



THE HAMMER

The Quarterly Magazine of the Geological Society of Trinidad and Tobago | June 2015



Visit to the PGS Ramform Atlas

A BHP Billiton tour for geoscience students

**SCOTLANDS WITH PINDELL—
BARBADOS 20th CGC FIELD TRIP**

Ms Nishala Ramkessoon relates her adventure

20th Caribbean Geological Conference

'A collision of ideas to uplift our understanding'

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The **HAMMER** is the fellowship magazine of the Geological Society of Trinidad and Tobago.



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Xavier Moonan

The Executive of the Geological Society of Trinidad and Tobago (2014-2015)

- **Dr. Krishna Persad** (President);
- **Mrs. Kim Gillezeau** (President Elect);
- **Mr. Xavier Moonan** (Immediate Past President);
- **Ms. Helena Inniss** (Treasurer);
- **Mr. Ron Daniel** (Director);
- **Mr. Rashad Ramjohn** (Director);
- **Ms. Reshma Maharaj** (Director);
- **Professor Brent Wilson** (Director)

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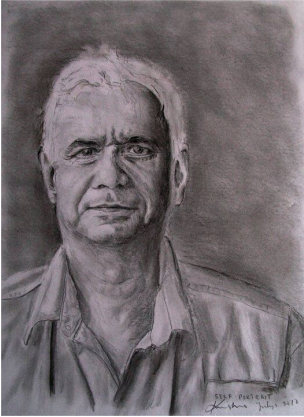
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ON THE COVER: A gas bubble escapes the main crater, Erin Bouffe Mud Volcano (photo by Mr. Sanjiv Samaroo, Petrotrin)



First let me apologise for the extended break we have had since our last Hammer. The GSTT strives to maintain a quarterly publication of the Hammer, but as you may know the 2014-2015 term entailed some additional features, which do not happen very often in Trinidad & Tobago. **IBA:** In April 2015, the GSTT co-hosted the AAPG Latin America and the Caribbean Region Imperial Barrel Award (IBA) Semi-Final. This is the first time Trinidad and Tobago was selected to be the venue for such an event. **20th CGC:** And as you all know, the GSTT successfully hosted the 20th Caribbean Geological Conference, 17-22nd May, at the Hyatt Regency, Port-of-Spain. This was by far the largest geological event that the GSTT has ever held.

But before I go any further, let me start by saying a heartfelt “Thank you” to our incoming executive for agreeing to serve the Society. As we all know this is a voluntary job and earns nothing more than a thank you...so it bears saying...and repeating. It is refreshing to see some new faces as well as to see a mix of youngsters with older heads. I particularly welcome those persons on the executive who are not citizens of Trinidad and Tobago. A different outlook is often very helpful.

It was clear from our retreat which was held in early November 2014, when we get a review of last year's activities and plan our programme for the next year, that 2015 was going to be packed with activity, not unlike our past few years. This year, 2015, however, was going to have a major added feature, which does not happen very often. This year the GSTT hosted the 20th Caribbean Geological Conference (CGC). In fact this is only the third time we have hosted this conference. The first was in 1965. The second was, if memory serves me correctly, in 1995.

I wish to talk about the first conference that we hosted in 1965. I use the term “we” loosely as the GSTT was not yet formed and while it was held in Trinidad and Tobago, the Committee comprised a mix of local geologists and those from other Caribbean countries, an arrangement that still applies. It was actually the 4th CGC and was held at the Trinidad Hilton Hotel during the break between the second and third terms of UWI Mona. (Yes, back in those days we still had terms not semesters! LOL).

Many memories have stayed with me from that conference as it was the very first geological conference I had attended. At the time I was a second year student at UWI Mona and was pursuing an Honours degree programme in Geology there. I am grateful to Texaco Trinidad, who had given me a scholarship to pursue these studies, for also agreeing to pay my airfare back to Trinidad and my registration fee for the conference. I will share two of these memories with you.

The first actually has nothing to do with geology or the conference. Just by coincidence the opening day of the conference was also the start of the first day of a test match between the West Indies and England. There was a break between the opening ceremony and the start of the first technical session in the afternoon, which was long enough for a person to go to the Oval to see the start of the match and most of the first session of play. So Dr. Tony Coates, one of my lecturers at Mona, and I decided to try out luck at getting in. When we got there the lines were long and all tickets were sold out. Unfazed we presented ourselves at the pavilion entrance gate, all dressed up in suit and tie. Tony who was a proper English gentleman with beard and moustache said in his best English Accent “Going there” and just pointed to the pavilion. To our surprise the policeman just waved him in. When he looked me I said “I am with him”. So he waved me in as well. So we watched the first ball from Wesley Hall and much of the first session of play ensconced in comfort in the pavilion.

The second memory was that of the intense rivalry between two groups of micro-paleontologists. The first was a BP Group comprised of Eames, Banner, Blow and Clarke. The second group was a Texaco Group led by John Saunders. The former group had just written a book entitled “Mid Tertiary Diastrophism in Northern South America” in which they used micro-fossil assemblages to document a major diastrophic event in the southern Caribbean area. There was some disagreement about this as other workers who based on evidence from Eastern Venezuela thought sedimentation to be continuous. They did not know it at the time, but that diastrophism was recording the eastward migration of the Caribbean Plate and its interaction with northern South America. It was not until years later that the term “Plate Tectonics” came into being.

To the best of knowledge I was the only student at the 4th CGC due to Texaco's sponsorship. I am pleased to state that the GSTT, along with Event and Diamond Sponsors BHP Billiton, Staatsolie and BPTT sponsored more than 90 students to attend the 20th CGC. For most this was their first conference and maybe like my 4th CGC experience, their first conference may very well be their most memorable.

Dr. Krishna Persad
GSTT President

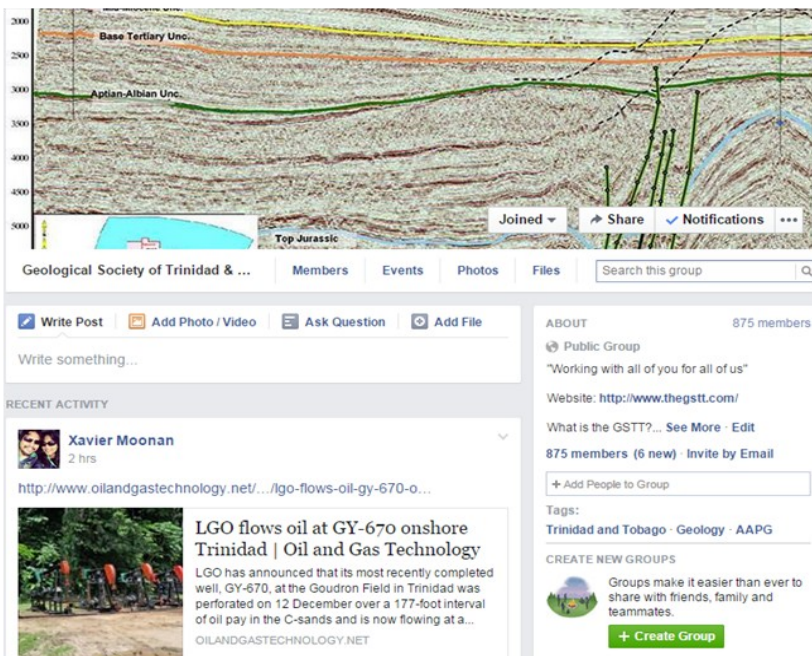
EAGE to collaborate on shale workshop in Argentina

Exploitation of Argentina's huge shale oil and gas reserves is promising to transform the country's energy and economic future. The prospect has provided the catalyst for cooperation between the European Association of Geoscientists and Engineers (EAGE) and the Instituto Argentino del Petróleo y del Gas (IAPG). The two organizations are collaborating for the first time to hold a highly topical workshop on *Geophysics for Unconventionals*. The event is scheduled for 3-6 November 2015 in Buenos Aires at the Alvear Art Hotel. The four-day workshop will discuss how the application of a range of geophysical methods and techniques can optimize the exploration and production of unconventional resources. EAGE is a long established, multi-disciplinary professional society with 18,000 members around the world, most of whom are associated with the oil and gas industry. EAGE's participation in the workshop means the organizing committee will be able to draw on the knowledge and expertise of a wide range of specialist geophysicists and engineers from both industry and academia worldwide.



For IAPG, involvement in the workshop fulfills its role as Argentina's key non-profit organization providing the country's oil and gas industry with technical, economic, legal, statistic and environmental support, including workshops, conferences and exhibitions. The geophysical solutions involved in the description, understanding and imaging of shale reservoirs are still evolving based mainly on experience in North America. The workshop is expected to focus on the advanced acquisition, processing and interpretation methods required, for example, for shale reservoir sweet-spot location, field development (well spacing, hydraulic fracture design, etc) and microseismic monitoring. In the Call for Papers, the IAPG/EAGE organizing committee is inviting oral and paper presentations under a number of topic headings: Seismic interpretation (including attribute analysis); Seismic reservoir characterization (including rock physics, elastic inversion and seismic anisotropy); Seismic recording and processing; Microseismic (surface and near surface); Well seismic (vertical seismic profiling); and Non-seismic methods.

The deadline for paper submission is 30 June 2015. Those looking for more information on this very promising event, either as contributors or attendees, should consult the Events page on the EAGE website, www.eage.org.



GSTT Facebook Update

Our GSTT Facebook group has grown tremendously over the years. From July 31st 2012, the group has grown from 300 to 875 members! Even our very own Minister of Energy, Hon. Kevin Ramnarine actively peruses and comments on the page. The page entails more than 700 annotated field photos, seismic and cross sections relevant to Trinidad, the Caribbean and northern Latin America. The page is quite dynamic, modern and easy to view. Check us out at: <https://www.facebook.com/groups/THE.GSTT/>

PEOPLE POWER



Ms. Sadie Samssoondar (left), Dr. James Pindell (centre) and Ms. Jenai Valadere (right) following their luncheon presentation at the 20th CGC.

Sadie Samssoondar's lifelong fascination for earth sciences and her concern with providing a safe and clean environment for the inhabitants of planet Earth has led her to this field of Geoscience. While reading a BSc. Petroleum Geoscience at the University of the West Indies, she has served as Vice President of the Society of Exploration Geophysics Student Chapter, and is a member of several societies and clubs including The UWI Women's Rugby Club. By nature she is vivacious yet sensitive, creative, and has a human-centred passion for helping societies. However her analytical and focused approach to work has resulted in a quest for new knowledge and research that is evident in her paper presented at the 20th CGC luncheon (See page 38).

Jenai Valadere has developed a love for outdoor activities and travelling through the years which has led to her love for Geoscience. The BSc. Petroleum Geoscience Unit at the University of the West Indies has allowed her to engage in these interests. In October of 2014 she was granted the opportunity, thanks to the GSTT, to attend the Latin American Region Student Chapter Leadership Summit in Lima Peru where she represented, U.W.I.'s AAPG student chapter. Jenai is also a part of the African Society at U.W.I and the Master's Training Program in swimming at the Centre of Excellence. She also holds a great appreciation for theatre having participated in several productions throughout the years. Jenai portrayed her knowledge and skill she developed throughout her degree as she presented her final year thesis project at the 20th CGC luncheon (See page 38).

GSTT at the 77th EAGE Conference & Exhibition 2015

The 77th EAGE Conference and Exhibition 2015 was successfully held in Madrid, Spain from the 1st-4th June, 2015. The conference once again proved to be the largest and most comprehensive multi-disciplinary geoscience event in the world. The event included over 1,000 technical oral and poster presentations – and a technical exhibition presenting the latest developments in geophysics, geology and reservoir/petroleum engineering.



The EAGE Board visits the GSTT Booth

The GSTT, as an Affiliated Society of the EAGE was granted booth space and full registration for our delegate for this conference. This year, we were well represented by GSTT Director Ms Reshma Maharaj (Geophysicist at Petrotrin). Ms. Maharaj

noted that the GSTT booth attracted a lot of attendees, ranging from Caribbean students pursuing higher education at European universities, to seismic acquisition companies interested in getting in on the Latin America / Caribbean hydrocarbon exploration frenzy.

The GSTT sincerely thanks the EAGE for this opportunity to market the GSTT, Trinidad & Tobago, and Caribbean Geology. We look forward to Vienna Austria, 2016!



MSc Students from Imperial College, UK at the GSTT Booth



Interbedded sands and shale (turbidites) of the Late Cretaceous-Paleocene Toledo Formation Belize.

In Belize, oil exploration efforts began in the late 1930s; however, it was not until 1955 that Gulf completed the first exploration well, Yalbac. Most offshore exploration in southern Belize was dominated in the 1950s and 1960s by Phillips Petroleum Co., which drilled eight wells, including the country's deepest, Palmetto Caye.

Esso followed in the late 1970s, drilling two wells onshore and one offshore. By the early 1980s, two more offshore wells were drilled by Anschutz. Marathon in 1985 drilled the latest of the offshore wells. Although all wells drilled in southern Belize have encountered encouraging hydrocarbon evidence, failure to establish commercial production may be attributed to insufficient depth to penetrate a sealed reservoir, drilling off structure, or a lack of trapping seals. Several surface indications of hydrocarbons have been reported in southern Belize. Possibly the most important is the oil seep near the Temash area. Marathon concluded from analysis of the oil that extensive biodegradation had occurred and a kerogen of dominantly marine origin had been generated. These oil seeps were encountered in Upper Cretaceous limestones on an east-west trending, intensively deformed, surface anticline.

The Esso Temash was drilled on a nose south of this structure but failed to test structural closure at the objective level. During the drilling, steep dips (30-50) were encountered, and slight to good impregnations of viscous, tarry oil were reported throughout the drilled, fractured limestone. Other surface hydrocarbon indicators in southern Belize occur in carbonate rocks of the Late Cretaceous-early Paleocene Toledo formation and consist of oil stained limestones or asphalt veins filling limestone fractures. (from <http://www.ogj.com/articles/print/volume-88/issue-34/in-this-issue/exploration/why-wells-have-failed-in-southern-belize-area.html>)



New Region Names Approved at AAPG House of Delegates Meeting

By Emily Smith Llinas (Latin America & Caribbean Region Programs Manager)

AAPG members in the Caribbean will now receive special recognition thanks to a bylaws amendment approved at the House of Delegates meeting held in Denver, Colorado, USA.

Nine delegates from Argentina, Brazil, Colombia, Peru, Trinidad and Tobago and Venezuela attended the meeting to support a bylaws change to formalize the name "Latin America and the Caribbean" for the area stretching from Mexico to the Southern Cone.

The AAPG Constitution and Bylaws Committee recommended changing the names of international Regions to reflect common use. Previously, the Region was called the "Mexican, Central American and South American Region."

The bylaws change passed unanimously.

For Region President Victor Ramirez, adding "the Caribbean" to the region name provides a formal way to recognize countries that are culturally and linguistically different from Latin American countries, and that also serve as key partners.



"The Caribbean has become a very important arena for economic growth in the region and must be seen as an integral part of its development," he said.

Krishna Persad, president of the Geological Society of Trinidad and Tobago, said the change reflects a reality both for AAPG and for the energy industry. "The Caribbean has become a strong area for oil and gas production and is set to become even larger and to persist for a long time," he said.

Xavier Moonan, Region delegate with Centrica Energy in Trinidad and Tobago, described the outcome as great news. "This solidifies the Caribbean voice in AAPG affairs and is testament to the steadily growing geoscience community in the Caribbean," he said.



Attendees check out the AAPG Booth at the 20th CGC, Trinidad & Tobago

Approximately 4 percent of AAPG members in the Latin American and Caribbean Region come from Caribbean countries, including Trinidad and Tobago, Jamaica, Barbados, Belize and Saint Martin. Many of those members gathered in Port-of-Spain in May for the 20th Caribbean Geological Conference, which drew 326 people from 65 companies and 26 countries for technical sessions, an exhibition, a Caribbean Plate Tectonics Symposium, two short courses and five field trips. Members from the University of the West Indies-St. Augustine Student Chapter and the Trinidad and Tobago Young Professionals group served as event volunteers and recruited new members to AAPG.

Moonan, incoming Region Treasurer for 2015-17, said he is excited about the momentum building in the Caribbean. "We eagerly anticipate more Caribbean-hosted AAPG events and will work hand-in-hand with our Latin American colleagues to support such growth," he said.

Activities under way include a Geosciences Technology Workshop in Port-of-Spain in 2016, the expansion of the Visiting Geoscience Program in the Caribbean and new AAPG Student Chapters in Jamaica and Suriname.

GSTT ELECTIONS

The GSTT conducted a successful elections at the Annual General Meeting on October 16th, 2014 at the Normandie Hotel St. Ann's. The positions of President Elect (Mrs Kim Gillezeau) and Treasurer (Ms Helena Inniss) were unopposed. There were seven nominees for the position of Director. Four Directors were voted in.



