinces

Key Words: Paralic Sedimentology. Clinoforms. Deltas. Seismic. Seismic Stratigraphy. New Technology

In the offshore Columbus Basin, map-based attribute analysis and amplitude extractions have been historically used as a key tool to define the extent and character of paralic reservoirs. However, this approach is not without challenges, given the presence of significant shallow gas, fault-induced seismic attenuation, non-unique inputs for seismic attribute response and the inherent decay of seismic signal with depth.

In 2013 BP acquired more than 1000km² of high density, large offset and full azimuthal OBC data. Coupled with advanced processing workflows, the seismic image has been significantly upgraded to the historical towed-streamer datasets. For the first time, subtle seismic offlap breaks and clinoform geometries can be imaged in the deep subsurface of the Columbus Basin, previously documented only to the south in the relatively undeformed Plataforma Deltana region.

These Columbus Basin clinoforms are hundreds of feet in relief and exhibit consistent downdip seismic downlap onto underlying reflections. The seismic offlap break, which marks the top of the clinoform, consistently occurs in a predictable association with seismic attribute dimming. Additionally, wells drilled on either side of the offlap break and along the clinoform profile document a consistent progression of reservoir facies, consistent with classic outcrop models of shelf-margin depositional systems. As such these observed seismic features are interpreted as representing the reservoir shelf edge.

A second benefit of the improved seismic resolution is the ability to map intra-reservoir mudstones of typical Columbus Basin gross reservoir intervals, interpreted to represent the boundary between the subaqueous and subaerial clinoforms. This is a step change from the previous approaches of mapping just the top (and sometimes bases when possible) of gross reservoir packages. Attribute analysis on these constituent intra-reservoir packages exhibit spatial stacking patterns consistent with 1D vertical well-log stacking profiles, providing another possible tool for field-scale reservoir prediction and characterization.

The Cenozoic dextral-oblique collision of the Caribbean and South American tectonic plates has progressively deformed, exhumed, and eroded the northern South American margin

from Venezuela to Trinidad. Although sediment shed off the South American continent into the foredeep and accretionary prism ahead of the eastward-advancing Caribbean Plate provides a record of the timing and magnitude of collision, subsequent deformation and erosion limits preservation and the early history of the collision remains uncertain.

Outcrops and Exotic Boulders of Miocene - Cretaceous Reservoirs and their Exploration Implications

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Theme: HR: Revitalizing mature provinces

Key Words: Cretaceous, Miocene, Prospectivity

The study of surface outcrops allows the Geoscientist to make a reasoned prediction and provide insights into the subsurface. However, the tropical climate, legal and unauthorized quarrying both cause these outcrops to be short lived and need to be studied as they are created. Most of the type localities used to define the various formations in Trinidad no longer exist, are inaccessible or defined from wells, the researcher also needs to rely on the published literature.

Since the Kugler surface geology map was published in 1959 many refinements and additions have been made incorporating well data from the various acreage holders, however, nearly all of that well data is still confidential, in some cases for the past 100 years. The Tamana, Ciperó (Retrench & Herrera sand members), San Fernando (Mt. Moriah Glauconitic Sand member), Point-a-Pierre, Lizard Springs, Naparima Hill, Gautier and Cuche Formations will be reviewed in this study.

The spatial distribution, lithology and sedimentary features of these formations will be integrated with published literature to make predictions about their hydrocarbon prospectivity.

Pilot EOR Feasibility Study in Deltaic Channel Sands

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Theme: HR: Enhanced Oil Recovery

Key Words: water flooding, polymer flooding, EOR, recovery factor

Primary recovery in deltaic and turbiditic reservoirs in the prolific Southern Basin generally range from 10-18% for a solution gas drive. Overall recovery from conventional primary recovery operations has been low, leaving a considerable oil resource available for secondary and tertiary oil recovery. EOR has the potential to increase recovery factors. Hence, a recent feasibility study was conducted within one of Trinidad's southern onshore asset via a geology-based simulation software Baker Hughes Jewel Suite.

The purpose of the model was to recommend an EOR method that would maximize the oil recovery from this reservoir. A static 3D model comprising faults and stratigraphic surfaces was constructed for the area followed by iterative reservoir simulation exercises. Petrophysical analysis controlled the interpolation process between wells and the reservoir parameter distributions populated the grid. Permeability was defined by a relationship to VShale using data from an offset field.

The reservoir properties were screened using an EOR technical criteria matrix augmented by EOR historical terms of reference, to determine the most suitable EOR method. EOR screening results favored water/polymer flooding as most suitable for the specific reservoir. Simulation results revealed that recovery factors can be increased by 3-5%, maximizing the overall recovery to 44.5%, using polymer/water injection with a combination of new and existing wells as offtakes.

New surface and subsurface infrastructure would be required to optimally and safely deliver this EOR project, due to the pre-existing aged infrastructure and associated mechanical and HSSE risks. Although the latter negatively affect the project NPV and IRR, the technical analysis demonstrates that EOR in the Southern Basin can boost production.

Subsurface Modeling to Predict the Performance of a Horizontal Well Southern Basin, Trinidad

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Theme: HR: Brownfield development

Key Words: horizontal well, reservoir simulation

In the prolific Southern Basin, Trinidad, there are stranded reserves in fault blocks which represent appreciable oil volumes. Traditionally, these reserves have been targeted using vertical development wells. Oilbelt Services Limited, through their upcoming drilling campaign will seek to drill their first horizontal well in an effort to change the paradigm of optimally drilling and producing reserves.

A static 3D geological model was constructed, using Baker Hughes' Jewelsuite software, to predict the potential production inflow rates for various horizontal well lengths and reservoir permeability values. Geological data sets such as well survey/trajectories, formation markers, seismic interpretation and petrophysical well logs, provided essential inputs for the model. This data was used to populate a model grid with integrated reservoir properties such of V_{shale} , S_w and porosity.

Data from an analogue field in the Southern Basin was used to establish the relationship between permeability and V_{shale} to supplement the porosity and permeability data in the area of interest. The grid provided the platform to run reservoir simulation iterations using input oil parameters, such as solution GOR, oil gravity and gas specific gravity. The model was history matched for validity based on the current production rate and performance of a nearby offset well to the proposed horizontal well location.

Permeability modeling sensitivities applied showed production performance increased significantly with an increase in reservoir permeability. Production rates were also increased by two to three times that of a vertical well by increasing horizontal completion length. The model was based on a maximum horizontal well length of 500 ft that could be achieved based on the size of the fault block of interest.

Horizontal wells can be the solution for maximizing initial well inflow by increasing sand face exposure thus enabling production returns to be realized sooner than traditional vertical wells.

Trinidad & Tobago Exploration Potential Unveiled by High Repeat Offshore Satellite Oil Seep History

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Theme: HR: Petroleum systems and geochemistry

Key Words: Oil Seeps, exploration, deepwater, frontier

Trinidad & Tobago is located at the meeting point of the Caribbean Islands and South America, right in between Venezuela to the West, Guyana to the East and Barbados to the North. The region is a prolific hydrocarbon discoveries area mainly with the famous onshore oil fields of the Orinoco belt in Venezuela. However, Trinidad & Tobago itself has had its share of success, mainly with Trinidad Basin and Tobago Basin.