The voting results were as follows:

1. Mr. Rashad Ramjohn - 39
2. Prof Brent Wilson - 36
3. Mr. Ron Daniel - 35
4. Ms. Reshma Maharaj - 32
5. Dr. Ryan Ramsook - 31
6. Mr. Richard Coutou - 29
7. Ms. La Reine Williams - 19


As such the 2014-2015 GSTT Executive is as follows:

President - Dr Krishna Persad
President Elect - Mrs Kim Gillezeau
Immediate Past President - Xavier Moonan
Treasurer - Ms Helena Inniss
Director - Mr Rashad Ramjohn
Director - Prof Brent Wilson
Director - Mr Ron Daniel
Director - Ms Reshma Maharaj


The Geological Society of Trinidad and Tobago
presents the
Elected 2014-2015 Executive




Dr. Krishna Persad
President




Mrs. Kim Gillezeau
President Elect




Mr. Xavier Moonan
Immediate Past
President




Ms. Helena Inniss
Treasurer




Mr. Rashad Ramjohn
Director



Prof Brent Wilson
Director



Mr. Ron Daniel
Director



Ms. Reshma Maharaj
Director

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Geological Society of Trinidad & Tobago



In June 2015, GSTT Director Rashad Ramjohn accepted a foreign work assignment with BG Group. The GSTT Executive wishes Mr. Ramjohn all the best in this new chapter of his career. For the remainder of the 2014-2015 term, the GSTT Executive has appointed the runner up - Dr. Ryan Ramsook, to serve as a Director. We welcome Dr. Ramsook onboard and look forward to our membership's continued active participation in GSTT Executive Elections in October 2015.

COMING SOON!!



th Geological
Conference



of the Geological Society of Trinidad & Tobago *Working with you, for all of us*

2017



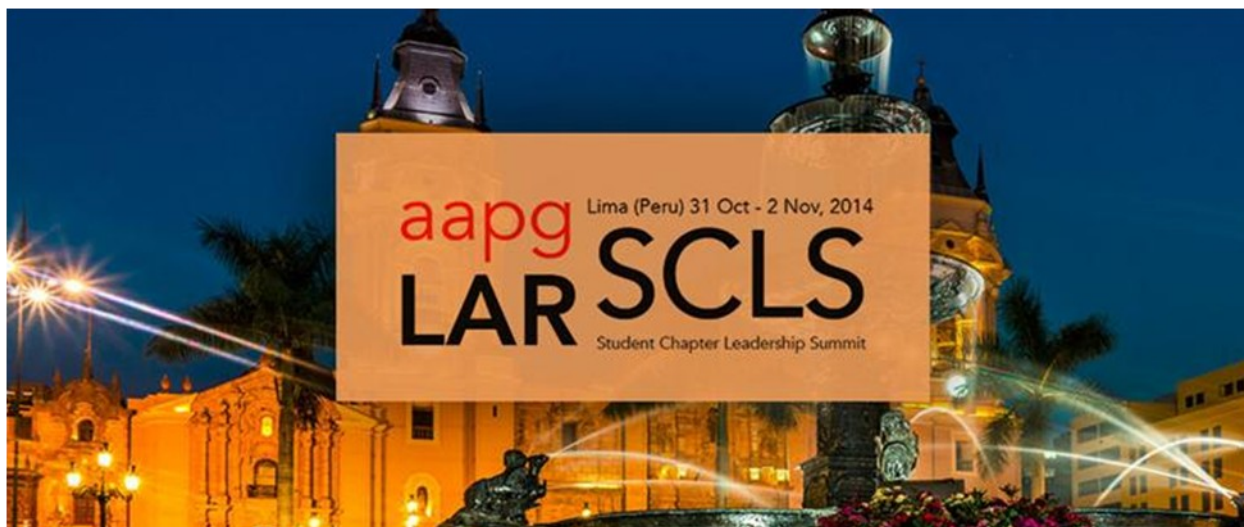
The American Association of Petroleum Geologists (AAPG) Latin America Section partnered with the Geological Society of Trinidad and Tobago (GSTT) to host the Imperial Barrel Award 2015 Semi-Final in Trinidad and Tobago. The Semi-Final took place on Friday 10th April, 2015 at BGTT offices, in Port-of-Spain. A total of 17 Latin American teams participated in a virtual round, with the top four teams advancing to the semi-final in Trinidad.

AAPG's Imperial Barrel Award Program (IBA) is an annual prospective basin evaluation competition for geoscience graduate students from universities around the world. University teams compete to win scholarship funds for their geoscience department and the international recognition that comes from competing or winning in the competition. The program is rigorous and contributes to AAPG's mission of promoting petroleum geoscience training and advancing the careers of geoscience students. In this global competition, university teams analyze a dataset (geology, geophysics, land, production infrastructure, and other relevant materials) in the eight weeks prior to their local competition. Each team delivers their results in a 25 minute presentation to a panel of industry experts. Students have the chance to use state of the art technology on a real dataset, receive feedback from an industry panel, impress potential employers in the audience, and win cash awards for their school. The judges will select the winning team on the basis of the technical quality, clarity and originality of presentation. The IBA is a hands-on opportunity for students to experience the creative process and the high-tech science that is the foundation of the Energy Industry today.

The GSTT was honoured to host yet another AAPG event in Trinidad and Tobago. In March 2014 the GSTT co-hosted a very successful AAPG Latin America Geoscience Technology Workshop titled 'Deep Horizon and Deep Water Frontier Exploration in Latin America and the Caribbean'. We have significantly strengthened the ties with AAPG and AAPG Latin America Region and continue to work closely with such international bodies to provide greater opportunities for our geoscientists.



(above) The Latin America Region IBA champions! - Mizael Bravo, Clara Brañar, Kristian Torres, Victoria Jimenez, Roberto De La Rosa and Sary Zambrano (advisor) of Simón Bolívar University, Caracas, Venezuela. (right) Sponsors of the AAPG IBA, GSTT IBA trip to Maracas & Las Cuevas, and the IBA Closing Ceremony at BGTT.



AAPG Latin America Region Student Chapter Leadership Summit by Barry Beckles, Jenai Valadere & Renelle Bascombe of the U.W.I AAPG Student Chapter

The Latin America Region Student Chapter Leadership Summit (LAR-SCLS) held in early November at the Peruvian Geological Society in Lima, Peru was an action-packed event. It brought together 45 students representing 20 AAPG Student Chapters from seven countries, plus representatives from Young Professional (YP) chapters in Colombia and Peru. Special guests included AAPG President Randi Martinsen, Secretary Richard Ball and Executive Director David Curtiss, each of whom delivered presentations and participated in activities throughout the weekend.

Travelling abroad is usually enlightening, and no less can be said for our experience at the Conference on both an academic and social level. From the start of the event we were given many interesting lessons. The conference began with a dinner in which we were addressed by the President of AAPG, Randi Martinsen. Her contribution stressed on the importance of our minds and being thinkers. She highlighted that our industry is built on ideas and thinking outside the box, particularly because it is a field built on research and discoveries. She also spoke again towards the end of the conference in which she focused on her experience as a female in the field of geoscience and having pierced through a male dominated profession.

Fellow colleagues, Jenai Valadere and Renelle Bascombe also expressed their delight in Martinsen's presentation. In describing her experience, Valadere said, "She (Martinsen) posed a pertinent question to the audience. From the back of the room, I jumped up and gave the appropriate response. So enthused was she, that she immediately walked down to me, took off her AAPG shirt which she was wearing at the time, and presented it to me as a prize for my answer. This was one of my most memorable moments. It gave me a sense of belonging to this Association and even to the geological world."

Additionally, several lectures and topics were discussed by professionals at the Geological Society of Peru, where we were introduced to the geology in the Wind Rover Mountain, Wyoming and Frontier areas in Peru. There was a session dedicated to Chapter reviews that allowed us to learn about the operations of each Chapter and the activities they partook in. The ideas shared could also be integrated into the operations of each Chapter. This proved to be extremely helpful since challenges that were faced were also expressed and members provided possible solutions and suggestions on how these could be solved. This forum also allowed for the expression of ideas for the improvement of AAPG as a whole. Personal development sessions were carried out and these were tied to the importance of using the mind to create and push the existing limits in our field.

We were encouraged to do important work and move out of our comfort zone. Although there was a high level of professionalism and formality, the icebreakers and activities introduced a lively and delightful aspect of the Conference. We were able to visit the local restaurants and dance clubs with all the members and get a taste of the Latin American culture. Even though the language barrier existed, it added some extra fun to the interactions and we were able to learn a bit of Spanish and Portuguese in the process. The participants were always intrigued when we began describing our culture in the Caribbean and we took this opportunity to invite them to attend and participate in the 20th CGC in May 2015 to experience the warmth of our culture and the hospitality of the people of Trinidad while stimulating their professional development.



Participants from Trinidad and Tobago with AAPG President. From left: Renelle Bascombe, President Randi Martinsen, Barry Beckles and Jenai Valadere.

In summary, Bascombe described the trip as having “...opened my eyes to the endless opportunities for work related travel available in this industry, something that I have always been interested in.” The experience gained from this trip was truly invaluable. It was a unique learning experience filled with many memorable and enlivening moments, truly a remarkable event.



Participants of the Latin America Region Student Chapter Leadership Summit (LAR-SCLS)



Representatives from Trinidad and Tobago. From left: Jenai Valadere, Barry Beckles, and Renelle Bascombe.

We would like to specially thank the GSTT and the AAPG Latin America region for providing us with this memorable experience. We will be forever grateful for the opportunity that you all provided.

GSTT on Youtube!



Geo's, The Geological Society of Trinidad & Tobago has launched its official Youtube Channel. This will serve as yet another platform from which we will be able to share geotechnical ideas and presentations with our colleagues and co-workers in Trinidad & Tobago and throughout the region. We have embarked on video recording our Technical Sessions as of October 2014, and discussions from field trips. We wish to sincerely thank the respective parties for allowing us to share these videos with the geological community. Check us out at: https://www.youtube.com/channel/UCH03DKweQ_WEEQj55kBsntQ



The Winning Team – GSTT Rocks!

It was a rollicking, frolicking evening of fun at the card tables in the quiet ambience of Petrotrin's Sports Club in Guaracara. Ah beg, take one, hang jack and bulleye's were the repetitive cry at the annual GSTT/SPETT all fours competition on October 5th. The competition got off to a late start but once the directive to deal was given it was dealing and wheeling all the way.

This was one of the closest fought competition in years with the margin of victory being a mere two (2) bullseyes. SPETT members (players) out-numbered their GSTT counterparts but being good sports that they were, they lent the GSTT some of their players to ensure a full compliment of participating tables. Lots of old talk, picong, good food and drinks were the order of the evening but in the end it was the GSTT that sneaked home.

Congratulations to all participants and supporters for a truly memorable event and congrats to Team GSTT. We look forward to 2015 for an equally competitive event. Kudos to the organizers (SPETT) for a job well done, we all wore white and it was only the logo's and two bulleyes that separated us.

GSTT Upcoming Events

Geos apart from our Monthly Lunch & Learn Technical Sessions lookout for announcements on the following GSTT Events:

AUGUST: GSTT Family Day

SEPTEMBER: SPE/GSTT All Fours Competition

OCTOBER: GSTT Annual General Meeting

DECEMBER: GSTT Annual Dinner Dance & Awards Ceremony

Nature's Balancing Act

IereEye@Gmail.Com

By: Dr. Junior Darsan



Manzanilla Sediment Plume

Sediment plume diverts northerly due to longshore currents along the N-S trending Manzanilla Bay, east coast Trinidad. The hills in the far left are the Middle Miocene limestones which occur along the SW-NE trending Central Range Fault. From this water divide, streams flow south and south easterly to the Nariva Swamp. This major catchment feeds the north to south trending 20-30m wide Nariva River which parallels the Manzanilla coast and is punctuated occasionally by easterly trending distributaries such as demonstrated in this photo. (from Iere Eye Aerial Photography)

Manzanilla Beach is part of a barrier beach system about 20 kilometres long located in Cocos Bay, embraced by two prominent headlands at Manzanilla Point and Radix Point, and separates the Atlantic Ocean on the east from the Nariva Swamp on the west. This "barrier beach" impounded the east-flowing rivers (L'Ebranche, Nariva and Ortoire) and created the extensive Nariva freshwater swamp - declared an international wetland reserve in 1993 under the Ramsar Convention (1988). Nariva Swamp is the largest in the country and home to a wide variety of flora and fauna (including the endangered West Indian manatee) and forms a distinct wetland ecosystem. The viability and longevity of this wetland depends on the maintenance of the Manzanilla barrier beach. It is on this barrier beach that the Manzanilla/Mayaro Main Road and other coastal infrastructure have been built and impacted by the recent flooding event. Manzanilla's coastline is constantly changing as it is exposed to the dynamic marine processes of the Atlantic. The underlying geology of Cocos Bay is composed of sediments which form a wide gentle low-lying plain.. The inherent geology as well as the high energy marine environment of the Atlantic have created conditions which promote coastal erosion. Because of the fairly low topography of the Manzanilla sand bar, with some sections below sea level, there is a threat that coastal erosion could breach the barrier beach.

There is also significant recorded erosion along several parts of the coastline in the vicinity of L'Ebranche Nariva and Ortoire River mouths - attributable to fresh water outflow and tidal inflow dynamics. At several points along Manzanilla Beach, the sand bar has been eroded from fresh water outflow and sea water inflow; creating points where salt water is able to directly penetrate and alter salinity in the Nariva Swamp (Environmental Management Authority 2001).

The flooding event

While the threat of coastal erosion and coastal flooding from storm surges exists, flooding from the swamp's freshwater discharge was not previously considered a high threat. Although documented cases of freshwater discharge flooding sections of the roadway has occurred in the past, it is evident that this event supersedes all previous occurrences. So what led to this extreme flooding event? Under normal conditions wetlands act as sponges that soak up, retain and slow the release of water. However, due to the prolonged and continuous rainfall that occurred, the hydrological capacity of the swamp was exceeded, resulting in large volumes of water flowing over the land surface. The water's flow was obstructed on reaching the barrier beach and forced to flow adjacent to the roadway, following the lowest elevation. This flow became channelled along the road resulting in severe erosion which undercut the road causing it to collapse. The water followed this new flow path and upon reaching topographic low points along the barrier beach, eventually cut channels out to the sea, which caused damage to property. The resultant communication disruption this event has created, will potentially have negative economic implications for the southeastern communities that have been cut off.

Rehabilitation: no quick fix

While there may be many issues surrounding what led to the event itself, at present, there are three pressing matters that require addressing. The first issue involves the reconstruction of the damaged portions of the Manzanilla/Mayaro Main Road in an attempt to restore connectivity between the communities to the north and south. The approach needs careful consideration of the environmental setting of the area. It is evident that a road diversion may be temporarily constructed while construction on the main road progresses. This temporary road however will have to be located some distance away and parallel to the existing collapsed roadway, closer to the swamp. This engineering would have to consider the effects of the hydrologic regime of the area, so that the natural delicate balance in the wetland is maintained. Consideration also needs to be given to the temporary construction of a seawall or similar type hard structure which might be used during rehabilitation of the main road. Seawalls and other hard structures reflect wave energy, and usually lead to adjacent beach erosion, which is of particular importance in this high energy marine environment. In this regard, the use of hard and soft approaches may yield more desirable results.

Secondly, the erosion channels cut across the beach by the flood waters have introduced a new twist to the flooding debacle. While these channels are allowing flood waters to drain out to sea, owing to the low topography of the channels, high tides have already begun dumping sea water into the erosion channels. If these channels are not repaired, then marine erosion will attack the breached sections of the beach, and induce further damage to the roadway. The question is whether repair to these channels should be allowed to take place naturally, or whether human intervention is needed. Improper engineering solutions can have serious negative implications for the barrier beach and the Nariva Swamp. It is imperative that credence be given to proper scientific understanding of the dynamism of this coastal area, instead of hasty reactive solutions.

The third issue relates to damaged property, and whether or not reconstruction should be permitted as opposed to establishing appropriate setbacks. Placed in the context of vulnerability, this is by far the greater issue that needs addressing. The environmental setting of Manzanilla makes it highly vulnerable to several natural disasters such as earthquakes, storm surges from hurricanes and flooding. The barrier beach upon which the main road and homes were built, is just a few metres above sea level (with some sections actually below sea level), and maintains a delicate balancing act between the Atlantic Ocean on the eastern side, and the freshwater Nariva Swamp on the west. The beach shifts its position from time to time in response to nature's forces. Historically, the swamp has flooded onto the barrier beach, and is nature's way of relieving itself of excess water. In the absence of human infrastructure, nature would undoubtedly repair itself over time, and these effects may have gone unnoticed. But, should these homes be reconstructed on the same sites where the effects of flooding have been witnessed? The reality is that the entire Manzanilla beach is vulnerable, and infrastructural development should not have been permitted in the first place, particularly along the sections below sea level. And, put in the context of climate change, these events would possibly become more frequent. Rather than simply adopting a reactive approach to these disasters, it would be prudent to start thinking along the lines of a national set-back policy, not only for coastal areas, but also for inland flood-prone areas, such as swamps and riverine settings. A setback policy would consider the vulnerabilities that exist in specific areas, and suggest an appropriate distance that infrastructure must be built away from the perceived risk.

These policy approaches should be informed by rigorous data collection and computer-based simulation modelling to account for extreme events that have longer recurrence intervals. Such approaches will prove to be more sustainable in the long term, and actually result in cost savings both in the public and private sectors.

Dr Junior Darsan is a coastal geomorphologist, Department of Geography, The University of the West Indies
Dr Matthew Wilson (hydrologist) and Hamish Asmath (PhD candidate) contributed to this article

U.W.I.'s Petroleum Geoscience Students Visit the PGS Ramform Atlas!

by Renelle Bascombe and Denielle J. Ferrier (Petroleum Geoscience Unit, UWI)



Have you ever had the opportunity to board one of the largest seismic vessels in the world?



Five students of the Petroleum Geoscience Unit of The University of the West Indies were offered this rare opportunity when BHP Billiton extended a kind invitation to host a visit to the PGS Ramform Atlas. On the day of the visit, 11th September 2014,

these students were given a safety induction as they arrived at Crews Inn's Captain Cabin. BHP Billiton stressed the importance of safety on the vessel and so provided each student with personal protective equipment for the duration of the tour.

"The Ramform Atlas is a site to behold! The vessel is like a hotel on water!" described one of the lucky students. This statement was made after the students saw the numerous relaxation rooms housed within the vessel.

The extraordinary vessel comprised of a helipad, sauna, gym, swimming pool, and a day room equipped with musical instruments, just to name a few, all for the crew's free use. In addition, it was a previous perception that the crew slept in cabins filled with bunk beds. However, they were astounded to be informed that each crew member on the vessel had his/her own single



cabin. Jenai Valadere, another student, stated that the Ramform Atlas made a career at sea seem very appealing and luxurious. The tour not only highlighted the recreational facilities but also made some emphasis on the seismic operations of Petroleum GeoServices, PGS. The group's guide gave brief explanations on the operations of the vessel and allowed them to view the seismic lines that were to be used in Trinidad's deep-water survey.

Unfortunately, they were unable to take pictures of them due to the unique setup of geophones and hydrophones. This unique setup was



characteristic of PGS and hence they would not want their competitors to gain knowledge of the way in which they do their operations. The group got to visit the room in which the acquisition of seismic data and the room where mammal monitoring was done. Technology in these rooms was far beyond advanced as they were constantly in awe. Attached are some pictures of the rooms housed within the vessel. At the end of the tour the students agreed that it was an eye opening experience, however, they knew and were warned not to expect this luxurious lifestyle on all seismic vessels.



Figure 3: Acquisition Room

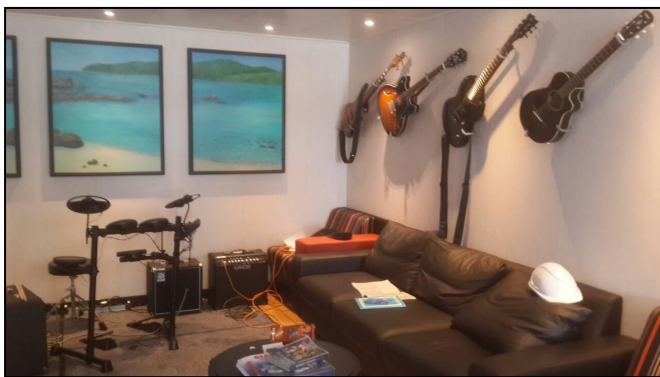


Figure 4: Day Room equipped with trap set, guitars and sofas



Figure 5: Helipad

Report of the Executive: Stewardship for the year 2013-2014

by Xavier Moonan GSTT Immediate Past President

Let me first take this opportunity to thank you all for your commitment and support towards the GSTT. We can surely be proud of a number of achievements over the last year, and I'm sure you will agree that we have a lot to look forward to. Motivated by our passion for geosciences, we strive to improve the Society in every facet year after year, and it's always good to reflect on where we have come from every now and then. We take this afternoon as an opportunity to reflect on the ups and downs of the Society over the past year.

The 2013-2014 Executive did not get off on our journey on proper footing as many of you know. We were short of a Treasurer and after numerous notifications to the membership we eventually established a full Executive by the end of 2013. We temporarily added the position of an Assistant Treasurer to support the Executive so that we could kick off full throttle from January 2014. And we did.. The biggest project for the 2013-2014 Exec was the execution of the AAPG GSTT GTW which was held in March 2014. This successful event saw 130 participants from 30 countries. We proved ourselves to the internationally recognised AAPG and plan to work with them to hold many more joint conferences in the future.

20th CGC: The GSTT's big project for 2015 may be the biggest project the GSTT will hold for many years to come. The GSTT will host the 20th Caribbean Geological Conference from 17-22nd May 2015 at the Hyatt Regency. It has been some 20 years since this conference was last held in Trinidad - and we all know that a lot has changed in the local and regional industry since. We have a very high powered Steering Committee comprising of the Outgoing GSTT Board members, the Incoming GSTT Board members and key industry personnel as well as regional researchers such as Dr Jim Pindell, Prof Grant Wach, Prof John Weber, Dr Lesli Wood, Prof Ewald Poetisi, Prof Paul Mann, Dr Grenville Draper, Prof Simon Mitchell, Barbados Division of Energy etc along with the likes of our very own Curtis Archie, Dr Hasley Vincent, Keisha Fletcher, Philip Farfan. Our call for abstracts closes on January 30th, 2015. The 20th CGC will comprise of three days of technical presentations, the second day focussing on a Tectonic Symposium led by Dr James Pindell and Dr. Robert Erlich. Five local field trips and 1 overseas trip to Barbados will be on the 4th and 5th days. Students will be eligible for sponsored registration, with preference given to students that are presenting at the conference.

Discussion Forums/Workshops: We continued with our revitalization of research geology by launching a series of Stratigraphic Renewal Workshops geared to establishing a new Stratigraphic Chart by 2017, and at the same time educating our members on the latest understandings of each basin, formation, member etc. The Stratigraphic Committee prepared a full proposal to Ministry of Energy for funding to undertake the necessary research to revise the Stratigraphic Chart of Trinidad and Tobago. The GSTT took the initiative to fund these workshops to get the ball rolling for this project. These sessions were held on Saturday mornings. One such session was held on San Fernando Hill and saw participation from Petrotrin, BPTT, Centrica Energy, Range Resources and UWI.

Publications and Website: The Hammer - not only did we resuscitate it, but thanks to the tremendous support from the membership we have had quarterly publications of the Hammer, each packed with lots of interesting articles. Kudos to Ms Keisha Fletcher for her excellent work as editor. We have begun updating our new website - www.thegstt.com and we receive quite a number of hits on a daily basis. For instance upon the release of the September 2014 Hammer - the Hammer was subsequently hit more than 400 times in three days...We are currently in the process of upgrading the website to accept online payment for membership and conference fees.

GSTT Home: With respect to establishing the GSTT Home a number of venues were explored. We were initially in talks with the Forestry Division and the San Fernando Hill Landmark to secure a plot of land on and adjacent to the Hill for the potential construction of the GSTT Home and Museum. We are currently in talks with Petrotrin to partner with the Petroleum Historical Society to re-establish the Historical Museum which may serve as a stepping stone towards our Society establishing its own headquarters.

GSTT Administration: I believe you can all agree that our current Secretariat Mr Keston Brown has made a very positive impact on our Society. Keston has now served for just over a year and has now been recruited on a full time basis. With his strong accounting background he has done a very good job in terms of cleaning up the books, assisting the auditors and ensuring that outstanding payments, fees, sponsorships for past events have been settled.

Technical Sessions: To date eleven technical sessions were held for the financial year 2013-2014, most were lunch and learn sessions, mainly held at the Arthur Lok Jack GSB to facilitate the student membership. The topics ranged from unconventional, core analysis, petroleum systems and deep water channels. Between the Technical Sessions and the Stratigraphic Workshops there were a total of 22 presentations available to every GSTT financial member. Going forward into 2015 we have begun video recording Technical Sessions to populate the GSTT's Youtube page.

Short Courses: Two short courses were held for the year 2013-2014. These were Fault Seal Analysis by Dr Tim Needham and Operations & Wellsite Geology by Kronus Geological Services. Both courses attracted quite a lot of attention from various companies but did not manage to attain the number of attendees we were hoping for. We have embarked on approaching Technical Chiefs in all companies to seek suitable Short Course topics for 2015.

Field Trips / Geotours: The annual visit by Dr Grant Wach and his students at Dalhousie University allowed us to jointly run 6 field trips in February 2014. We also ran a Northern Range field trip thanks to our Treasurer Sisnarine Seegobin and Anastasia Baboolal of UWI. But I must say our most epic field trip this year was the visit to Soldado Rock. It was the first ever GSTT field trip to Soldado Rock, but sadly it was not the most well attended. Again the Society has been plagued by last minute cancellations by attendees. The GSTT also ran another successful geotour to Angel Falls - I'm sure everyone would have read Ron Daniel's review of the trip. It's a wonder of the world in our backyard, and I hope this will encourage more individuals to venture with their family and friends to these places. We hope to visit the Merida Andes and Los Rocques in 2015. We also held a Down D Island geotour - led by Mr Curtis Archie.

Social: The GSTT held its Family Day at Saline Bay this year, with a bit of a curry cook off, a hike to start the day, kayaking to cool it off, topped off with afternoon drinks. Thanks to our Assistant Treasurer, the Family Day was a huge success. And on to even better news - led by our Secretariat Keston Brown we recently participated in our annual GSTT vs SPETT All Fours Competition. The GSTT emerged victorious after having lost the trophy three years consecutively. Kudos to those that came out and had a great afternoon with the SPETT.

Other Projects: The Geosigns project is still in pipeline (two geological signs to be placed on San Fernando Hill). This project also ties into the Stratigraphic Renewal Project as some of the stratigraphic zonations that will go onto the signs needs to be acceptable by the local geological community. Also a number of local and regional researchers have volunteered to support the material that goes onto the signs. We hope to have the signs installed before the 20th CGC. The GSTT Facebook page now stands at 830 members - many geos from around the region, and Trinidadian geo's in projects around the world. A total of 670 annotated geological photos have been uploaded, mostly on a daily basis, containing geological data/ideas/events/news from around the Latin America, Caribbean region.

In closing I would like to thank the members of the Executive, the numerous sponsors, the facilitators and you the members for your support to the Society. Almost everyone who has given of their time has a demanding 8 to 4 job and find it difficult at times to give of themselves. We want to acknowledge your sacrifice and reiterate that for us to progress there is need for sacrifice.

GSTT donates to the Moruga Museum



Dr. Hasley Vincent (right) presents a poster on the Moruga Delta to Mr. Eric Lewis (left) of the Moruga Museum. For more information on the Moruga Museum visit :

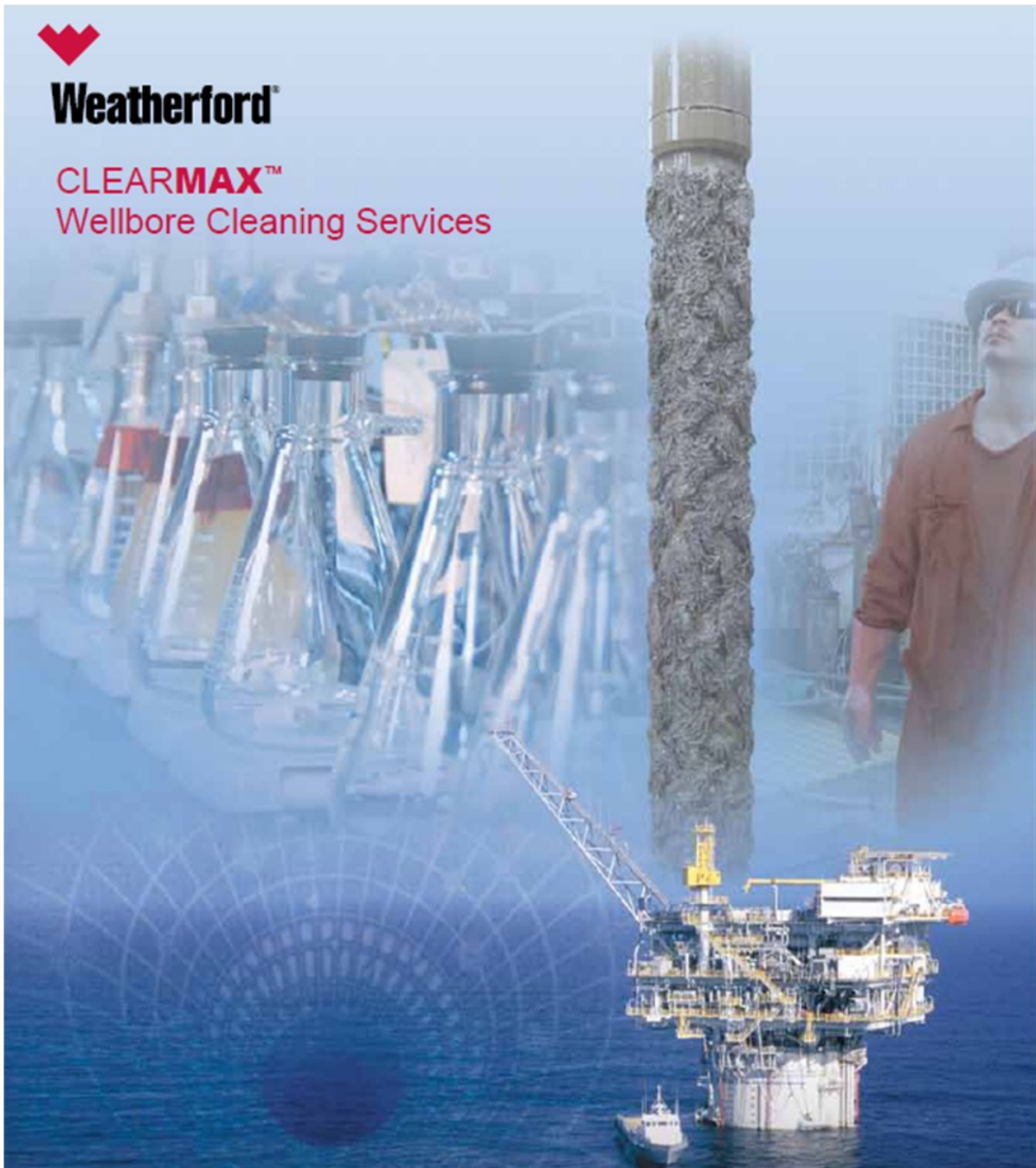
<https://www.facebook.com/morugamuseum?fref=ts>

During the 20th CGC Moruga River Delta field trip led by Dr. Hasley Vincent, Mr Richard Coutou and Ms Dana Tankoo, participants visited the Moruga Museum. The Moruga Museum was opened by Mr Eric Lewis in 2013. Fuelled by his yearning to preserve history, his personal collection soon grew to this establishment which promotes education on heritage, history and anthropology of the many civilisations that occupied the Trinidad and Tobago area. The GSTT donated a poster on the Moruga Delta to the Moruga Museum to educate visitors on geomorphology of the Moruga coastline. This poster adds to Eric's already growing rock collection, including ammonites from the nearby Marac quarry.



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20th Caribbean Geological Conference Review

by CGC Convener Xavier Moonan



17th-22nd May, 2015
Hyatt Regency Hotel



Working with you, for all of us

20TH CARIBBEAN GEOLOGICAL CONFERENCE 2015
Port-of-Spain . Trinidad & Tobago, W.I.

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'A collision of ideas to uplift our understanding'

Sponsors, Exhibitors and Participants!

I am very pleased to inform you that the 20th Caribbean Geological Conference (CGC) was a huge success. This historic conference, hosted by the Geological Society of Trinidad and Tobago (GSTT) attracted some 326 participants from 65 companies and 26 countries.

Caribbean Geological Conferences are usually held every four years at different locations in the Caribbean Region. Some twenty years ago Trinidad and Tobago hosted the 14th CGC. The 20th CGC was officially opened on 18th May 2015 by the Minister of Energy, the Hon. Senator Kevin Ramnarine and entailed a packed 3 days with over 90 technical presentations held at the Hyatt Regency, Port-of-Spain Trinidad.

The 20th CGC attracted sponsorship from a total of 17 companies throughout the region, with a further 9 companies utilising the Exhibition area. The GSTT also received conference tokens from Centrica Energy, Staatsolie, Baker Hughes, ION, CGG Veritas, Weatherford, RWE Dea, LandOcean and Tourism Development Company.

The GSTT coordinated 5 fully subscribed local field trips:

1. Moruga River Delta led by Dr. Hasley Vincent (BPTT), Dana Tankoo (Petrotrin) and Mr Richard Coutou.
2. Central Range, evidence for an early Tertiary Petroleum System led by Mr Philip Farfan (AGES)
3. Trinidad's Northern Range: reversal of fortune led by Prof John Weber (Grand Valley State University) and Ms Jenny Arkle (University of Cincinnati)
4. Middle Miocene Carbonates of the Central Range led by Mr. Philip Farfan (AGES) and Prof Brent Wilson (UWI, Petroleum Geoscience)
5. Mud Diapirs & Mud Volcanoes led by Mr Curtis Archie (Petrotrin)

and one overseas field trip to Barbados led by Dr. James Pindell and Dr. Rod Graham (Tectonic Analysis) and Mr Lesli Barker (Hydroterra).

Two fully booked short courses were also held during the conference days at the Hyatt Regency:

1. Recent developments in understanding the regional tectonics and petroleum potential of offshore Trinidad, Tobago Basin, Grenada Basin, Barbados Ridge and Orinoco Delta by Prof Paul Mann (University of Houston) and Tricia Alvarez (University of Texas at Austin).
2. Full Wave Inversion & Velocity Model Building by Dr. David Yingst and Dr. Ian Jones (ION).

We thank everyone for pledging their support to the 20th CGC, the GSTT and geoscience community of Latin America and the Caribbean. Undoubtedly, without such support this conference would not have been possible. For this the GSTT is truly grateful. We look forward to your support at our upcoming 6th Geological Conference of the GSTT carded for 2017.