We will focus here in the deep-water frontier areas of Trinidad & Tobago, a large sedimentary prism fed by the Orinoco River, mainly in the area of the Northeast Caribbean Deformed Belt. This sweet spot where attractive blocks 23, 25 and 27 have just recently been acquired by BP and Shell expands as far as the edges of world class Guyana Basin to the East. In satellite oil seeps studies, time and recurrence are the key to assess the true potential of an area.

Large amounts of SAR satellite dates enable high coverage of data on every location of a study zone (60 to 100 different dates per each X/Y). Those high coverages allow for spatial proximity and seep repeat and are best suited to offer what we're hunting: concentrated oil seeps in the same place repeating themselves over time. Satellite oil seeps are a very powerful tool to highlight the presence of a generative petroleum system and the escapes of migration plumbing systems both in mature and frontier areas. They deliver two vital pieces of information: are there any seeps and where?

The purpose of this presentation is to discuss the presence of numerous and repetitive offshore oil seeps in Trinidad & Tobago's eastern boundaries with Guyana shaping at least 3 very promising oil seep anomalies. This new seep data could revive the interest in the area which is still largely underexplored compared to nearby basins.

Using 2-Dimensional Seismic Modelling to Support Observed DHIs the Columbus Basin, Trinidad

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Theme: FG: Geophysical techniques

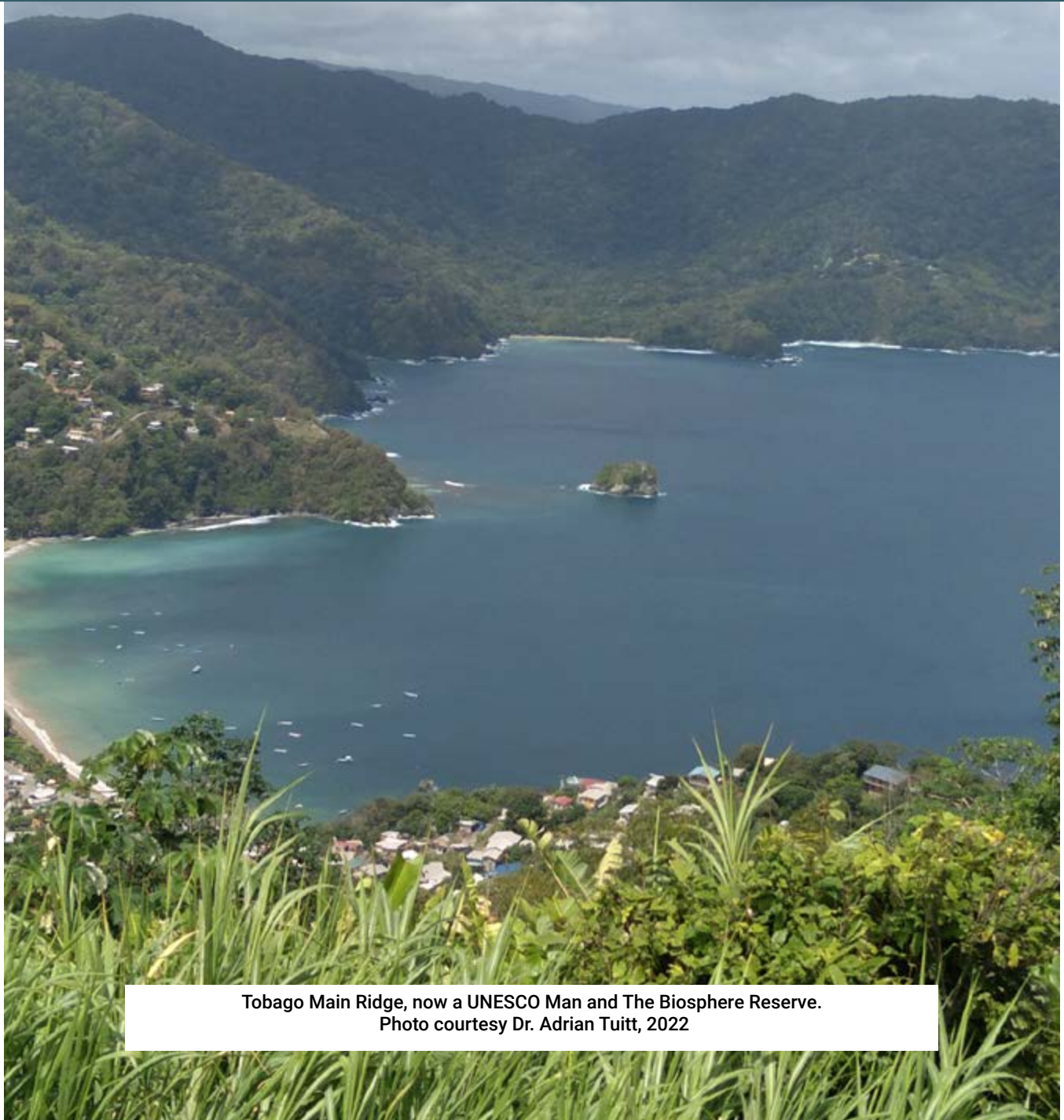
Key Words: geophysics, modeling, DHI

The presence of direct hydrocarbon indicators (DHIs) has been proven to be a good criterion when assessing the technical risk and uncertainty of undrilled hydrocarbon prospects in Trinidad's Columbus basin. Cross-cutting reflectors (CCRs), also known as flat spots, are great as fluid indicators but can present themselves on seismic data for several reasons. It is therefore important to test their validity as a hydrocarbon indicator. This presentation uses a case study to demonstrate how integrating 2-dimensional (2D) seismic modelling together with common seismic interpretation and analysis of an unpenetrated segment can be used to support the validity of using an observed CCR to represent a gas water contact (GWC) and help determine its depth and uncertainty range.

The segment was identified as a three-way dip closure trapped against normal fault with good amplitude conformance and an accompanying CCR. Attribute analysis such as amplitude extractions and a series of amplitude versus depth plots were generated for the segment. These were then used to assess the possible depths of the GWC. An analogous offset well was identified, and rock property analyses were carried out on the well for use in the 2D model. The 2D model of the segment in a strike orientation was generated using similar frequency content as the real seismic data and compared with the initial observations to determine both the validity and depth of the CCR.

The analysis supported the use of the observed CCR as the GWC for the segment. The model observations had a high correlation with the real data. These observations were then used to determine a final GWC uncertainty range and better inform the technical risk profile of the segment. Key learnings on the frequency of data used and the importance of alternative datasets were highlighted as part of this study.

GEOSCIENCE & THE ENVIRONMENT



Tobago Main Ridge, now a UNESCO Man and The Biosphere Reserve.
Photo courtesy Dr. Adrian Tuitt, 2022

An Assessment of some Geological Challenges in the Implementation of a Carbon Capture, Utilization & Sequestration (CCS) and Carbon Dioxide Enhanced Oil Recovery (CO₂ EOR) Project in Trinidad

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Theme: GE: Carbon sequestration and storage

Key Words: carbon capture, sequestration, EOR, Trinidad

This paper intends to review some geological aspects of the recently announced mega plan by the Government of Trinidad and Tobago to conduct a Carbon Dioxide (CO₂) Enhanced Oil Recovery (EOR) project, utilizing emitted CO₂ to inject into previously producing reservoirs of some of Heritage Petroleum Company's fields, with the dual purpose of decreasing the country's CO₂ emissions, as part of the country's commitment to the Paris agreement and secondly to increase its oil production.