The following 20th CGC documents are available for download:

20th CGC Conference Booklet

<http://www.thegstt.com/20th-caribbean-geological-conference/technical-programme/>

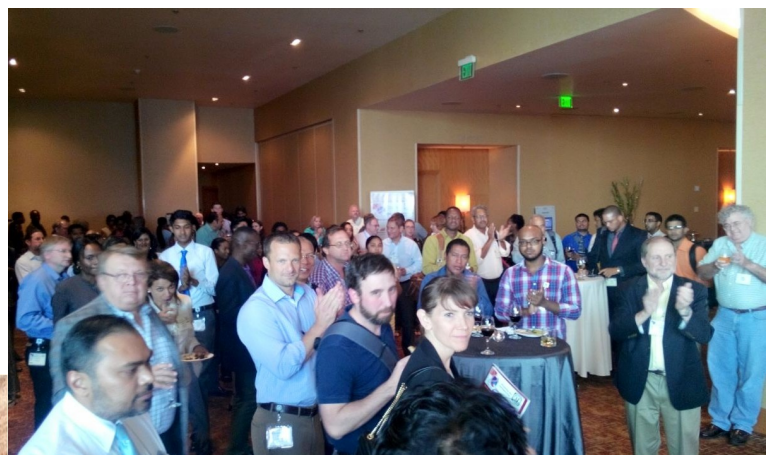
Field Guides

Barbados - <http://www.thegstt.com/20th-caribbean-geological-conference/barbados-field-trip/>

All Local Trips - <http://www.thegstt.com/20th-caribbean-geological-conference/local-field-trips/>



(Above) 20th CGC Participants visit the GSTT Booth; (top right) The Energy Minister, Hon. Kevin Ramnarine speaks with Prof Brent Wilson (UWI) during the tour of the Exhibition Area; (right) GSTT President Dr. Krishna Persad gives the Vote of Thanks; (bottom right) participants at the Closing Cocktails.



Got 20th CGC photos to share?
Email us at thegstt@gmail.com



Hyatt Regency, Trinidad venue for the 20th CGC



Surprise! Happy Birthday!! Jack up Rig Cake for GSTT President Dr. Krishna Persad



Student volunteers with Mrs Emily Llinas at the AAPG Booth



The Minister of Energy addresses participants at the Opening Ceremony

Northern Range Field Trip Group picture, led by Prof John Weber and Ms Jenny Arkle



Dr. Hasley Vincent discusses the longshore processes at the Moruga Delta Field Trip. Shallow Boreholes acquired were incorporated into the story of the evolving delta

Speech by the Energy Minister Kevin Ramnarine

20th Caribbean Geological Conference Hyatt Regency, Port of Spain May 18th, 2015

Good morning. It's good to be here at this 20th Caribbean Geological Conference that is being hosted by the GSTT. The upstream is the most important part of the country's economy. Your careers are all in the upstream. Without the upstream there is no Atlantic, no Point Lisas and no Refinery. We must continue to explore for more oil and natural gas to keep the economy moving along. Some people when they speak about the country's energy sector they only speak about Point Lisas others only speak about natural gas. It's a lot more than that. In the last four years, I would like to think that we have done a lot in the MEEA to stimulate the upstream and get it moving.

Upstream

In the years 2008 to 2010 data from the Central Bank show that there was a collapse in investment in the upstream sector. This is corroborated by the upstream companies. This was as a result of an atmosphere of uncertainty around the country's fiscal regime. For most of the last decade the industry and the then South Trinidad Chamber of Industry had been warning the then Government that failure to change the fiscal regime would have dire consequences. The warnings were not heeded.

In the first decade of this century there was a focus on something called "the demand driven model" of natural gas development. It is a fairy tale story that says that if you create demand, somehow magically supply will always follow. It does not always work. Many people do not appreciate the risk involved in finding oil and gas and seeing that to commercialization.

The result was that by mid-2010 there was just one rig working offshore. That was the Transocean Constellation One. There was no drilling in Trinmar and drilling on land was at a low. The upstream was stagnated.

Upon becoming Minister I set about to first listen to what the energy sector was saying. We introduced fiscal incentives that would re-start the upstream sector. There was resistance to that and there usually is resistance to any change. Fiscal incentives are but one component. The other has to do with the general atmosphere for investment. It had to do with the body language of the Government towards investors. We built bridges and we built trust. I understood that at the heart of decision making and allocation of capital was economics. If the return on capital did not meet the hurdle the capital would simply go elsewhere.

We signaled that we wanted investment to come back to the upstream and we committed to no increase in taxes or royalties. Indeed in the last five years there have been no new taxes imposed on this sector and no increase in existing taxes. We communicated that clearly and it gave companies the confidence to invest in what was a challenging environment.

In total, fourteen amendments were made to the Petroleum Taxes Act and the Income Tax Act. Changes were made to other items that did not require legislative change such as the rate of cost recovery in deepwater.

What are the results? Today there are seven rigs working offshore. In 2010 total rig days was 1132 by 2014 it had increased to 2443. In the first four months of 2015 Rig Days is 8% more than the corresponding period in 2014. Last week BP signaled its confidence in this economy by announcing the arrival of the Ocean Diamond Victory that will drill five wells in the Juniper development and then move on to drill the Savannah exploration well in 2016. It will be followed by the Angelin development. The remainder of the decade will be a busy time for BP.

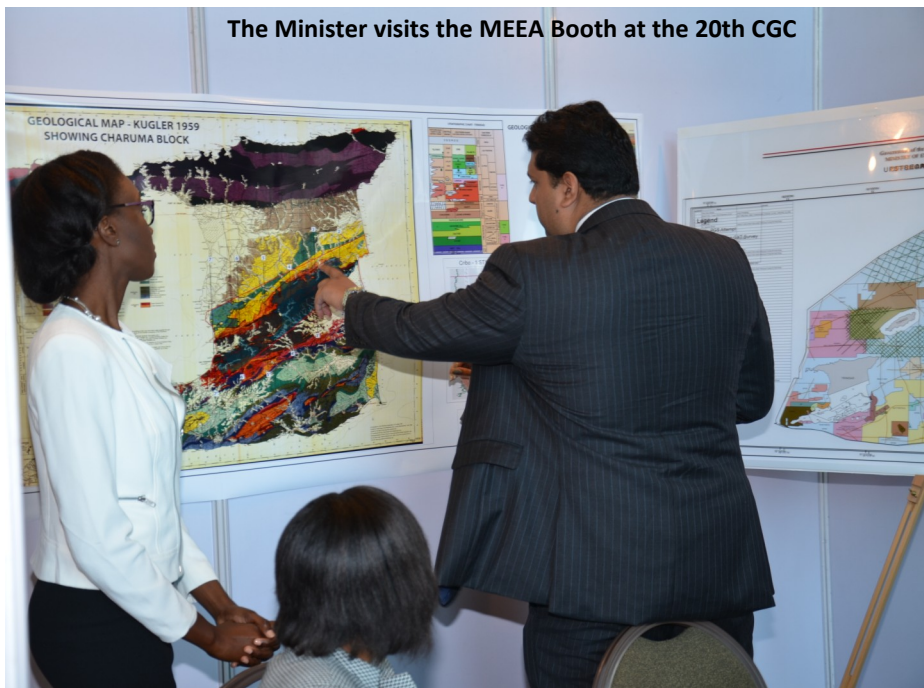
Another metric we can use to gauge activity offshore is helicopter flights. In 2010 between BP, BG and BHP there were 4369 helicopter flights. In 2014 that figure was 6953. This is a 59% increase in helicopter flights by these three companies. The trend continues into 2015 and this year may be the busiest ever for Bristow and National Helicopter. Therefore we can conclusively say that despite the drop in oil and gas prices, drilling activity in 2015 will be higher than in 2014.



BP is also moving full steam ahead with Juniper despite the challenges at TOFCO with industrial relations. Juniper is important for the country any delay on the project will impact on the schedule of the project and will delay the date of first gas. Any delay in the schedule of Juniper is not in the interest of the country. At a price tag of \$US 2.1 billion Juniper is the most expensive upstream development in the history of this country. Had it not been for policy intervention in the last four years there would be no Juniper and no deepwater exploration.

In total BP is expected to spend \$1.5 billion in 2015 in this country making that the highest ever capex by BP in a single year in Trinidad and Tobago.

BG will be investing in developing the reserves in Blocks 5C and 5D. Currently the company is drilling the Bounty Appraisal well in Block 5C and will thereafter drill an exploration well in Block 5C named Lobster. Both Blocks will require a new platform which we expect will be fabricated at Labidco. Later this year, BHP will be using the Rowan Joe Douglas later this year for the Angostura Phase III development and EOG is currently drilling in Oilbird.



Ladies and gentlemen, Ryder Scott has identified 151 prospects with an unrisksed mean volume of 39.9 Tcf. On a risksed (expected) basis this portfolio delivers 6.2 Tcf. Sixty four percent (64%) of these prospects are less than (200Bcf) on an unrisksed basis and when we risks these 151 prospects it 94.7% are less than 200 bcf. These small deposits, depending on their liquid content and distance to infrastructure may not justify exploration expenditure. A separate fiscal regime will be required to develop these small prospects. However we cannot ignore these stranded reserves. Poten and Partners have identified this as a key finding of the Natural Gas Master plan.

Geology of Deepwater

Let us start with optimism. I have never met a pessimistic geologist. I will treat

with two books. The first is "The Petroleum Geology and Geochemistry of Trinidad and Tobago" edited by Dr. Krishna Persad. The second is Oil, Gas and Beyond by Trevor Michael Boopsingh.

This is what Dr. Krishna Persad and his colleagues concluded:

"Our belief is that there are significant resources of oil and gas remaining to be found in the various geologic basins of T&T. The estimate by various industry professionals as well as that given by Ryder Scott report around 60 tcf of gas remaining is to our mind good if anything is on the low side. This includes the 30 tcf or so of proven, probable and possible gas already identified. There is probably another 2 to 3 billion barrels of oil yet to be found over and above which consist of already identified proven, probable and possible. In addition there is perhaps a further 3 billion barrels which is potentially recoverable using enhanced recovery methods like Carbon Dioxide."

The other book is from Oil to Gas and Beyond by Trevor Boopsingh and Gergory McGuire.

On page 232 of that book a well know local geologist Anthony Paul says:

"T&T stands at the gateway of one of the last unexplored deepwater extensions of a major river/delta systems in the world. Added to this it is the one with the most prolific hydrocarbon systems."

Oil has been found in the deepwater Gulf of Mexico related as it were to the depositional environment of the Mississippi River system. Oil discoveries in the deepwater off the West Coast of Africa are related to the depositional environment of the Niger River system. Oil discoveries in the deepwater in India the KG Basin is a product of the depositional environment created by the Krishna and Godavari Rivers. Oil discoveries in deepwater in Brazil's Foz do Amazonas is a product of the depositional environment of the Amazon River system. The deepwater depositional environment in T&T is a product of the Orinoco river system is

now being explored by BHP and its partners.

What we know is that we have some key geological ingredients. Firstly we have the depositional environment. Secondly we have the source rock in the form of the Cretaceous. Thirdly, the 2D seismic that was acquired in 2002, and re-processed in 2011, shows the existence of big reservoir systems and large traps. These two features would be easier to see and understand using the recently acquired 3D seismic which was of high quality and that has allowed for faster processing.

Finally we have the “Atlantic Mirror Theory” and this says that there are similarities between the deepwater Tano Basin in Ghana and the deepwater off French Guiana/ Suriname/Guyana. In 2011 Tullow and Shell created a lot of excitement when they discovered oil in the deepwater Zaedyus well and many believe that the Zaedyus discovery of 2011 proved the theory was correct. This month Exxon announced that they encountered hydrocarbons in Guyana’s deepwater. Our very own Krishna Persad sees Nigeria / Equatorial Guinea’s deepwater as a better analogue for Trinidad and Tobago’s deepwater.

Interestingly we have a deepwater campaign in 2001/2002 and it came out of the 1998 bid round. That campaign focused on the continental slope and found hydrocarbons (a working hydrocarbon 4 system) but nothing commercial. The same thing I am told happened in Nigeria. They explored the slope and didn’t find commercial deposits of oil and gas. Then they stepped out into the deepwater and they found hydrocarbons.

In T&T’s deepwater for the northern cluster of blocks these are expected to be on the same Oligocene trend as Angostura. For the southern cluster of blocks we will be looking for reservoir rocks in the late Miocene to early Pliocene plays in turbidite reservoirs similar to what obtains in Nigeria.

The MEEA in house estimates for deepwater oil potential range from a low of 3.1 billion barrels to a high of 8.2 billion barrels of oil initially in place (OIIP).

Interestingly, Anthony Paul concludes on page 229 of the book “From Oil to Gas and Beyond” that oilfields in the deepwater tend to be extremely large and have highly productive wells. He concludes with a profound prediction:

“The expectation is that T&T will discover several oil and gas fields in deepwater areas, with three to five giants and a few small one which together have the potential to deliver a country production of as high as one million barrels per day.”

In February of this year, BHP Billiton using contractor PGS completed a seismic survey over the nine deepwater blocks in an area of 20,199 square kilometers. That is four times the size of T&T. It is the largest seismic survey ever conducted by an IOC in the history of the oil industry. Next year BHP brings in the drillship the Transocean Invictus. BHP is looking for some big prizes in our deepwater and I am happy that the geological community is excited about this campaign.

We look too with interest at the recent signing of offshore licenses with the Barbadian Government with BHP Billiton and the announcement by Exxon of its discovery of hydrocarbons in Guyana. We stand ready to assist Barbados and Guyana in the development of their hydrocarbon exploration portfolio. Our vision is that T&T must be at the centre of this emerging Caribbean energy sector.

Heavy Oil Potential

Staying with upstream oil, I wanted to speak a bit to heavy oil resources and EOR. Presenting at the Heavy Oil Technology Conference in Alberta in July 2010 Professor Richard Dawe, Dr. Raffie Hosein and Wayne Bertrand stated that this country had 1.5 billion barrels of heavy oil in place on land and a further 3.6 billion offshore.

The Minister chats with Prof Brent Wilson (GSTT Director)



This is a significant resource that cannot be ignored. The potential of EOR to produce heavy oil in this country has never been fully realized and we believe that this has significant potential to increase oil production on land and in the Gulf of Paria. It is expected that the land based 3D seismic will be very valuable in planning future investments in EOR. Of course all investment is driven by economics and I suspect we would need better oil prices to justify investments in Heavy Oil / EOR projects. Nevertheless the potential is significant.

The Minister examines some rock specimens at the GSTT Booth



There is a major heavy oil opportunity on land in the Morne L'Enfer, Forest and Cruse reservoirs. The time is right at present for a major heavy oil thrust with the availability now of 3D seismic data over the heavy oil areas. The 3D seismic data has the potential to correct one of the main reasons for the many failed heavy oil projects in the past by defining the complex Geology of the heavy oil areas in the detail which is necessary for the design of a successful project. Such a thrust has to be supported by a new fiscal framework.

The Ministry of Energy and Energy Affairs when it signs Production Sharing Contracts provides for monies to be set aside annually by the oil companies for R&D. This money has never been used for its intended purpose of R&D related to oil and gas. I am pleased to announce that Cabinet has agreed to the grant of \$TT 4.5 million to UTT for two projects one to quantify heavy oil resources and another on using Carbon Dioxide from Point Lisas in EOR projects. You may recall that I recently went to Parliament and made public the findings of the Netherland Seawell audit of our oil reserves.

In the last five years we have laid a platform for the future of this country's energy sector. The exploration of the deepwater, the development of heavy oil resources, enhanced oil recovery and the commercialization of cross border reserves – all of which will feature in the next five years are part of what I have coined "the new energy economy".

I am happy that today you are recognizing Ken Birchwood and Barry Carr Brown two of the prominent geologists that have passed on. I have studied their respective contributions to the industry and in both cases it is significant. The baton is being passed to a new generation of geologist who will have to take us forward. I commend the GSTT and its executive on a successful and I think we all are looking forward to hearing what BHP has to say tomorrow.

Thank you.
Senator Hon. Kevin Ramnarine

Special thanks to the Event & Diamond Sponsors of this historic 20th Caribbean Geological Conference, Trinidad & Tobago, May 17th –22nd, 2015.

17th-22nd May, 2015
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The 20th CGC Experience!

by Dana Marie Jacob (WRA)

‘A collision of ideas to uplift our understanding’, appropriately themed for the recently concluded 20th Caribbean Geological Conference. The 20th CGC buzzed with activity over a week long period with the formalities hosted at the modern and exclusive Hyatt Regency on Trinidad’s Waterfront. The conference attracted the attention of Geosciences enthusiasts across the board and borders. From geophysicists to hydrogeologists to palaeontologists to petroleum engineers; there were exchanges of ideas among the geoscience minds especially between students and professionals.

Monday morning came with eager anticipation of attendees perusing sponsor booths and poster presentations. The conference promised to be an informative and interactive from the first morning. All the exhibition booths were very accommodating to demonstrate or further educate the conference attendees on their business and upcoming opportunities. Both the EAGE and AAPG booths captured much attention and invited interaction especially from students and young graduates who were very much intrigued with connecting to the wider geosciences world. The AAPG exposed attendees to the recent and future happenings of Latin America; the region to which Trinidad and Tobago belongs.

The GSTT ensured to warmly welcome all attendees as the host society for the 20th CGC. On display at their booth, were several exquisite rock samples from across Trinidad and Tobago. The throughout the conference, the GSTT executive ensured that attendees visited the booth not only for the pleasing goodies but to ensure that all attendees left the conference with more affiliations to the GSTT. The Minister of Energy, Honourable Kevin Ramnarine, graciously and addressed the conference at the opening ceremony itemising the importance of the oil and gas industry to the energy sector of nation. He showed a deep appreciation for the geosciences field who endeavour to explore and tap into the black gold of small island state.

Jenny Arkle’s presentation on the ‘Late Neogene-Recent Evolution of the Northern Range, Trinidad’ was notably captivating as it presented a fresh and recent perspective of the Northern Range evolution. Also notable was Randy Partap’s work on the ‘Caribbean plate evolution; Intra plate model observations and interpretation’. This topic area has attracted and continues to capture the attention of all Geosciences minded individuals especially in this region of the world. Curtis Archie’s brilliant illustrations and demonstrations on his and Nancy Gallai Ragoobar’s poster ‘Stratigraphic units in the North Marne area, how are they defined? What is the nature of contacts between them?’ was quite captivating as it usually spurred numerous questions.



Ms Dana Jacob meets Dr. James Pindell!

The conference was a first for many young graduates and students alike. It was the perfect opportunity to interact with professionals from all corners of the globe and exchange intrigues about the fascinating world of Geosciences. To many students, Paul Mann, Grenville Draper and James Pindell were celebrities! As a recent graduate, it felt like royalty to exchange banter with take photos with these notable names whose papers were major contributors to our understanding of Caribbean Geology.

Overall, the 20th CGC was a very successful exchange of scientific chatter and conference talks. Xavier Moonan must be recognised for his extremely hard work and professional presence working assiduously with all stakeholders to ensure the event was pulled off without a fault. The theme of the conference was indeed typified through the conference talks, posters and exhibitions as all attendees were on board to ensure that the conference was a resounding success. The closing ceremony concluded the formalities of the weeklong conference and ensured that everyone were in high spirits. The entertainment, sumptuous dishes and boozy blends ended the festivities nicely for all in attendance. The atmosphere was fitting for a ‘Trini closing’ as all would agree the 20th CGC was quite a success. Hats off or in this case, hammers up to the GSTT and the CGC committee for a job well done as we anticipate and even brighter 6th Geological Conference of the GSTT in 2017!

Want to share your 20th CGC experience?
Email us at thegstt@gmail.com

Petrotrin at the 20th CGC

by Karuna Moonan (Geophysicist—Petrotrin)

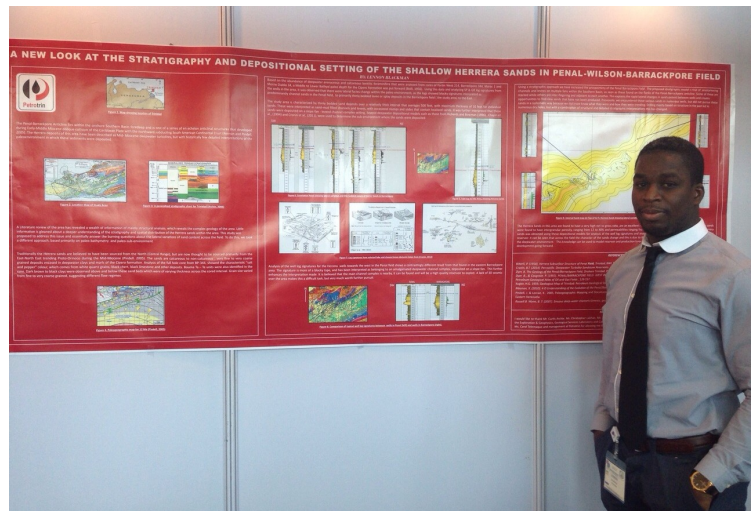
Petrotrin and its predecessor companies have always been avid supporters of these conferences and this year's was no exception. The Company joined local and international energy giants in sponsoring the 20th CGC and also supported the attendance of 28 Exploration and Production/Exploration and Development (E&P/ExD) employees, all whom participated in short courses and workshops, and attended lectures and field trips.

13 employees from Petrotrin's E&P/ExD departments rose to the challenge of presenting their work at the conference through both oral and poster presentations in the areas of: Micropaleontology and Biostratigraphy, Geology, Geophysics and Reservoir Engineering. These presentations were met with much enthusiasm from conference participants, which encouraged lively discussions, thereby enabling the sharing of ideas and much-appreciated recommendations for future work.

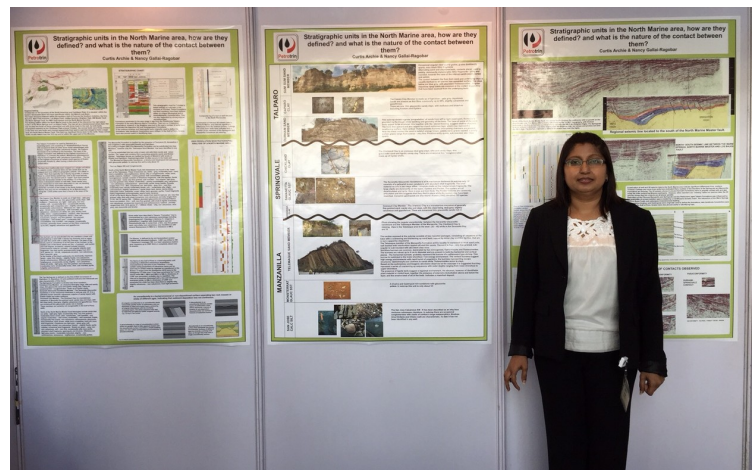
In addition to well-representing Petrotrin's technical capabilities; E&P/ExD employees also expertly demonstrated their creative talents and organizational competencies. Krystal Ramdin (Exploration Geophysicist) volunteered the ingenious theme of this year's conference: "A collision of ideas to uplift our understanding"; a fitting, geological metaphor which sufficiently captured the underlying challenge to all participants of the conference. Reshma Maharaj (Exploration Geophysicist) and Kim Gillezeau (Manager, Prospect Generation – Land) served diligently on the (2014-2015) GSTT Executive, and were heavily involved in the planning and successful execution of the conference. Mrs. Gillezeau effused; "The CGC exceeded my expectation for level of organization and commitment of the committee in the planning and execution, and the high standard of presentations and interest shown by attendees". Curtis Archie (Manager, Exploration and Geophysics) also served on the 20th CGC Steering Committee and successfully led one of the main field trips to South Trinidad's mud volcanoes.

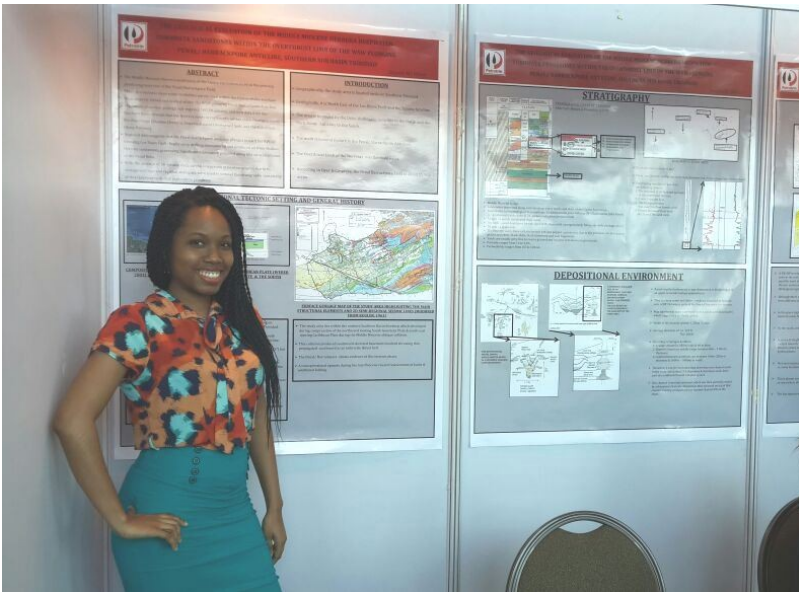


Karuna Moonan presents her study on the HGOR Area



(above) Lennon Blackman (geologist) presents his findings on the Penal/Barrackpore Anticline; (below) Nancy Gallai presents the stratigraphy of North Marine





Josanne McMillan presents her evaluation of the Mid Miocene Herrera turbidites of the Penal Field



Candice Richardson on the Northern Range Field Trip



(above) Therese Steel and Reshma Maharaj present their geological and geophysical planning towards drilling a horizontal well in Forest Reserve; (below) Karuna Moonan engages participants in discussion



(above) Petrotrin employees at the 20th CGC coffee break; (below) Candice Richardson with Dr. James Pindell & Dr. Rod Graham on the Northern Range Field Trip



20th CGC Barbados Field Trip



22nd –23rd May by Nishala Ramkesson (Petroleum Geoscience, UWI)

A petite island of approximately 431sq.km, Barbados basks in the glory of being one of the leading tourist destinations in the Caribbean. A short plane ride away from the Piarco International Airport, this Caribbean gem abounds with exotic locations, caressed by crystal clear blue waters and painted in tapestry of illustrious colours.

However, the true attraction for the group of geos who embarked on a two day field trip to this incredible island was its complex and intriguing geology. For those unfamiliar, the stratigraphy of Barbados comprises the Coral Limestone, the Oceanics, the Intermediate Unit and the Scotland Formation, refer to Figure 1. According to the Barbados Division of Energy, 2015:

- The coral cap ranges in thickness from 200 to 500 feet whereas the oceanic clays are generally 1200 to 3000 feet. These units are non-hydrocarbon bearing but act as an important seal for the reservoirs situated below.
- The Intermediate unit is considered to be a prism cover that was deposited on top of the main accretionary prism. This unit ranges in thickness from 200 to 2000 feet. It contains highly variable sands and is sometimes difficult to distinguish the difference between them and the underlying Scotland formation.
- The intermediates have not been subject to severe tectonics and are generally more predictable than the Scotland sands. They possess the potential for both structural and stratigraphic traps.
- The Scotland Formation is the deepest known producing unit in the stratigraphic column and is located in what is referred to as the Basal complex. It has been subject to severe accretionary tectonics and hence is structurally complex.

Perhaps the most striking and memorable moment of this two day escapade occurred at the Greenlands Shale Quarry, refer to Figure 2

Across steep gullies and up sharp inclines, nestled safely beneath the shade of a small plant, and surrounded by boulders, the group was greeted with the sight of black gold, refer to Figure 3 below. This small pool of oil which bubbled to the surface, livened the spirits of the group which had been traversing the terrain for some time before its discovery. Interestingly enough, according to the Division of Energy, Barbados does possess a history of oil production dating as far back as the eighteenth century where oil was collected from hand dug pits.

Further adding to this claim of oil in Barbados, rocks impregnated with oil were found along the Bath Cliffs Oceanics unit, refer to Figure 4 below. These rocks had the appearance of obsidian with the strong and distinctive smell of pitch, reminiscent of the Pitch Lake in La Brea, Trinidad.

Series	Stage	Zone/Formation
Pleistocene	Pleistocene/Corals	Reef, Coral rock
Miocene to Late Eocene	Oceanics	Oceanics
	Intermediate Unit	Upper Intermediate Shale
Intermediate Sands		
Lower Intermediate Sands		
Upper Scotland Sands		
Basals		
Middle & Lower Eocene	Basal Complex, Upper and Lower Scotlands, Joe's River and Basals	Upper Scotland Shale
		Joes River
		Lower Scotland Sands
		Lower Scotland shale

Figure 1: Stratigraphic of Barbados. Adapted from the Barbados, Division of Energy 2015



Figure 2: Greenlands Shale Quarry, Barbados.



Figure 3a: The oil pool which was discovered at the Greenlands Shale Quarry

Conclusion:

This two-day trip to Barbados proved to be a rewarding and fulfilling experience. However, much of the island's tectonostratigraphic evolution remains largely unknown and yet to be deciphered. Nevertheless, this trip has unveiled great promise for the future of the hydrocarbon industry in Barbados.

The GSTT sponsored Ms. Nishala Ramkesson's participation in the 20th CGC Barbados field trip as an award for attaining the 'Best Final Year Thesis Presentation, Class of 2015' from the Petroleum Geoscience Unit, UWI St. Augustine.



Figure 4 : Oil-impregnated rock found of the Bath Cliffs Oceanics.



Figure 3b: Oil – stained leaf from the Greenlands Shale Quarry.

(below) 20th CGC Barbados Field Trip group at Greensland Quarry; Field Leader Dr. Pindell lectures the group about the next stop



(above) Group discussion overlooking the east coast of Barbados; (below) Kyle Reuber (ION) looks at the spectacular Scotland turbidites



As Clear as Mud Volcanoes

20th Caribbean Geologic Conference Field Trip

by Sanjiv Samaroo (Exploration & Geophysics, Petrotrin)



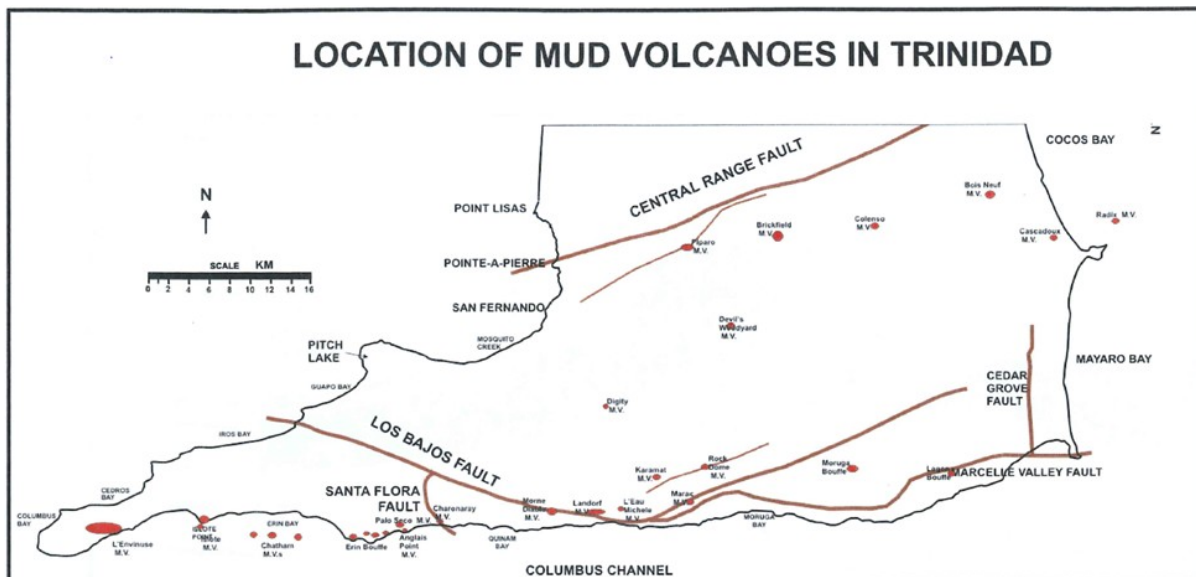
On Friday 22nd May, 2015, as part of the 20th Caribbean Geological Conference, a field trip was held which offered participants the opportunity to visit some of the active mud volcanoes located in southern Trinidad. The trip was led by Mr. Curtis Archie, Manager of the Exploration and Geophysics Section at Petrotrin, and was attended by a variety of participants including students, a university lecturer, and working professionals from Suriname, Jamaica, the USA and Trinidad.

The term “mud volcano” is generally applied to an eruption or surface extrusion of watery mud or clay, accompanied almost invariably by methane gas (Hedberg, 1974). These eruptions can be either violent or effusive, and commonly builds up a solid mud or clay deposit around its orifice which may have a conical shape. While in the past there have been violent eruptions associated with mud volcanoes in Trinidad, such as at Devil’s Woodyard in 1995 and at Piparo in 1997, participants of the trip took comfort in the fact that the volcanoes to be visited were known for eruptions of a more docile nature- characterized by a slow continuous release of fluids and gas.

The mud volcanoes of Trinidad all occur south of the Central Range / Warm Springs fault, and form three main groups based on their geographic location and the age of material ejected (Archie, 2015). The first group occurs in the Central Range area and erupts sediments mainly of the of the Navira Formation; the second group is found to the north of the Los Bajos Fault in the ‘Naparima fold belt’ and erupts material of the Cipero/Karamat Formations; while the final group is located to the south of the Los Bajos fault and erupts material predominantly from the Lower Cruse and Lengua Formations. These formations all consist mainly of thick deepwater claystones that were rapidly buried by Plio-Pleistocene deltaics, which led to the overpressures that help drive their mobilization. The field trip consisted of three main stops, each showcasing a number of different vents and cones. The first locality visited was at Erin Bouffe, the second at Beach Camp, Palo Seco, and the final one at Digits Trace, Penal (figure 1).

Stop 1 – Erin Bouffe

After driving down a long, narrow, bumpy road, and a short walk through an undulating wooded area, we arrived at our first stop - the spectacular Erin Bouffe. Here we were treated to the volcano with reportedly the widest cone in Trinidad, spanning about 15’ in diameter (figures 2 and 3). Surrounding this large deep main pool were a number of smaller vents and cones, all clearly displaying gas bubbles escaping at regular intervals. While over the past few years most of the areas of activity have remained fairly fixed in this area, we were told that new vents were reported to have emerged within recent months.



There was the distinct smell of hydrocarbons present around the vents, and every so often loud hissing noises could be heard announcing the escape of gasses from one vent or another. We were urged caution when walking near the edge of the main crater as it was known to be very deep (rudimentary tests with nearby tree branches confirmed that it was indeed greater than six feet deep), but we were also told that it was not uncommon for the more adventurous of visitors to have mud baths in the main pool, presumably trying to eke out any potential health benefits.