The importance of the geological aspects of this project can never be understated; both at the surface and sub-surface level. The review indicates that geology plays an important role in the design of the pipeline, its configuration to counter any stress brought about by earthquakes or slippages associated with swelling clay rocks and in areas of outcropping aquifers. It is evident that a detailed understanding of the surface geology of the area of the pipelines and the fields is necessary so that mitigation efforts can be developed prior to any large scale injection of CO₂.

The stratigraphic framework of the reservoirs as a result of their being more of structural complex than a genuine formation, as was previously interpreted, has implications for the performance of the flood as well as management of break-outs and micro seismic activity, which can result from the sealing capacity of the discontinuities between reservoir rocks and seals breaking down with increasing pressure of the displacing gas in the reservoirs. The structural complex nature of the reservoirs would also explain several anomalies that were observed in the pilot CO₂ EOR projects of the 1970s.

The critical importance of predicting the reservoir bodies, their orientation and discrete gross rock volumes, before any injection occurs cannot be overstated. Detailed simulation techniques in the discrete reservoir packages need to be employed so that the CO₂ flood performance can be monitored and changes, where required, can be timely addressed.

Finally, this project is driven by environmental concerns and leakages/blowouts as well as any release of anthropogenic CO₂ into the atmosphere are to be avoided. Remapping surface geology and monitoring of seepages will assist in identifying potential surface zones of weakness, which could develop into breakout zones once the CO₂ injection has reached certain pressure hurdles.

A Mission for Sustainable Energy - Harnessing the Energy of the Sun

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Theme: FG: Unconventional and alternative resources

Key Words: solar energy, renewable energy, sustainability

The climate change pandemic has affected the world long before the spread of the novel Coronavirus. Unquestionably, Trinidad and Tobago's economy has increasingly relied on Oil and Gas (O&G) for many decades, and the Southern and Columbus Basins are considered mature after many years of production. Our anthropogenic practices in the upstream and downstream energy sectors, coupled with our heightened dependence on these carbon-based resources, negatively impact the natural cycle of our environment.

In Trinidad and Tobago, this has resulted in our Small Island Developing State (SIDS) having the second highest global CO₂ emissions per capita in 2018. Renewable energy can, not only close the broadening gap in meeting the country's increasing energy demand but tremendously offset our carbon footprint. RESSCOTT Ltd. was founded in 2016 and is the only ISO 9001, engineering based renewable energy company that focuses on renewable energy. The company has offset the emission of millions of KgCO₂ annually across the oil & gas, petrochemical, manufacturing, commercial and residential sectors.

The engineers, solar specialists, entrepreneurs, environmental activists and energy management experts at RESSCOTT LTD aim to fulfill the government's target of energy and environmental sustainability. The use of carbon free energies in T&T have somewhat been impeded by some factors, namely the cost of natural gas electrical generation and national policy. To this end, the government should work with both the private and public sector and incentivize the use of solar energy through, inter alia, more tax credits for the sale of renewable energy, renewable obligation certificates and carbon credits. SIDS would be at the mercy of socio-economical factors due to climate change. The nation, therefore, must ensure that it rigorously and strategically achieves decarbonization targets and by extension, our climate change agenda.

Indeed, this climate change pandemic can be cured by the implementation of policies that would allow nations to meet their energy demands sustainably.

Historic and Recent Mud Volcano Eruptions in Trinidad, Impacts on Surrounding Communities

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Theme: GE: Geohazards and slope stability

Key Words: mud volcano, negative impact, fire

Mud volcanism in Trinidad extends from Pedernales in Venezuela into the Atlantic off the east coast. The activity primarily occurs to the south of the Central Range in formations dominated by thick claystones that were impacted by compression associated with thrusting, strike slip faulting and hydrocarbon generation.

Features associated with mud volcanism range from small vents to large cones and mud lakes. Activity ranges from a few gas bubbles, water and liquid mud oozing from vents and large pools to explosive eruptions lasting less than 5 minutes. The earliest record of activity was in 1821 in the Cedros area of SW Trinidad.

More recent eruptions in 2000 and 2001 offshore Chatham, Devil's Woodyard in 1995 and 2018, Piparo in 1997, Offshore Point Radix in 2006 and Tabaquite in 2019 have had some impact on their surrounding communities. These range from destruction of houses and roads, forest, crops or individuals not being able to access their property due to safety restrictions. Other negative impacts include, fire, offshore navigation hazards, gas and liquid hazards. One positive impact has been a constant stream of curious people who visit the mud volcanoes, some collecting mud for use as a beauty aid on their skin.

The Office of Disaster Preparedness and Management (ODPM), regional corporations and Ministry of Works have been coordinating responses to recent eruptions and activity. For example, in the Piparo area an evacuation plan was developed and warning sirens installed as part of an early warning system.

Integrating Water, Land and Ecosystem Management Approaches to Quarry Rehabilitation in Northeast, Trinidad

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Theme: GE: Geohazards and slope stability

Key Words: ecosystems management approaches, quarry rehabilitation, Trinidad

Land degradation caused by unsustainable quarrying affects more than 100 countries on all continents except Antarctica. Land degradation as a consequence of unsustainable quarrying has escalated in recent years in Small Island Developing States, leading to extensive and adverse environmental and economic effects. These unsustainable quarry practices, increase risk to vulnerable ecosystems and socio-economic development of territories.

The Global Environment Facility Small Grants Programme facilitated the four-year IWeco national sub-project. The IWeco sub-project employed an Ecosystem Management Approach that involved the delineation and assessment of baseline characteristics; explicit definition of intended management goals; adoption of temporally and spatially appropriate on-the-ground interventions; and identification of a socially appropriate model to facilitate linkages between social and environmental benefits. In addition, it allowed for the adoption of techniques to improve monitoring and evaluation, particularly regarding fulfilling the obligations of Multilateral Environmental Agreements.

The results demonstrated the holistic, inclusive and replicability of the Ecosystem Management Approach on the rehabilitation of 18 Hectares (Ha) of degraded quarry land in northeast Trinidad, in addition to three (3) demonstration and training sites, approximately 7.05 Ha in area and a nursery. Other project outcomes included evidence of replicability of rehabilitation techniques with two (2) privately operated quarries, each establishing 1- hectare pilot sites at their facility. A key outcome was also the production of the Quarry Rehabilitation Guidebook and Quarry Rehabilitation Training Manual - management strategies for public education and awareness and opportunities for carbon account training and institutional capacity building.

An Ecosystem Management Approach to sustainable quarry management is essential in the development of a robust rehabilitation plan. This innovative approach to quarry rehabilitation presented a paradigm shift that promotes ecological integrity and ecosystem functioning, livelihood opportunities and minimises the impacts of land degradation associated with unsustainable quarrying practices.