Figure 3. Collecting mud samples and attempting to determine the depth of the main crater at Erin Bouffe

A prominent feature observed stemming from the main pool was a long channelized active flow of mud down the eastern flank of the volcano (figures 4 and 5). Extruded mud that breached the crater flowed slowly and steadily down this feature, drying out along the way, forming layers of new solid material on the flank. It was at this location that we were introduced to the use of a possible ‘geobotanical indicator’ for locating mud volcanoes. It was pointed out that in the area, there was a strong correlation between the presence of mud volcano vents and a particular type of Bromeliad with a pinkish-red flower and serrated edges (figure 6). This was put to the test and sure enough wherever we encountered patches of the Bromeliads, a volcanic vent was found close by. No pebbles or boulders were observed at this site although these are commonly found surrounding other mud volcanoes on the island, and in the areas where the mud had been washed away, the terrain consisted of a grayish brown, powdery, silty sand.



Figure 4. Channelized mud flow stemming from main crater

Stop 2 – Palo Seco Mud Volcanoes

The mud volcanoes of Palo Seco consisted of a number of pools and cones of various sizes spread over a few acres (figures 7 and 8). The Palo Seco area lies near the crest of the Southern Range Anticline, and down dip and to the north, the Palo Seco Field is found which produces oil from as shallow as 500ft. The first mud volcano at this location was encountered after a short trek through a cool, forested path. Having stopped to admire exotic birds, wild orchids, and colourful spiders along the way, we knew we were upon the first of the mud volcanoes when we noticed a patch of spiky Bromeliads – the geo-botanical indicator. The mud volcanoes encountered on this stop were much like those seen at Erin, with gas bubbles emerging at regular intervals and eerie hissing noises piercing the quiet every so often. At the principal vent, which was about 12ft in diameter, a visible oil ring was observed at the edge of the crater and a sheen was noted in the mud within it. The strong scent of hydrocarbons again filled the air, and we were reminded to exhibit caution around the main crater as the depth of this one was thought to exceed 150’.



Figure 5. Channelized mud flow stemming from main crater

It was explained to us here that the gas being emitted was thermogenic in origin, and the analysis of noble gas radiogenic isotopes suggest that the residence time is shorter for the gas expelled by the mud volcanoes than for gas present in producing fields. This suggests that the gas is not coming from the nearby fields, but from the deep source rocks themselves. The gases that reach the surface contain mainly methane, with a very small amount of ethane. Two wells were drilled in the vicinity of the mud vents at Palo Seco in the 1940's, which encountered mainly claystones with minor sands, but these wells had to be abandoned as the presence of mudflows near the surface caused significant problems.

Figure 6. Bromeliad, used as a Geo-Botanical Indicator

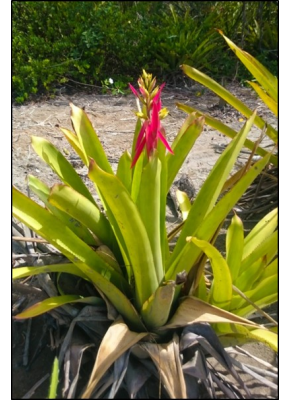


Figure 7. Main Crater at Palo Seco



Figure 8. Examples of smaller mud volcanoes encountered at Palo Seco



Stop 3 – Digity Trace Mud Volcano

The final stop for the day was at Digity Trace, Penal. The volcano here is nestled on top a small, breezy hill, surrounded by agricultural fields, and proved to be the easiest accessible for the day. The area has been developed as an attraction for locals and tourists alike, with paved roads leading to it and a picnic area set up close by. The main volcano here has a large classical cone shape, approximately 20ft high (figure 9). The volcano appeared to be inactive when we were there, with no liquid mud or gas being emitted, but we were told that activity is usually cyclic and increases in the rainy season. A small active vent was seen towards the base of the hill, a short distance away from the main crater, oozing liquid mud and with gas bubbles escaping.

The day was concluded with a short discussion of the presence and significance of mud volcanoes and mud diapirs in Trinidad's offshore acreage, and their impacts on oil and gas exploration there. Mud diapir bounded mini-basins exist in some of Trinidad's eastern deepwater blocks, and although some wells have been drilled in these mini-basins with little success, they have not been fully explored.

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The mud rich layers which feed the diapirism extend into the accretionary complex where they act as the primary detachment layer for its associated thrust faults. Whether or not these thrust faults involve the Cretaceous may introduce considerable risk associated with the migration pathway for hydrocarbons moving from the source rock to the overlying strata.

As we wrapped up, we were finally reminded that by observing the little gas bubbles escaping throughout the day, we were actually witnessing first hand, evidence of part of the working petroleum system that has served Trinidad and Tobago so well for so long. Staring into the mud, taking a final look at that last bubble of gas for the day, one couldn't help but imagine the journey those molecules of gas had taken - from their parent organic matter being deposited and buried deep in the subsurface, their very chemistry being altered under the burden of pressure, temperature, and time; to them being expelled and tenaciously migrating upwards against the force of gravity, along a tortuous path through thousands of feet and millions of years of strata; finally making it to the surface. We embarked upon the long journey home, our shoes a little muddier than when we started, but our minds a little less so.

References

Archie, C., 2015, Mud Diapirs, GSTT field trip Guide, 20th Caribbean Geological Conference

Hedberg, H. D., 1974, Role of methane generation to under compacted shales, shale diapirs and mud volcanoes. Bull.



Figure 9. Deep in discussion at Digity Trace Mud Volcano

EAGE at the 20th CGC

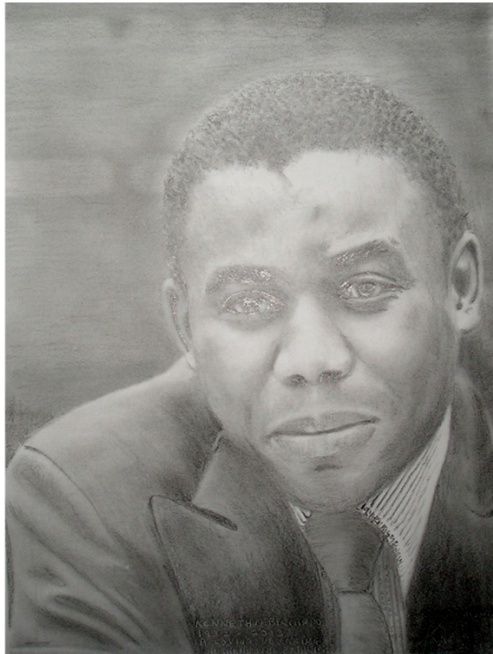


Historic has been the term used to describe the GSTT hosting the 20th Caribbean Geological Conference. But even more so was the active involvement of the European Association of Geoscientists & Engineers (EAGE). Ms. Alexandra Chroma, Manager of Membership and Cooperations Department based in EAGE Headquarters, The Netherlands, participated in the Opening Ceremony of the 20th CGC. This is the first time the EAGE has participated in a geological event in a Caribbean island. The EAGE further held an Exhibition Booth where Ms Chroma, advised conference participants on upcoming EAGE events and encouraged students to form an EAGE Student Chapter for Trinidad and Tobago. The GSTT is an Affiliated Society with the EAGE and our active involvement in the Caribbean Region, and by participating in EAGE Conferences, has encouraged the international geological societies to actively participate in our events. The GSTT thanks the EAGE for their participation in the 20th CGC and we look forward to their involvement in the 6th Geological Conference of the GSTT in 2017.

A Tribute to Regional Geological Stalwarts

20th Caribbean Geological Conference Hyatt Regency, Port of Spain May 17th - 22nd, 2015

The 20th Caribbean Geological Conference paid tribute to two regional geological stalwarts who have since passed on, Mr Kenneth Birchwood and Dr. Barry Carr-Brown. The main ballrooms for the 20th CGC were named after these gentlemen who both contributed tremendously to the developing geological sciences of the Caribbean region.



Portrait by Dr Krishna Persad (GSTT President)

KENNETH 'KEN' BIRCHWOOD

1932 - 2013

Ken was one of the great icons of our industry and the GSTT takes this opportunity to record some of his achievements:

CAREER

1960	B. Sc. Special Honours Geology Mc Gill University Canada
1960	Joined British Petroleum as Assistant Geologist
1967	Promoted to Senior Geologist
1968	Transferred to Trinmar as Chief Geologist
1976-1977	President Geological Society of Trinidad and Tobago
1979	Transferred to Trinmar as General Manager
1995-2001	Chairman of National Energy Corporation

While Ken Birchwood received many awards in his distinguished career, the most outstanding was being chosen in 2009 by the Ministry of Energy and the Energy Chamber as one of the forty individuals who had contributed the most to the oil industry in the first hundred years of the history of oil production in Trinidad and Tobago.

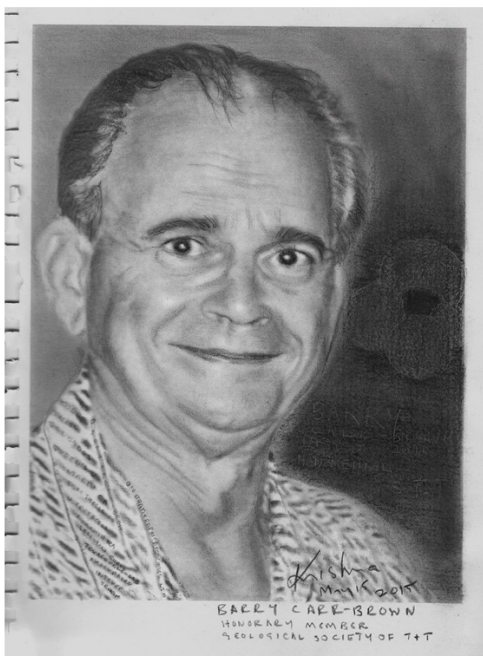
BARRY CARR-BROWN

1936 - 2011

Barry was one of the great icons of our industry and the GSTT takes this opportunity to record some of his achievements:

CAREER

- Graduate thesis on Upper Cretaceous foraminifera
- First worked at Shell Trinidad, as an exploitation engineer
- 1965 - Joined the Texaco Geological Laboratory to work in biostratigraphy
- 1968 - Joined Pan American Oil (later Amoco) as Palaeontological Group Leader, working on the Columbus Basin
- Developed the company's foraminiferal zonation while collaborating with Amoco's Gulf Coast Paleontological Group to compare stratigraphic and palaeobathymetric ranges of the taxa of both regions
- 1980 - Moved to INTEVEP, Venezuela
- Manager of the BioStratigraphics Unit of McClelland Engineers
- Geological Services Superintendent with TRINTOC
- 1990 - Established Biostratigraphic Associates (Trinidad) Limited



Portrait by Dr Krishna Persad (GSTT President)

Was a fellow of the Geological Society (London) and an Honorary and Founding Member of the Geological Society of Trinidad and Tobago

High resolution benthic foraminiferal ecostratigraphy of the Cipero Formation, Trinidad

by Sadie Samsouandar¹, Jenai Valadere¹, Brent Wilson¹, Karuna Moonan² and Xavier Moonan³

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² Petrotrin: Exploration & Geophysics Department, 1 South Street, Petrotrin Camp, Pointe-a-Pierre, Trinidad

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The south easterly verging Early to Mid- Miocene La Fortune Anticline plunges into the Oropuche lagoon along the NW-SE trending Godineau tear fault at South Trinidad. This anticline is well known as the prolific playground for Early Miocene ‘Retrench’ deep water sand-rich turbidite member of the marly Cipero Formation. Though many wells have penetrated the Retrench Marl throughout the Southern Basin, the benthic foraminiferal ecostratigraphy of this radiolaria-rich member is currently unknown. A 4 m section exposed by excavation along the La Fortune Anticline was sampled in the summer of 2014. Twenty samples were recovered from it. They were washed over a 63 µm mesh to remove silt and clay, gently dried, and 250 – 300 benthic foraminifera (*N*) picked and sorted into species from each sample.

The planktonic foraminifera were examined to verify the age of the outcrop. The data acquired were compared with comparable data from the calcareous Princes Town Member (*Catapsydrax stainforthi* planktonic foraminiferal Zone, N6) and the Upper Cipero Formation (*Globorotalia fohsi robusta* Zone, N12). The lowest sample at the La Fortune anticline contained the planktonic foraminifera *Praeobulina circularis*, indicating late *Praeobulina glomerata* through *Globorotalia fohsi peripheroronda* Zone (= late N8 – N9) which is now placed within the early Middle Miocene.

A total of *N* = 4338 benthic foraminifera were picked and counted from Zone N9, of which 149 species were identified. Few species were common with only 8 species > 3% recovery of all the specimens picked. The single most abundant species was *Planulina wuellerstorfi*, and subdominant species *Oridorsalis umbonatus* with recoveries 20.8% and 1.7% respectively.

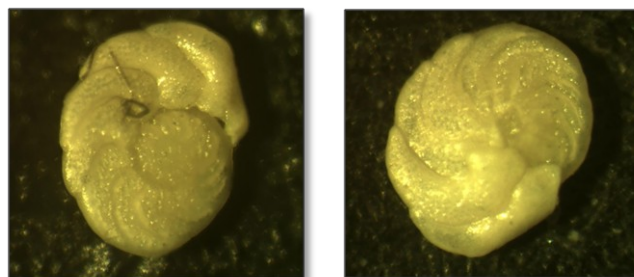


Figure 1 – The two images above are digital photographs of a *Planulina wuellerstorfi* specimen recovered from zone N9.

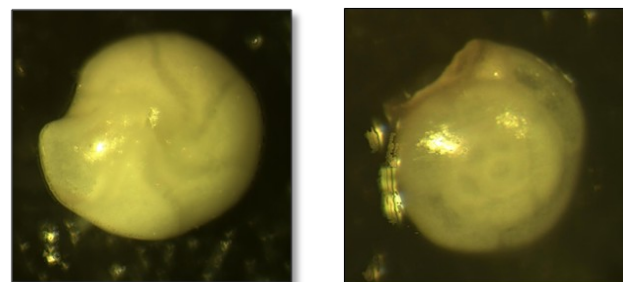


Figure 2 – The two images above are digital photographs of a *Planulina wuellerstorfi* specimen recovered from zone N9.

P. wuellerstorfi is characterised as being a generalist species with a wide ecological niche. It is cosmopolitan in the deep sea, where it is adapted to environments with a relatively high food supply. This species was not previously recorded from the Zone N6, but is abundant in Zone N12. It appears that *P. wuellerstorfi* evolved between Zone N6 and N9. *Oridorsalis umbonatus*, the most abundant species recorded from Zone N6, is associated with sediment with relatively low organic carbon content and deep pore-water oxygen penetration depths. This species, which has been characterised as being a specialist with a narrow palaeoecological niche, was only sporadically recovered from Zones N9 and formed only 3.3% of the total recovery from Zone N12.

It is concluded that there was an overall increase in the organic matter input to the Cipero Formation between Zones N6 to N12.

A series of statistical procedures including the Assemblage Turnover Index (ATI), one-way ANOVA (analysis of variance) and Tukey's Pairwise were conducted on palaeontological findings. ATI is a key tool used in determining regime shifts. The term *regime shift*, in this paper, refers to an interval of environmental change that occurred as sediments were being deposited. These intervals occur when there is a change in mean ATI.

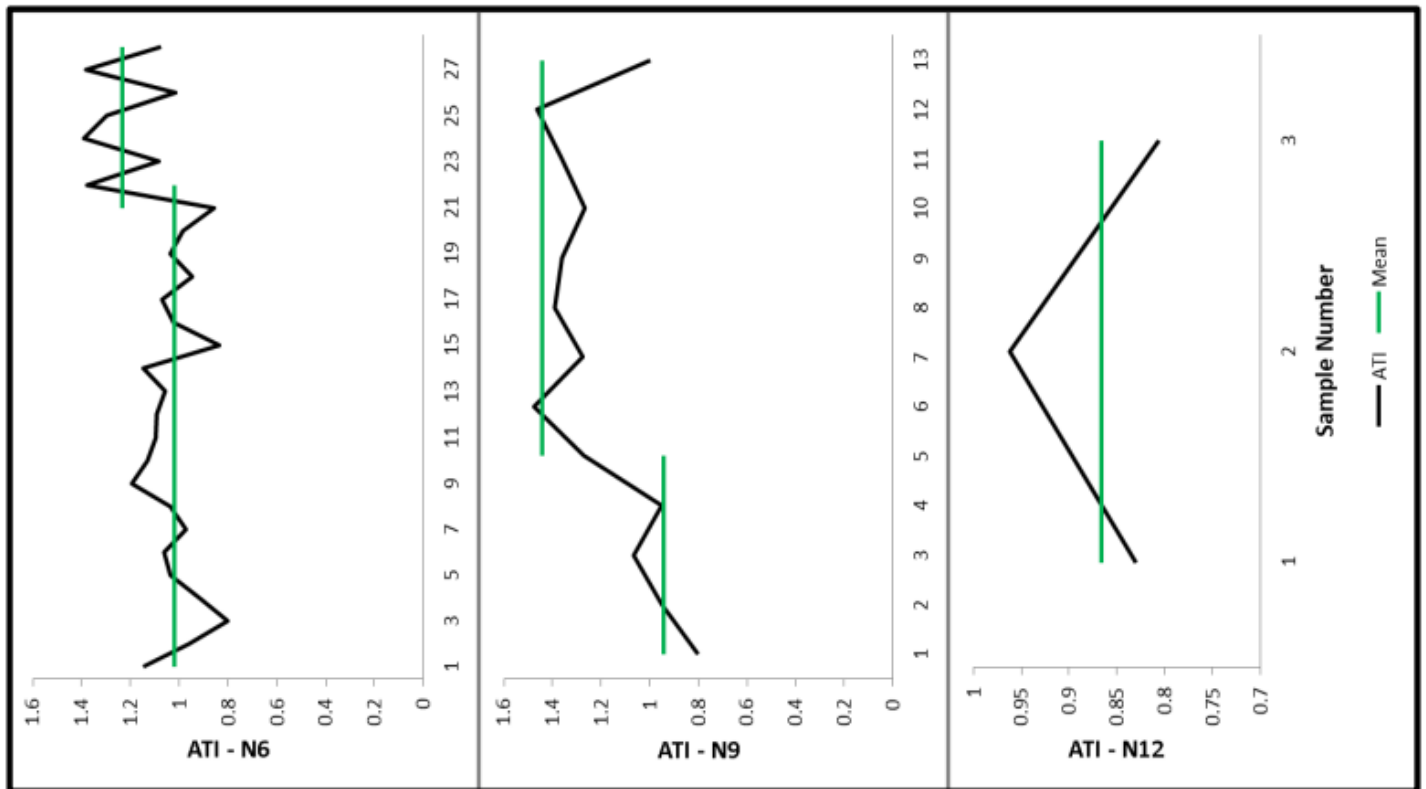


Figure 3 – The three graphs above show ATI calculated for Zones N6, N9 and N12 respectively (left to right). The black lines represent ATI and green lines represent mean ATI. A regime shift occurs at the point where the mean ATI changes within a single foraminiferal zone. From the graphs above, a regime shift occurred in Zone N6 as well as in Zone N9.