Managing the Transition – Getting CO₂-EOR to Pay for Future CO₂ Storage

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Theme: GE: Carbon sequestration and storage

Key Words: CO₂

The world will continue to need energy, and oil for manufacturing, but with less CO₂ emissions. An opportunity is to convert the cost of CO₂ storage into a benefit with increased revenue, looking at CO₂ utilization. For the oil industry this can be done with enhanced oil recovery, but this is a careful balance as the oil that has been enhanced will have been in contact with CO₂, so the produced oil may have more CO₂. The project needs to work without becoming a gas cycling scheme.

Conventional CO₂-EOR has been designed to minimize the use of CO₂ and maximize the recovery of oil because CO₂ is expensive. CO₂-EOR can also be used for the dual purpose of EOR and CO₂ storage. A study by the International Energy Agency (IEA) has shown that the profitability of conventional and dual-purpose CO₂-EOR is highly sensitive to both CO₂ and oil prices. Neither one is profitable unless the oil price exceeds \$50/bbl, regardless of the cost of CO₂. Therefore, it is unlikely that CO₂-EOR will be implemented in a low oil price environment, and a carbon emission tax or capture credit will make dual-purpose CO₂-EOR profitable at a lower oil price.

This paper provides an overview of carbon dioxide enhanced oil recovery (CO₂-EOR) and carbon storage and its ability to reduce greenhouse gas (GHG) emissions in oil production to meet the challenge of decarbonization. The simulation model evaluated different scenarios to assess options for improving throughput gas injection rates in the field and the efficiency for carbon storage.

Preliminary simulation cases suggest that FDP focuses on CO₂-EOR and storage strategy could be allowed to reduce GHG emissions; The estimated improved GHG emissions are around 6000 Kt equivalent CO₂ for the total Asset.

In the simple injection case for GHG emissions, simulation suggests the storage will be marginal because production rises after 18 months, and the CO₂ comes back from the reservoir. Injecting gas deeper in 6 new wells helps CO₂ storage, but the gas comes back from the reservoir; a production constraint is needed to control the CO₂ injection rates and reduces the facilities dimension, however a large facility for 7 Mscf/d is required.

The estimated CO₂-EOR incremental oil cumulative production range between is 22-93 Mstbo, which depends on the facilities, production constraints, and the amount and location of injector wells.

Small Island Developing States (SIDS) in the Zone Tropical and Plate Boundary Vulnerabilities Risk Multiple Hazards: Jamaican Case Study

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Theme: GE: Geohazards and slope stability

Key Words: tectonics, plate boundary, natural hazards, earthquakes

Tropical zone cities in tropics near active plate boundaries are undergoing urbanization at a rapid pace in hazardous/environmentally sensitive areas. Tropical zones and plate boundary countries landforms profoundly influence related geologic history and tectonic structure. Jamaica case study review SIDS in the tropical zone and plate boundary vulnerability of multi-hazard risk risk evaluation to recurrent natural disasters: geophysical, meteorological, hydrological, climatological and biological.

Jamaica SIDS tectonic location in the seismically active plate boundary zone, geographic location tropics in the path of storms and hurricanes which provide periodic heavy and intense orographic rainfall leading to water saturation of slope materials. Although landscapes are a major geomorphic process in Jamaica, being primarily controlled by the underlying geology and active tectonics. A majority of slopes are over 30° and are underlain by intensely jointed, faulted and weathered bedrock. Neotectonic uplift has enhanced chemical weathering and mass movements. The triggering mechanisms landslides include rainfall associated with tropical storms and earthquakes. Jamaica the mountainous landscape steep valley slopes are covered with colluvium, often fault controlled and deforestation as a result of large-scale human interference of slopes to facilitate agriculture, road building and housing needs. Slope movement in this area occur both in bedrock (deep landslides) and also in the colluvium that overlies deeply altered bedrock (shallow landslides). The landslide hazard is to a large extent a consequence of changing landuse. The capital city of Jamaica, Kingston Metropolitan Area (KMA) is located on the Holocene gravel fan of Liguanea at the base of the faulted mountain front of the Port Royal Mountains.

This paper reviews the status of Jamaica multiple natural hazards and risk, active processes-tropic-plate boundary zone, geomorphologic neotectonic landforms, geological history, tectonic and structural framework. Hazard mitigation understanding and application of the knowledge of the Jamaica island's geology and tectonic structure, geomorphology, Quaternary environments, hydrology, geotechnical characters of rocks and soils in planning land use and civil engineering design. Most of the baseline data have been generated by the local earth science and engineering communities. Priority disaster risk reduction (Sendai Framework Disaster Risk Reduction, 2015-2030) measures understanding natural hazards and disasters, resilience, preparedness and, in "Build Back Better" in recovery, rehabilitation and reconstruction.

The Exploration of the Role and Benefits of Solar Photovoltaic Energy Production in the Diversification of Jamaica's Energy Mix

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Theme: FG: Unconventional and alternative resources

Key Words: solar photovoltaic energy mix, Jamaica SIDS, greenhouse gases

Concentrated Solar Power or CSP is a Renewable Energy Technology (RET) approach with little research and impact in Trinidad and Tobago beyond rudimentary applications in food preparation and water purification schemes. The driving force behind this Solar Thermal Concept is direct and uninterrupted sunlight. This forms the basis of Solar Irradiance - measured solar energy hitting the surface of the earth per unit area. The latitudinal location (close to the equator) gives Trinidad and Tobago an uncanny advantage over temperate and polar regions.

The ability to harness this energy over a given area into a focal point can be accomplished by the unique shape of a parabolic dish. A repurposed parabolic solar cooker formed the backbone of the apparatus to test the suitability and scalability of a system to generate hot water for typical single-family households. Key measurements and readings include solar irradiance, ambient temperature, temperature of heated receptacle, time taken to boil and evaporate water etc which were taken over a 23-day period (17th November to 9th December 2021) during peak solar hours (10am to 2pm) for maximum effectiveness.

Several observations were made and key trends were established for this Design-Build post graduate thesis. The greater the solar irradiance the higher the temperature of the receptacle containing a specific volume of water at the focal point. The water would ultimately reach boiling point faster and evaporate quicker as well. The best day resulted in an efficiency calculation of 17.63%. Low solar irradiance from cloudy or rainy days rendered the experiment useless.

Still, the CSP hot water generator can potentially reduce or eliminate the use of conventional tank based electric water heaters where a typical 30 gallon heater accounts ~2.3 tons CO₂ emissions annually and takes on average \$1418 TTD per year to operate using 2021 TTEC electricity rates.

Vetiver Grass and the Vetiver System (VS) as a Green Infrastructure Tool

Author: ¹Jonathan Barcant

¹ jcb.vetivertt@gmail.com - Presenter, Vetiver TT Ecological Engineering Solutions Ltd, Trinidad and Tobago

Theme: GE: Geohazards and slope stability

Key Words: stability, water, resilience, vetiver, climate

Vetiver grass is a unique plant species which when applied correctly according to the Vetiver System (VS) approach can serve as a powerful bioengineering tool to tackle a wide range of soil and water related challenges. The Vetiver System (VS) can help with land stabilization, erosion control, infrastructure protection, soil and water conservation, topsoil regeneration, flood mitigation, water treatment and more.

Vetiver TT Ecological Engineering Solutions Ltd is a green engineering company which specializes in use and application of the Vetiver System (VS) along with other green infrastructure tools, to provide more cost-effective and greener solutions as compared with hard-engineered steel and concrete approaches. While many cases will still require these traditional methods, it is often possible to reduce the degree to which they are needed or to remove the need altogether in some situations.

Natural and softer-engineered approaches not only save money but are beneficial to surrounding ecosystems, and can be attractive for people as well. In this presentation you will learn about the Vetiver System (VS) as a green infrastructure tool, looking at its application on different sites around T&T and the Caribbean to serve a wide range of functions. The VS can also serve as a community and country development tool, to protect properties and public lands, and build resilience to many climate-driven challenges such as hurricanes, landslips and flooding.

The leaves and roots of the plant are also used to produce beautiful carbon-negative handicrafts. Vetiver TT and its sister organization IAMovement have worked also to take this knowledge to communities through the Vetiver Education & Empowerment Project (VEEP) model they developed in 2016/17. With support from the Ministry of Planning and Development's Green Fund and the IDB Lab, they have been working to take it to communities in need across T&T at the national level.

FUTURE OF GEOSCIENCE



2D Multicomponent Adaptive Focused Beam Migration

Author: ¹Chao Chen, Zhenchun Li and Jianping Huang

¹B19010033@s.upc.edu.cn - Presenter, China University of Petroleum (East China)

Theme: FG: Geophysical techniques

Key Words: multicomponent, adaptive focused beam

Gaussian beam migration based on ray theory is an imaging method with both computational efficiency, imaging accuracy and flexibility. However, the initial width of Gaussian beam has a great impact on the imaging quality.

The adaptive focused beam developed on the basis of Gaussian beam can adaptively change according to the local velocity field in the propagation process and has a small beam width on the whole central ray, which makes it able to adapt to the strong lateral velocity variation region and improve the imaging quality of complex structure region.

In this paper, we extend Wang(2015)'s method to multicomponent seismic data and present a multicomponent adaptive focused beam migration by modifying the propagator of Gaussian beam. According to Cerveny and Psencik(1983a,1983b,1984),we derive the adaptive focused beam formulas for elastic media. Then we use adaptive focused beam of elastic media to calculate the Green's function and the Claerbout's imaging condition to obtain images. This media can focus the reflected energy accurately, enhance the amplitude of middle and deep layers, improve the signal-to-noise ratio, and make the migration results clean and clear.

The model test verifies the correctness and adaptability of the method in this paper.

A Whirlwind Tour of Shell Seismic Technologies Employed in the NCMA Basin

Author: ¹Analiесе Ferreira, ²Nwenna Crooks-Smith, ³Faria Badhal; ⁴Michael Koop, ⁵Paul El Khoury; ⁶Henning Kuehl, ⁷Ahmad Zamanian, ⁸Satyakee Sen, ⁹Jorge De La Torre Guzman, ¹⁰Tom Merrifield, ¹¹Oriol Falivene, ¹²Neal Auchter, ¹³Patricio Desjardins, ¹⁴Pedram Zarian; ¹⁵Marianne Vissinga, ¹⁶Olga Rodina; ¹⁷Austin Boles, ¹⁸John Martin

¹aanaliесе.ferreira@shell.com - presenter, Shell Trinidad NCMA Asset Team, Trinidad and Tobago

^{2,3} Shell Trinidad NCMA Asset Team

^{4,5} Shell International Geophysics West Team

^{6,7,8,9,10,11,12,13,14} Shell International Digital Interpretation Team

^{15,16} Shell International QI West Team

^{17,18} Shell International Structural Geology & Reservoir Quality Team

Theme: FG: Geophysical techniques

Key Words: seismic reprocessing, seismic volume interpretation & technologies, portfolio maturation

NCMA prospectivity is highly seismic amplitude driven and uncertainties include reservoir extent, NtG distribution, saturation, and lateral and vertical reservoir connectivity. Multiple technologies were applied in this project to polarize Tobago basin prospectivity and de-risk key uncertainties.

This effort included the joint reprocessing of two legacy streamer surveys - NCMA-4 and Block 22. The seismic processing faced various challenges:

- 1) A streamer merge with different acquisition parameters, varying degrees of noise, feathering, and suboptimal fold coverage - especially for the shallow depths and small offsets.
- 2) Varying seafloor depth and surface related multiples with very short to long periods.
- 3) Overburden shallow gas with low seismic velocities and high absorption creating imaging challenges at the reservoir level.
- 4) Amplitude preserving, high resolution processing throughout as a prerequisite for subsequent QI and pre-stack amplitude interpretation. QI was integral to QA/QC at every key step, ensuring amplitude compliance.

An overview of the principal processing, model building and imaging steps that resulted in more reliable, higher resolution seismic images will be provided. With the reprocessed seismic as a backdrop, advanced volume interpretation workflows were utilized to support identification of depositional environments, quantification of the seismic response and establishment of acreage-wide prospectivity via a deep learning screening tool. Examples of these applications will be discussed in the context of assisting reduced cycle times for prospect maturation and portfolio generation.

This project demonstrates how leveraging Shell's toolbox of advanced technologies and working as a natural team across disciplines is the key to the understanding of subsurface opportunities and risks.

Angelin Fault Seal Analysis: A Case Study on the A Sand Hanging - Wall Trap Anomaly In FB4

Author: ¹Kareem James, Nirala Boodoo, Randy Partap

¹Kareem.James@bp.com - Presenter, bp Trinidad and Tobago

Theme: FG: Geological applications and workflows

Key Words: fault seal analysis, hanging-wall trap

The Columbus Basin can be described as a Pliocene/Pleistocene gravity driven extensional basin that is superimposed on a Mid Miocene foredeep basin. Traps are set up by the juxtaposition of the two main structural elements in the Columbus Basin - the NW-SE trending normal faults and the SW-NE trending anticlinal ridges. Most of the traps are fault-controlled accumulations. A plot of Column height vs Fault throws and SGR by Partap et. Al. 2017 shows an average column height range between 50 to 300 feet.

The Angelin field is in the northern catchment of the Columbus Basin and was discovered in 1971 with first gas in 2019. This talk aims to highlight the Angelin FB4 A Sand, a hanging- wall trap. Extensive fault-seal analyses have been done on the Angelin reservoirs, and the A Sand stands out as having a higher than average column height relative to the Angelin Field as well as the Columbus Basin fault-seal database. Building on earlier work by Gibson and Bentham 2003 and Partap 2017, possible reasons would be discussed in addition to why understanding this anomalous interval can be important to further development in this field.

Allan plane diagrams, triangle diagrams, cross plots (shale gouge ratio vs column height), spectral decomposition and amplitude maps were generated for the A Sand using existing well log and seismic data. The results were then calibrated to the Angelin fault- seal database as well as the wider Columbus Basin database.