Figure 3 above displayed a distinct regime shift in Zone N9 and Zone N6. One-way ANOVA and Tukey's Pairwise now confirms that there is a change in mean ATI between Zones N6 and N9, and Zones N9 and N12. As such, there were at least two regime shifts while the Cipero Formation was being deposited during the early Middle Miocene.

In 1948, R. M. Stainforth suggested that the Cipero Formation was an open-sea deposit laid down at water depths 400 – 500 meters. However, any research prior to the 1960's did not take into account the Theory of Plate Tectonics. The presence of *Planulina weullerstorfi*, and *Oridorsalis umbonatus* now indicate that the Cipero Formation was deposited at water depths between 1000 m to 3000 m during the Middle Miocene as deep water marls encasing sand-rich turbidites.

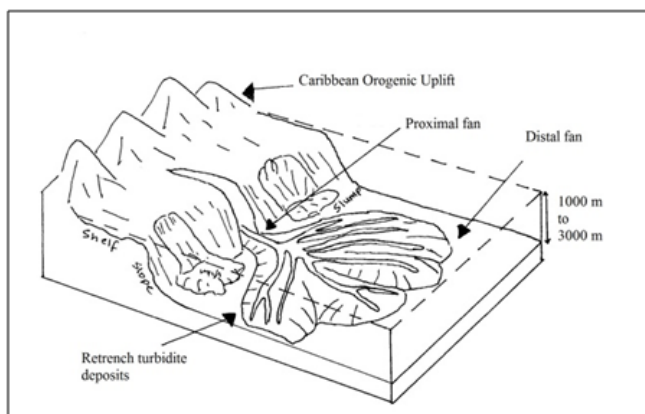


Figure 4 – A sketched model of a Retrench submarine fan deposited at the foot of submarine slopes at water depths between 1000 – 3000 m during the early Middle Miocene.

Southern Trinidad possesses all the elements of a working petroleum system; source, reservoir, migration pathway, trap and seals:

- **Source** – Type II source rock: Cretaceous Naparima Hill Formation
- **Reservoir** – Retrench, Herrera, and Karamat sand members
- **Migration Pathway** – Deep-seated thrust faults that link Cretaceous source rock to Miocene reservoirs
- **Trap** - Structural Traps: Thrust faults, tear faults, and rotated hanging wall blocks; Stratigraphic Traps: Sands pinch out onto growing La Fortune Anticline
- **Seal** – Shale smear and prodelta shales

The major challenge we face today however, is unravelling the location of these reservoirs.

The 90-174 SBC 2D seismic line running through the La Fortune Anticline area was acquired and interpreted where four thrust faults and four horizons were picked using palaeontological reports from respective wells. Focus was placed on two main horizons including the Retrench (Gg32) horizon seen in purple and the Nariva (Gg24) horizon seen in orange. The beds in the area were folded along thrust faults as they grew. The shortening associated with each thrust slice was calculated and was used to reconstruct the Restored Retrench Surface.

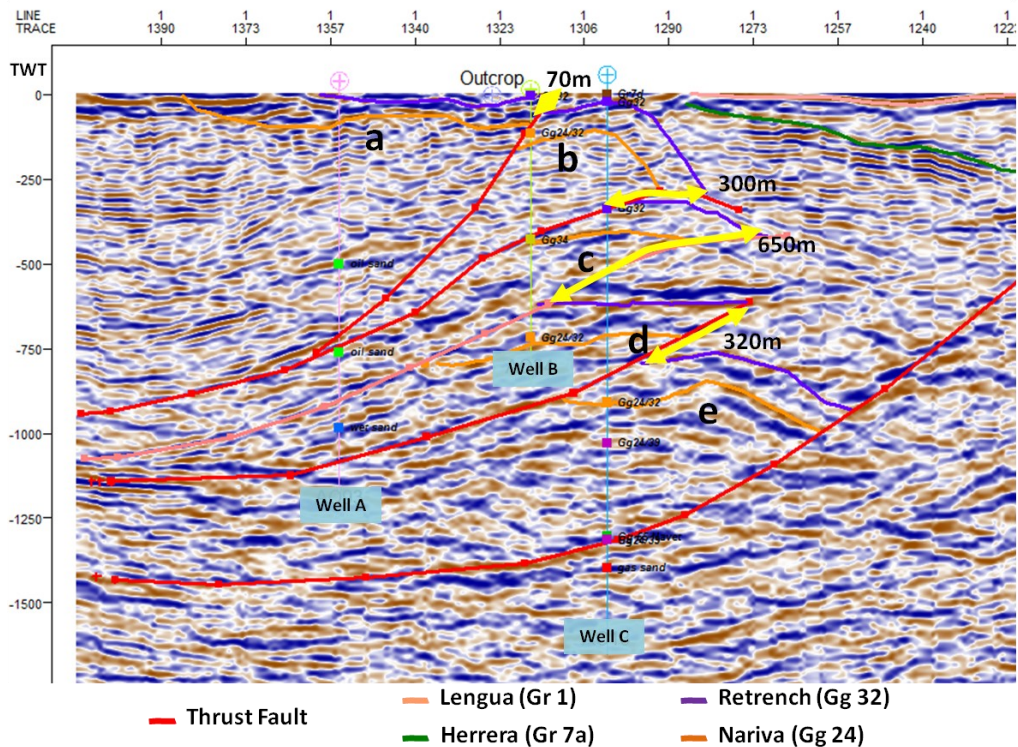
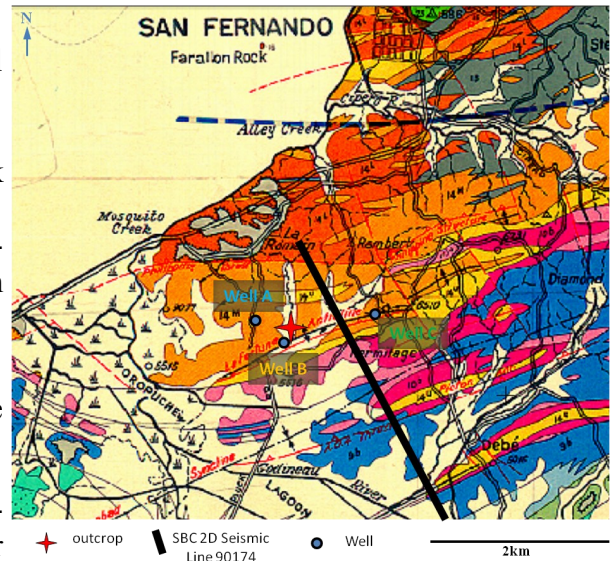


Figure 5 – Interpretation along SBC 2D Seismic Line 90174 at the La Fortune Anticline showing estimated shortening.

The restoration of the Retrench Marl Member Surface (**Figure 6**) shows sands based on gamma ray signature from well data (yellow patches) as well as postulated Retrench deposits based on the modelled topography of the Nariva surface (yellow patches with question marks).

A key part of the project was the integration of the Palaeontological findings and Geophysical data. Palaeontological research showed the outcrop was deposited at water-depths between 1000 to 3000 m. These water-depths can now be used to determine the water-depth of the outcrop and relatively shift the Nariva

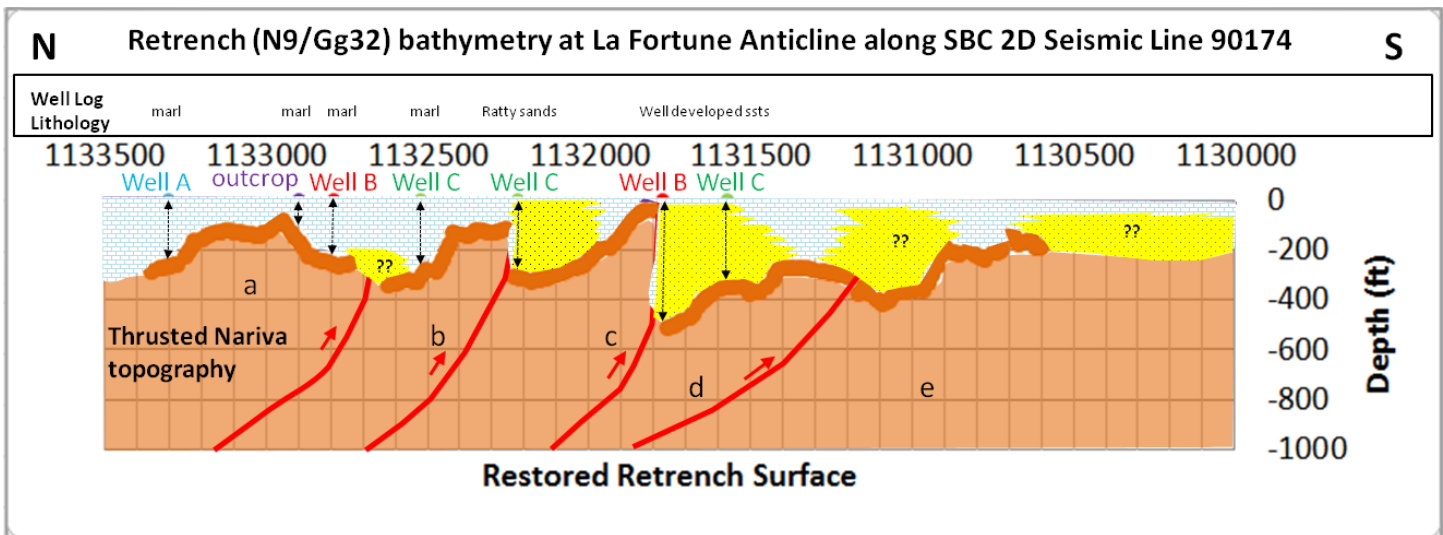


Figure 5 – The restored Retrench Marl Member surface after interpretation of SBC 2D seismic line with respective well data and palaeontological reports.

palaeotopography deeper. In other words, we can now determine the relative depths of the areas further north or south of the outcrop area. This is important as it would give researchers a better understanding of the evolution of the southern basin and also help companies in understanding the depths of target reservoirs.

The palaeontological data also demonstrated regime shifts occurring while the Ciperó Formation was being deposited, alluding to some environmental changes at time of deposition. We now hypothesize that this regime shift can be linked to a Retrench turbidite flow. For example, if such an event resulted in a drop in eustatic sea level we can expect instability on the exposed narrow shelf associated with the Caribbean uplift, and the deposition of Retrench turbidite sandstones in the Trinidad area, within synclinal features seen on **Figure 6** above.

The seismic line acquired (**Figure 5**), showed Well C penetrating the Retrench horizon three times. These three penetrations are depicted on the restored surface. As such, The La Fortune Anticline is an excellent playground for petroleum drilling as Retrench reservoirs are repeated in numerous thrust slices. This restoration of the Retrench Marl Member surface can aid in the prediction of potential reservoirs and thus, reduce the risk of missing a Retrench prospect.

20th Caribbean Geological Conference 2015:

Two authors of this project, Sadie Samsóondar and Jenai Valadere are students at the University of the West Indies, St Augustine, pursuing their degrees in Petroleum Geoscience. For the first time, these students were given the opportunity to present their research at an academic forum, the Caribbean Geological Conference held by the Geological Society of Trinidad and Tobago at The Hyatt Regency, Trinidad. Both girls experienced mixed emotions of true enrichment and pre-presentation nerves being among influential people in geology, geophysics, palaeontology and persons in the oil and gas Industry. Miss Valadere stated, "These were the great minds, who I knew would be in the audience listening to our presentation. As I stood at the podium, the first face I could see, was that of James Pindell, whose work I was about to mention and I was sure it would come as a surprise to him."

However, as the girls began to present all their work, nerves were relinquished and they felt a sense of pride and fulfilment in their research. "We were showcasing something new and unique to the industry and we were ecstatic to share," said the girls, "Our presentation ended, and we were approached by many in the audience commending our work which made us feel even more honoured for the opportunity we were given." Miss Samsóondar stated, "This project truly ignited my interest for micropalaeontology, and as such, I plan to continue my research on the Ciperó Formation here in Trinidad." The opportunity to attend and present at the CGC was an incredible experience as it served not only as an excellent platform for the girls as first-time researchers, but also to gain knowledge from professional and experienced persons in the field, both regionally and internationally. Miss Samsóondar and Miss Valadere closed with much thanks to their supervisors, Professor Brent Wilson, Xavier Moonan and Karuna Moonan, without whom, this project would not be possible. They hope to inspire other young geoscientists to question everything and to work on projects that they truly love, because possibilities are endless and you will never know what you can discover until you try.

Gas Deliverability Issues in the Trinidad & Tobago Natural Gas Industry and Advancement of Possible Solutions

by Helena Inniss (Energy Consultant Kronus GSL)



Introduction

I decided to write this paper because the term shortage is being used to describe the current natural gas deliverability issues and it is being stretched to imply that Trinidad and Tobago is running out of natural gas. I have been asked whether this would impede further investment in the Trinidad and Tobago downstream natural gas sector and my answer is that it should not. The discerning investor would have to properly research the history of the gas industry in the country and understand the dynamics of the industry before making an investment decision and it is my view that a discerning the investor will not be deterred by the obvious chatter that surrounds the subject.

The article is divided into three sections. Some of the relevant history is detailed up to 2011 in the first section to provide the background dynamics re the evolution of the industry. The second section builds on the first because of the influence of the past on the current structure of the industry. The third highlights the issues and the fourth attempts to offer some solutions.

Short History

Natural gas has been utilised in Trinidad and Tobago since the early 1950s when gas was used for power generation; and the use of natural gas as feedstock for the petrochemical industry commenced in 1959 with gas being used to manufacture Ammonia. However its use was not widespread in this early period and the wells on the east coast in which gas was discovered, even in the 1970s, were plugged and abandoned because there was no market for the gas. In fact it is instructive to note that when the government negotiated upstream agreements with Amoco in 1970, the royalty on gas paid to the government was a penny and this was so until 2004 when the negotiations for the Train 4 agreement was used as leverage to obtain more value for the country.

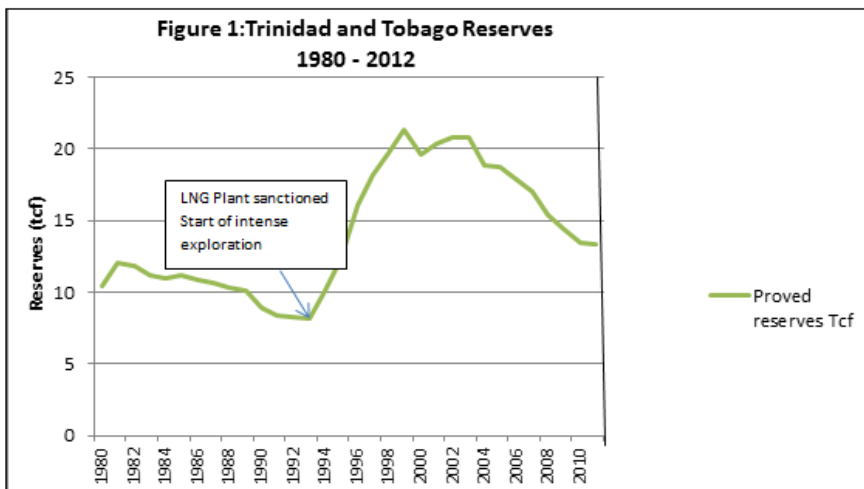
In the late 1970s, the Government took steps to create a market for natural gas and facilitated the construction of the transmission facilities.

The National Gas Company was the midstream vehicle created to purchase gas from the upstream suppliers and sell to the downstream consumers (1973). In doing so the government deliberately provided a cushion for the downstream consumers as the price at which the gas was sold by the NGC was tied to the market for the particular commodities. The NGC therefore absorbed the gas price risk, thus providing the incentive for investment in the downstream sector. The Government also directly invested in and bore the cost for development of the industry (ISCOTT, FERTRIN, Tringen etc) and thus provided the seed for the growth of the petrochemical industry. This provided the impetus for targeted gas development and the country's first dedicated gas platform (non-associated gas as opposed to associated gas in Teak) was installed in 1983. This was Amoco's Cassia Platform. This platform developed wells in which gas was discovered in the 1970's and because of technological advancements between the initial discovery, the company was able to turn 25 million cubic feet per day (mmcf/d) wells into 100mmcf/d producers. It was this platform which really highlighted the potential of the east coast acreage.