It was found that this interval holds back a larger gas column height than expected. In addition, the trap is effective in FB4 but not in the adjacent FB3. These could be due to a combination of the following reasons: the proximity of the fault block to the shelf edge, the top of this sand has different petrophysical properties when compared to the rest of the sand, quality of the sand at the self- juxtaposition points, or there is a stratigraphic change in FB3 which can affect the sealing potential in FB4.

Integrated Machine Learning Unsupervised Log Facies and Seismic Facies Workflows to Delineate Stratigraphic Traps for Field Developments

Author: Stanley Wharton

stanley.wharton@subsurface-imaging.com, Center for Energy Resources and Digitalization Technologies, Subsurface Imaging Company Limited

Theme: FG: Geological applications and workflows

Machine Learning techniques in subsurface exploration have been employed for over twenty years to interrogate large, varied, datasets through use of various data conditioning processes, data manipulation techniques and Clustering algorithms. One Machine Learning technique, Unsupervised learning, is used to generalize the structure of subsurface data where no prediction is required. The relationships and trends can be further utilized for interpretation. Where large, varied, datasets occur, as in well log and seismic data analyses, these learning techniques can provide insights to enhance subsurface interpretation and to delineate subtle stratigraphic traps. Integrated Machine Learning Unsupervised log facies and seismic facies techniques are applied to an oil field characterized by a tidal depositional setting, with distributed hydrocarbon-charged reservoir units - oil filled, wet or with tar. The depositional setting transitions from a shelf into a deeper water basin defined by salt beds and consists of stacked hydrocarbon reservoirs with varying potential for stratigraphic traps. The techniques applied in the study include: - Definition of a seismic chronostratigraphy 3D model using a post-stack migrated 3D seismic volume to generate a series of stacked horizons for sequence stratigraphy interpretation seismic sequence definition. - Application of a horizon-based 3D seismic facies Unsupervised classification technique using neural networks for noise reduction and seismic facies map generation. - Application of a log-based facies classification technique using well-log elastic and petrophysical properties to define log facies for reservoir heterogeneity investigation. - Generation of Frequency Decomposition seismic attributes including geobody analysis to identify salt beds. The results of the integrated datasets derived from Machine Learning techniques provide indispensable information to generate a 3D Earth Model and to surgically map depositional sequences. The Machine Learning techniques may help with reducing exploration risk and identifying potential stratigraphic traps in field development settings.

Investigation and Analysis of Hot Water Generation Using a Modified Parabolic Solar Dish

Author: Stephen Jagdeo
sjagdeo@gmail.com - Presenter, UWI, St Augustine, Trinidad and Tobago

Theme: FG: Unconventional and alternative resources

Key Words: solar power, CSP

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The ability to harness this energy over a given area into a focal point can be accomplished by the unique shape of a parabolic dish. A repurposed parabolic solar cooker formed the backbone of the apparatus to test the suitability and scalability of a system to generate hot water for typical single-family households. Key measurements and readings include solar irradiance, ambient temperature, temperature of heated receptacle, time taken to boil and evaporate water etc which were taken over a 23-day period (17th November to 9th December 2021) during peak solar hours (10am to 2pm) for maximum effectiveness.

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Overcoming Governance Issues: Making Data Freely Available in Trinidad and Tobago

Author: ¹Helena Inniss

¹hinniss@kronusgsl.com - Presenter, Kronus Geological Services Ltd, Trinidad and Tobago

Theme: FG: Big data

Key Words: overcoming, governance, data

Typically, the role of any governing body with the responsibility for a country's petroleum industry is, inter alia, manager and regulator of all the data directly derived from the and long term preservation of data to be used for the stimulation of investment as well as scientific purposes. As investment within a country's oil and gas industry increases, so do the volumes and complexity of data.

An existing, efficient data repository is an attractive proposition to any company looking for new areas of investment, both upstream and downstream. However, the existence of a repository does not necessarily indicate ease of access. This relies on the rules and in the case of Trinidad and Tobago, only the regulatory body can set the rules governing access.

This paper will highlight some of the areas where simple rules and changes to law may assist in improving our competitive advantage in the natural resource business environment.

Qualitative and Quantitative Geophysical Data Integration for Better-Informed Decisions

Author: ¹Matthew Miller and Surender Manral

¹mmiller9@slb.com - Presenter, Schlumberger Trinidad and Tobago

Theme: FG: Geophysical techniques

Key Words: geophysical integration, reverse time migration, VIP gathers, inversion, colored stack

Integration of geophysical data throughout the entire lifecycle of an asset is a key enabler for commercial success. The integration of data throughout the project also allows experts from multiple domains to make both quantitative and qualitative decisions based on a multitude of data sources from various stages in an assets lifecycle. Both quantitative and qualitative integration of geophysical data on a shared earth platform is critical in planning wells and field development.

We integrated quantitative and qualitative geophysical data to get a better understanding of a subsalt target for comprehensive and accurate reservoir delineation. Vector image partitions (5D prestack gathers) produced from reverse time migration (RTM) allowed for improved interpretability of the reservoir by offering precise control of azimuthal and offset distribution for stacking. The 5D prestack gathers were used for qualitative visual inspection through interactive stacking followed by multi-attribute generation and analysis. Multi-attribute analysis (MAA) enabled working on several attributes simultaneously, thereby facilitating the integration of varied but vital information in an intuitive fashion.

The prestack workflows and detailed MAA produced the optimal image of the subsalt target reservoir and have significantly improved the illumination of the salt structure. Quantitative multidisciplinary data integration was accomplished through inversion followed by a Bayesian prediction workflow; this process was used to integrate well logs, seismic inversion, geological modeling, and interpretation. It provided an estimate of the most probable lithology/fluid and the uncertainty associated with the prediction.

The quantitative approach provided detailed insight into rock types, reservoir extents, and volumetrics and produced additional geophysical datasets that could be input to improve interpretation, generate pore pressure volumes, and help develop drilling scenarios. The integration of qualitative and quantitative data enables accurate reservoir delineation and reduces uncertainties, thereby supporting confident decisions.

Squeezing Every Drop Out of a New OBN Dataset (Columbus Basin, Trinidad & Tobago)

Author: Avinash Ramroopsingh

¹Avinash.Ramroopsingh@shell.com - Presenter, Shell Trinidad and Tobago

Theme: FG: Geophysical techniques

Keywords: OBN, Processing, Velocity,

In 2017, in partnership with Fairfield Nodal, Shell acquired the 1125Km² Flambeau Ocean Bottom Node 3D seismic survey over its East Coast Marine acreage to drive future investment decisions. Acquisition was completed in April 2018 and processing was accelerated to meet the business' demands with intermediate deliverables throughout the project and final data (Kirchhoff PSDM/RTLSOM0 PSDM) being delivered in February 2019. In the deeper section, the new data brought improved illumination of large structures where a complex velocity field, severe Q effects, steep dips, fault shadowing, diffraction effects and active gas migration are all in play. Residual imaging issues at depth, however, meant that confidence in prospect definition and relatedly operational safety to this uncalibrated stratigraphy remained low. A focused effort to further improve the velocity model, was kicked off six months after original data delivery. Work began in Q4 2019, and delivered by mid-March 2020, achieved image enhancement through the following: a smoothed starting velocity model derived from the original processing but with spurious areas edited and available well sonic data incorporated; more detailed velocity picking and residual move-out QC, possible given the smaller focus area; a linear delta starting model; further Q enhancement from QTomo; stacking of conjugate azimuths to increase signal-to-noise ratio; the use of Legacy Streamer data to constrain the velocity modelling, effectively increasing offset control in the dip direction for tomography; inclusion of fault boundaries in tomography constraint; three additional rounds of tomography. The outcome has led to a product with increased signal-to-noise ratio, enhanced fault definition, improved reflector continuity and a more geologically consistent velocity model for use in pore pressure prediction and rock property analysis. The results of this additional effort demonstrate the value of follow-on focused projects in the Acquisition, Processing, Interpretation, Re-processing cycle.

The Evolution of the Angelin Field Fault Framework, Northern Columbus Basin, Trinidad

Author: Alicia Bertie

alicia.bertie@bp.com - Presenter, bp Trinidad and Tobago

Theme: FG: Geophysical techniques

Key Words: Machine Learning; fault interpretation; well planning; OBC Seismic; reprocessing

The Angelin field was discovered in 1995 and is located on the shelf, offshore East Coast, Trinidad. The first phase of development in 2018 benefitted from a conventionally processed OBC survey, which was acquired in 2012. Shallow gas to the eastern part of the field, as well as complex faulting to the north, negatively impacted seismic image quality and led to two rounds of reprocessing which hoped to illuminate further infill opportunities. Updates to the structural framework are key to defining remaining prospects and the methodology has evolved along with the seismic data quality to provide an integrated product which incorporates best practice approaches and uses interactive machine learning to enable a faster output and more detailed results which adequately characterize subsurface uncertainty.

The improvement in our understanding was critical to delivering more robust structural interpretations, reservoir definitions and volumetric estimates to enable the progression of a possible drilling target in a previously poorly defined and unpenetrated fault block to the eastern part of the field. The new products are also immediately applicable for target and trajectory optimization work during well planning. Thus, the step change in our fault interpretation methods, which was driven by improvements in seismic data quality creates value through the life of the field and aims to maximize ultimate recovery.

Use of Satellite Imagery, Drones and 3D Models, as an Aid to Geological Field Mapping

Author: ¹Curtis Archie

¹curtis.archie@hotmail.com - Presenter, Consultant, Trinidad and Tobago

Theme: Other

Key Words: Drones, field mapping

In an era of COVID-19 lockdowns and other safety concerns, in person geological field mapping has become challenging, however technology has come to our rescue. In preparation for any trip, current and legacy, Google Earth imagery, field guides and other publications are examined to determine the location of any features of interest and their accessibility.

Where outcrops are inaccessible due to steep cliffs, rocky headlands, dense vegetation or even fences in the field, software such as Drone Deploy can be used to program a drone to take photos or video in these difficult areas.

When processed these photos can be output as an orthomosaic GEOTIFF, a relative elevation GEOTIFF or 3D model of the area. Examples from Anglais Point, Quinam Bay, Palo Seco Bay, Murray Trace and the mouth of the Ciperio River will be used to highlight the impact of these technologies.

SHORT COURSES




7TH GEOLOGICAL CONFERENCE OF THE GSTT | UPCOMING SHORT COURSE

Geoscience of the Future: Adapt. Innovate. Evolve.

SOUTH AMERICA-CARIBBEAN-CENTRAL ATLANTIC PLATE BOUNDARY:

TECTONIC EVOLUTION, BASIN ARCHITECTURE, AND PETROLEUM SYSTEMS



Professor Paul Mann
University of Houston



Dr. Tricia Alvarez,
Heritage Petroleum

July 7th, 2022

1-day Distance learning

\$ \$300 USD Professional Member
\$ \$400 USD Professional Non-member
\$ \$100 USD Full-time Students/
 Unemployed Grads (<2yrs)

In this one-day short course you will learn about new developments from tectonic and basinal studies in Trinidad and the south-east Caribbean region. Topics to be covered include plate reconstructions, outcrop studies, subsurface mapping with integration of well data, gravity modelling, seismic tomography and earthquake studies, and petroleum geochemistry. Lectures will be accompanied by hands-on exercises focusing on interpretation of seismic reflection images for structural types, timing of deformation, and delineation of hydrocarbon plays.

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7TH GEOLOGICAL CONFERENCE OF THE GSTT | UPCOMING SHORT COURSE

Geoscience of the Future: Adapt. Innovate. Evolve.

FAULT KINEMATICS



Randy Partap,
bpTT

July 8th, 2022

1-day Distance learning

\$ \$300 USD Professional Member
\$ \$400 USD Professional Non-member
\$ \$100 USD Full-time Students/
 Unemployed Grads (<2yrs)

This one-day course aims to give an understanding of the nature of faults and hands-on techniques for determining fault characteristics. The Trinidad and Tobago region sits on a plate boundary between the Caribbean and South American Plates. The tectonic history of the region has facilitated the formation of strike-slip, reverse and normal faults resulting in displacements in six basins in the region. Faulted anticlines are common trapping types in these basins. Consequently, an understanding of the geometries, networks and evolution of faults is key to future exploration, hydrocarbon production and carbon dioxide sequestration. The course will offer geologic methods to unravel fault networks, fault linkages, cross-cutting relationships and fault damage zones. Methods for fault interpretation, fault validation and fault timing will also be examined. In addition, the course, with the use of case studies, will introduce participants to fault seal analysis, structural restoration and techniques to resolve fault networks.

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Geoscience of the Future: Adapt. Innovate. Evolve.

7TH GEOLOGICAL CONFERENCE OF THE GSTT | UPCOMING SHORT COURSE

SUSTAINABLE ENERGY SOLUTIONS FOR SMALL ISLAND DEVELOPING STATES:

Trinidad & Tobago and the Caribbean




Dr. Adolfo Mejía Montero
University of Birmingham

 **July 9th, 2022**

 **1-day
Distance learning**

 **\$300 USD Professional Member**
\$400 USD Professional Non-member
**\$100 USD Full-time Students/
Unemployed Grads (<2yrs)**

In this one-day course, you will gain an integrated overview of the transition to sustainable energy in the Caribbean region. The course combines climate science, engineering, economics, and energy policy to provide insight into the technical and political solutions to the climate crisis. Real-world success stories will demonstrate viable options for a Trinidad & Tobago of the near future, and the roles that geoscientists, engineers, and policy influencers will play in this clean-energy scenario.

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Geoscience of the Future: Adapt. Innovate. Evolve.

7TH GEOLOGICAL CONFERENCE OF THE GSTT | UPCOMING SHORT COURSE

RESERVOIR MODEL DESIGN: HOW TO MAKE A GOOD RESERVOIR MODEL

It's not the software, it's the design!



Dr. Mark Bentley
TRACS Training and
Heriot-Watt University

 **July 14th - 15th, 2022**

 **2-day or 1-day options
Distance learning**

 **\$500 USD (Day 1 & 2) Professional Members**
\$300 USD (Day 1) Professional Members
\$600 USD (Day 1 & 2) Professional Non-members
\$400 USD (Day 1) Professional Non-members
\$100 USD Full-time Students/Unemployed Grads (<2yrs)

In this interactive course, you will learn about what makes a better quality reservoir model, whether you are using them, building them, or managing teams who make them. The course will address the common reasons for good and bad outcomes and how models add clear value to business decisions. Each participant will be introduced to the purpose of reservoir model design, followed by the four main areas on why many models fail and how to avoid them, including concept-based modelling, handling reservoir properties, scale and uncertainty. The course will be delivered in modules so that participants can opt for the full 2-days or 1-day only.

Dr. Mark Bentley, a renowned expert in reservoir modelling with 30+ years industry experience, Associate Professor at Heriot-Watt University and co-author of the popular book 'Reservoir Model Design' will facilitate the course. Any subsurface professional interested in learning more about reservoir modelling is welcome to join this course.

Day 1 - Introduction, Concept-based Modelling, Handling of Reservoir Properties
Day 2 - Handling Reservoir Scale, Handling Reservoir Uncertainty

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FIELD TRIPS

7TH GEOLOGICAL CONFERENCE OF THE GSTT | UPCOMING CORE WORKSHOP



STRATUM
RESERVOIR



Geoscience of the Future. Adapt. Innovate. Evolve.

MODERN COASTAL CLASTIC SEDIMENTARY DEPOSITS CORE WORKSHOP



The study of modern depositional systems around the world has underpinned our understanding of clastic environments. Trinidad's coastlines are characterized by numerous modern depositional systems such as deltas, estuaries, coastal lagoons, strandplains, beaches, and tidal flats. This core workshop will look at shallow sediment cores acquired across three of these systems: the Nariva River tidal inlet complex; the Erin asymmetric delta; and the Carli Bay tidal flats. It will examine their facies models, demonstrate the effects of mixed shoreline processes on their geomorphology and sedimentology, and discuss correlations with larger systems such as the Danube delta. Participants will be given a description of the coring methods and the opportunity to review the cores and apply quantitative classification methods.

📅 July 8, 2022

🕒 9am - 12pm
In-person

💰 \$40 USD

📍 Stratum Reservoir Trinidad Ltd.
Uriah Butler Highway,
Charlerville, Trinidad

👥 Trip Leaders:
Saeed Khan
Hasley Vincent (PhD)

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7TH GEOLOGICAL CONFERENCE OF THE GSTT | UPCOMING FIELD TRIP



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TURBIDITES OF THE ORINOCO HOW BIG? HOW WIDE?



On this trip, we will explore the south coast of Trinidad at Palo Seco Bay to discover the deepwater component of the paleo-Orinoco delta. We will observe the dominant sandy turbidite facies, their bed thicknesses, and the geometry of channels along both the upper and lower slope delivered by Cruse-aged shelf edge deltas. You will learn how these deepwater channels and associated channel-levee deposits change along the slope and the significance of delta topset regime to deepwater delivery. You will also gain insight to the reservoir quality of these deposits and whether we can find them across the Orinoco margin.

📅 July 9, 2022

🕒 10am - 11am
Online only

💰 Full Bundle Field Trips

\$100 USD - Professional Member

\$150 USD - Professional Non-member

\$75 USD - Students/ Unemployed

Grads(<2yrs)

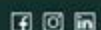
\$40 USD - Single Field Trip

👥 Trip Leader:
Ariana Osman

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7TH GEOLOGICAL CONFERENCE OF THE GSTT | UPCOMING FIELD TRIP



HISTORIC AND RECENT MUD VOLCANO ERUPTIONS IN TRINIDAD AND IMPACTS ON SURROUNDING COMMUNITIES



In the early morning hours of February 17th 2018, Devil's Woodyard erupted, and the arrival of daylight revealed dramatic changes to the area. Later, on September 23rd 2019, residents close to the Piparo mud volcano reported hearing a loud sound that shook their homes. Damage to nearby houses and roads in the area, the development of several large cracks around the mud volcano and the collapse of the existing large cone into a pile of bubbling mud were also observed.

Little however, has been said about changes in fault size, their orientation and density, location and numbers of active mud and gas seeps/vents/pools and the growth of the new cones. Google Earth imagery, drone geotiffs, 3D models and GPS data for the period 2018 - 2021 has been used to discuss any changes and trends to activity at Piparo and Devil's Woodward. Data from 2011-2012 will be compared to see if any similarities or differences exist between the two events and if there were any warnings of an impending activity.

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July 9, 2022
1pm - 2pm
Online only

Full Bundle Field Trips
 \$100 USD - Professional Member
 \$150 USD - Professional Non-member
 \$75 USD - Students/ Unemployed Grads(<2yrs)
\$40 USD - Single Field Trip

Trip Leader:
Curtis Archie

7TH GEOLOGICAL CONFERENCE OF THE GSTT | UPCOMING FIELD TRIP



TECTONOSTRATIGRAPHY OF TOBAGO AND IMPLICATIONS FOR SMALL ISLAND STATE DEVELOPMENT



In this virtual field visit we will seek to understand how the stratigraphy and structure of this beautiful small island developing state can provide benefits and challenges to sustainable living conditions to its people. You will learn:

- Regional setting of Tobago
- Description of the stratigraphy and structure of Tobago
- Neotectonics and seismology to understand geohazards
- Hydrogeology in Tobago
- Potential effects of climate change



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July 10, 2022
9am - 10am
Online only

Full Bundle Field Trips
 \$100 USD - Professional Member
 \$150 USD - Professional Non-member
 \$75 USD - Students/ Unemployed Grads(<2yrs)
\$40 USD - Single Field Trip

Trip Leaders:
Randy Partap
Adrian Tuitt (PhD)


7TH GEOLOGICAL CONFERENCE OF THE GSTT | UPCOMING FIELD TRIP

Geoscience of the Future. Adapt. Innovate. Evolve.

MIO-PLIO-PLEISTO-HOLOCENE NORTHERN RANGE

GEOLOGIC & GEOMORPHOLOGIC EVOLUTION:
RECENT ADVANCES



Participants will enjoy a virtual tour of Trinidad's Northern Range via dynamic 3D satellite scenes, as well as high resolution elevation, geologic, and geomorphic maps and color photographs.

The objectives of this field trip are:

1. To provide an overview of recent advances in understanding Northern Range geology and geomorphology
2. To review what these new data mean in the context of regional tectonic models
3. To review burgeoning efforts on what these data mean in terms of connections to the Northern Range biology

This field trip will integrate new findings and provide insight to the timing and spatial distribution of crustal deformation and geomorphic processes of the Northern Range from the Miocene to present. Our new findings include those from: 1) Raman spectroscopy of carbonaceous material, 2) apatite and zircon Helium thermochronology, and 3) terrestrial cosmogenic and optically stimulated dating.

July 10, 2022

**2pm - 3:30pm
Online only**

Full Bundle Field Trips

- \$100 USD - Professional Member
- \$150 USD - Professional Non-member
- \$75 USD - Students/ Unemployed Grads(<2yrs)

\$40 USD - Single Field Trip

Trip Leaders:

- Prof. Jenny Arkle, Augustana College
- Prof. John Weber, Grand Valley State Uni.
- Prof. Xu Chu, Uni. of Toronto

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