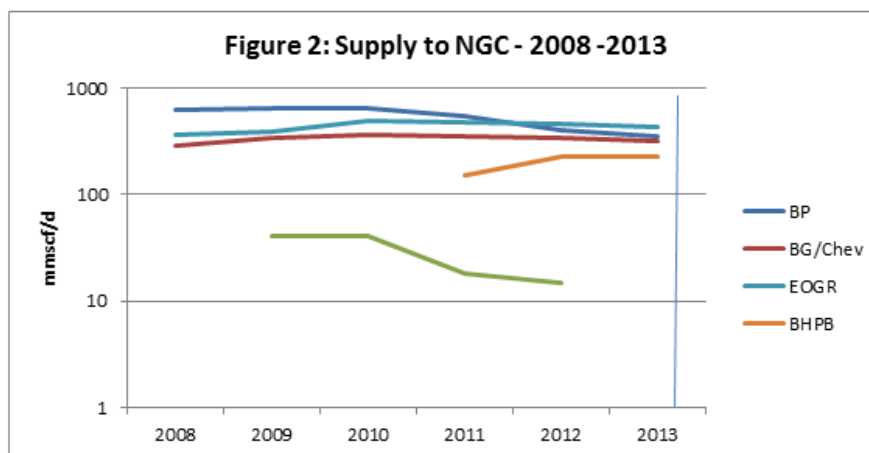
A leap to 1995, when the first LNG project was sanctioned. At that time Trinidad and Tobago's proved reserves were 9 trillion cubic feet ("tcf"). The demand anticipated in connection with this project and other proposed LNG trains led to focused exploration for natural gas. Amoco experienced an unprecedented "exploration" drilling success rate of 88% (it is ironic that at the Ministry of Energy we complained about this focus because it was at the expense of drilling for oil) and they developed many of the fields in double quick time. This was the early evolution of the gas industry as Amoco sought to vertically integrate through the value chain and to reserve for itself a dominant position in both the upstream and downstream, going so far as to build its own gas pipeline, for delivery of gas to ALNG, which it later turned over to the NGC. Figure 1 shows the steep response of proved reserves in response to the impetus of the development of a gas market. In the period from 1992 to 1999, proved reserves climbed from 9 tcf to 21

, driven largely by LNG development. There was approximately 30 tcf of gas in the exploratory category and with an established demand; companies committed the resources to exploration and development.

The government was experiencing some disquiet about the “accidental” monopoly that was being created in the industry and was of the view that a diversified upstream sector would be a better option for the country. The government therefore went out of its way to ensure that the country would not be at the mercy of any one supplier. A local company, Trintomar (a subsidiary of Petrotrin) was formed to takeover the operatorship of the South East Coast Consortium assets to develop the gas in the Pelican, Ibis and Kiskadee fields. After a few years of production, while drilling a well there was a massive blowout on the platform from which Trintomar never recovered. Coming on the heels of that disaster, the government entered into an agreement with Enron (now EOGResources) to develop the SECC block and incentivized British Gas (now BGTT) to develop the Dolphin Field and the North Coast Marine Area. These events took place in the 1990s and even though the aim was to maintain supply to the domestic market, BGTT also became a major player in the ALNG trains.



Trintomar (a subsidiary of Petrotrin) was formed to takeover the operatorship of the South East Coast Consortium assets to develop the gas in the Pelican, Ibis and Kiskadee fields. After a few years of production, while drilling a well there was a massive blowout on the platform from which Trintomar never recovered. Coming on the heels of that disaster, the government entered into an agreement with Enron (now EOGResources) to develop the SECC block and incentivized British Gas (now BGTT) to develop the Dolphin Field and the North Coast Marine Area. These events took place in the 1990s and even though the aim was to maintain supply to the domestic market, BGTT also became a major player in the ALNG trains.



It is instructive to note that Amoco (now BP) maintained its position as the major gas producer in Trinidad and Tobago and could be depended on to bring additional volumes to the market when other companies needed to take facilities offline whether planned or not. However in 2011, bpTT announced that it was no longer willing to be a swing producer. The company indicated that they had carried the industry for many years and that it was no value to be gained by keeping gas in storage. This would have meant drilling expensive development wells and shutting them in until needed, a poor economic proposition when

one considers the time value of money. While the announcement may have come as a surprise to many, it should not have been as from all indications the company with the most acreage with the potential to find and develop easier gas resources was not replacing reserves as it had done in the past. The reserves replacement rate fell from 80% to 50% in three years and the reserves figures spoke loudly to this. The company drilled only to maintain its contractual commitments to the NGC and ALNG. However there was still excess gas in the system when without warning in 2010 bpTT commenced its maintenance programme. The excess gas helped to maintain supply at acceptable levels in 2010 and 2011 as BGTT and EOGResources ramped up production and BHPBilliton came on stream with 225mmscf/d in May 2011. However as major BP facilities were taken offline and planned maintenance work occurred, the other companies were unable to fill the void. (Figure 2)

It is ironic that in 2009 and 2010 the NGC was faced with a situation whereby supply outstripped demand. The NGC had contracted to buy 550 mmscf/d of gas in anticipation of the start up of several downstream projects, including Alutrint and Essar Steel, etc, and once these projects were cancelled, the company was unable to find any alternative market for the gas it had contracted to buy. Several of the gas suppliers assisted the NGC by banking the excess gas. In response to a question in the Parliament, the Minister of Energy stated that NGC incurred a US\$11.6 million take-or-pay liability when these projects were cancelled as there was no market for the gas. On the one hand it may have been a lifesaver for the NGC when BP was unable to

supply their contracted quantities of gas but on the other hand it also proved to be a nightmare when the downstream consumers felt the pinch.

A brief recap of events show that in 2011 Trinidad and Tobago experienced an unprecedented drop in natural gas production because the major gas producer, bpTT, was placed in a position where it was unable to deliver its normal contract quantities and BGTT undertook planned upgrade programmes during the period. The reason given for BPTT's action, which actually commenced in May 2010, was that the company in response to the Gulf of Mexico incident in 2010 initiated a wide-ranging programme designed to enhance safety and risk management within the group to earn back the trust of the countries in which it operated. As part of this thrust, there was a phased shut down of facilities from May to July 2010 and in 2011, 2012 and 2013 as BPTT embarked on a platform and processing facilities inspection and maintenance programme to ensure the physical integrity of the platforms, ensure production reliability and to bring the platforms into conformity with international standards. This was necessary given that the platforms and processing facilities ranged in age from 10 to 30 years old, and while they had been subject to routine maintenance, BPTT because of the destruction of their reputation from the Deepwater Horizon / Macondo fiasco opted to err on the side of caution and audited all their producing facilities to ensure they were in line with current international standards. The result of the programme was a temporary natural gas curtailment for a three year period from March 2011 to December 2013 as bptt's facilities were taken offline on a phased basis. This was reflected in a fluctuation of the company's production over the period.

2011 to Present

Over the last three years because there was no available swing producer and each company drilled just enough to fulfil their contractual obligations, any planned or unplanned disruption in supply was met by an outcry from the downstream consumers that the supply situation was impeding their ability to take advantage of the increased demand and the high prices in the commodities market. The NGC and the Downstream industries located on the Pt Lisas Estate formed a committee to ensure that each would be aware, in a timely manner, of proposed mismatches in supply and demand but while downstream turnarounds can be planned with some degree of precision, upstream interventions are often not as pre-

-cise and without the cushion of excess supplies there has arisen the notion that the supply deliverability issues is a result of dwindling resources.

If one examines the Ryder Scott reports over the last thirteen years, while the gas exploration resources have fluctuated, they have remained consistently high even though there has been movement from this category to the reserves category (Figure 3). So that while the focus is on the proved reserves, I would contend that one of the main reasons for the very slow decline of proved reserves is the movement from the exploratory resources category to the possible and the development or projected development of the probable and possible reserves, in what the upstream companies consider a timely fashion. What we need to look at is the impetus for undertaking gas exploration or the country may be left with gas in the ground if or when it becomes irrelevant in today's world of fast paced technological development.

While the government has offered acreage for tender with the resultant discoveries of gas, there are problems facing companies with respect to establishing a market for the gas. Petrocanada discovered gas in Block 22 acreage which was later acquired by Centrica which also signed a Production Sharing Agreement for the NCMA 4 acreage in 2009. The company is yet to find a market for its gas. There is no readily available Trinidad and Tobago domestic consumer, given the structure of the market (NGC being the sole supplier to downstream consumers with the exception of ALNG) and the vertically integrated nature of the ALNG chain the company the company had no other option but to seek out extra territorial markets. Additionally the gas is located in deeper water acreage and the wells were drilled at a time when the drilling costs were expensive. Supplying to the domestic market was therefore a source of uneasiness for the company, an issue which is likely to crop up for deep water gas finds.

Trinidad and Tobago has been in the oil and gas business for the last 100 years and the gas business for over sixty years; however, two thirds of our marine area has yet to be explored. All of the white areas on the map (Figure 4) represent available acreage for exploration. Much of that available acreage is in frontier deep water and therefore exploration was fairly slow until petroleum companies were satisfied that the fiscal parameters were aligned with the technical risk (a win-win risk reward scenario) . The extraction of gas in deep water was not

an attractive proposition on its own; but as soon as the technical data provided by the Ministry supported a mix of possible oil and gas production and the fiscal regime was adjusted to render it more attractive, the deep water elicited more interest. The gas resources predicted for the deep water, approx. 20tcf, have never been included in the estimate of gas resources in the gas audit undertaken by Ryder Scott. There is therefore no real shortage of gas resources; it is just a question of having available deliverability at all times and the possible methods to achieving that goal.

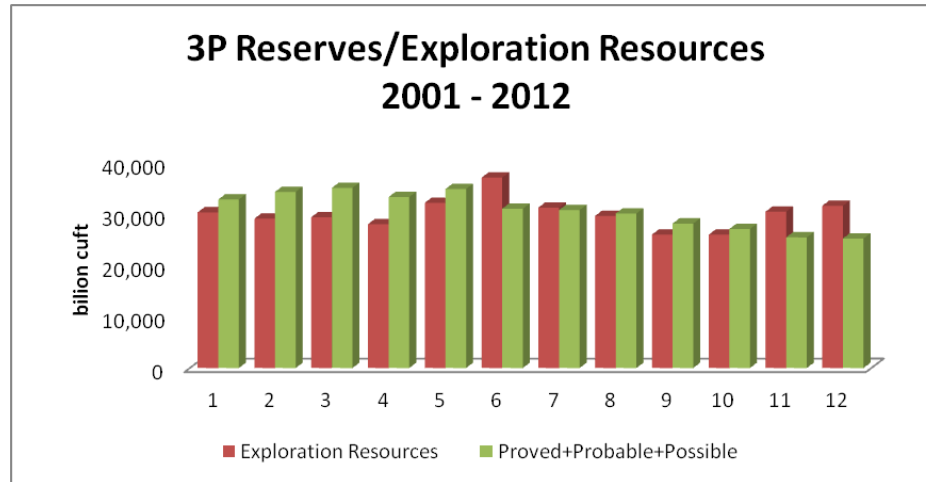


Figure 3: 3P Reserves/Exploration Resources 2001-2012

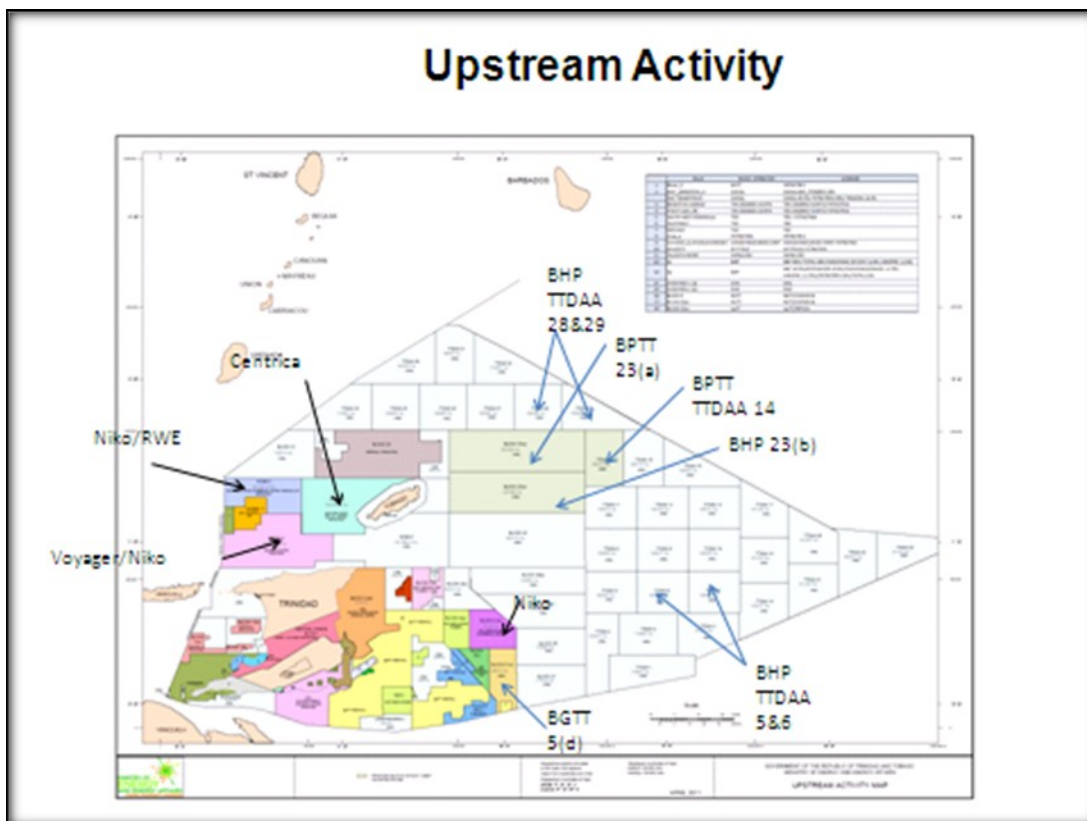
The Issues

Several key issues have reared their head over the years. While in the earlier years, the alignment of the objectives of the upstream supplier, the midstream purchaser and the downstream consumers were aligned and this contributed to T&T's dominant position in the gas industry, it also served to entrench a system which is no longer beneficial given the change in circumstances for each of the parties. The following are the issues:

1. Bpft's dominant, almost monopoly position in the gas value chain over the years. While addressing this somewhat from time to time, the company still has much of the acreage capable of bring new gas onstream at affordable prices. The position is compounded by the award of deep water acreage to one company which has managed to obtain a controlling interest in all the blocks recently awarded.
2. Demand and supply is so closely aligned that should there be work undertaken on any producing platforms and it is shut down for any period of time, it results in deliverability issues. One might ask how we got to this position. After years of being the major upstream swing producer Bpft is no longer willing to be the one holding the bag. Is this a reasonable position to adopt? Given that they are the major producer and has been the swing producer throughout the life of T&T's gas industry, they earn nothing for gas kept behind pipe until there is a need for it and in today's world given the cost of drilling wells, it is imprudent to drill development wells to provide production on an as needed basis.
3. Concentration of assets – few platforms produce the bulk of the gas. There are gas wells producing up to 250mmcf/d, platforms producing nearly 1bcf/d. Therefore shut down of facilities for any reasons, planned or not will result in severe disruptions downstream. There will always be maintenance work, upgrades, workovers etc. but given the productivity of producing wells, the problem has been exacerbated. What can we put in place to mitigate these problems?
4. The NGC is the sole buyer and seller for the domestic market. This was a necessary position when the gas industry was in its infancy as the company deliberately absorbed a lot of the gas price risk in its bid to incentivize investment in the downstream sector (Gas prices were tied to commodity prices so that when prices were low, the NGC which had entered into agreements with upstreamers at a particular price absorbed the loss). NGC therefore was an intermediary and continues to maintain its position between the upstream suppliers and the downstream consumer. The position has enabled them to claw back some of the losses sustained in the earlier years. However NGC was in a Take or Pay position three years ago and is now caught up in a balancing act. Should the company remain with the status quo?

1. The downstream consumers want to be able to vary production in line with market demand; their DCQ is thus really an estimate of the supply required. When demand is high and correspondingly price is high, downstreamers wish to produce to the name plate capacity of the plant. However they are not willing to contract for name plate quantities but are putting pressure on the NGC to supply such quantities. What is the impetus for current licence holders to explore for gas and drill development wells – markets- What markets? Does the company contract for more gas on the off chance that downstream consumers would nominate more than their DCQ? Should the NGC bear this burden alone?

Figure 4: Upstream Activity Map



Possible Solutions

1. There are several upstream agreements which are due for renewal in the 2017 -2018 time frame. The Ministry of Energy and Energy Affairs should avail themselves of the opportunity to remove idle acreage from the hands of companies which have held this acreage for years without the intention of performing any work. The acreage should then be tendered.
2. With respect to the deep water acreage, it may be in the country's best interest to engage in selective tendering so that the unhealthy concentration of acreage in the hands of one company will not reoccur.
3. Remove from the NGC the role of middle man in the gas value chain. Let the upstream companies sell directly to the downstream consumers at terms and conditions agreed between them.
4. Should NGC be retained as the middle man, the structure of agreements between the parties (the Government with the upstream supplier, the upstream supplier with the NGC and NGC with the downstream consumer) in the value chain should be aligned and treated with in a holistic manner, such that each party's goal is realized.
5. Gas storage is another possible solution which would help to smooth out the highs and the lows.

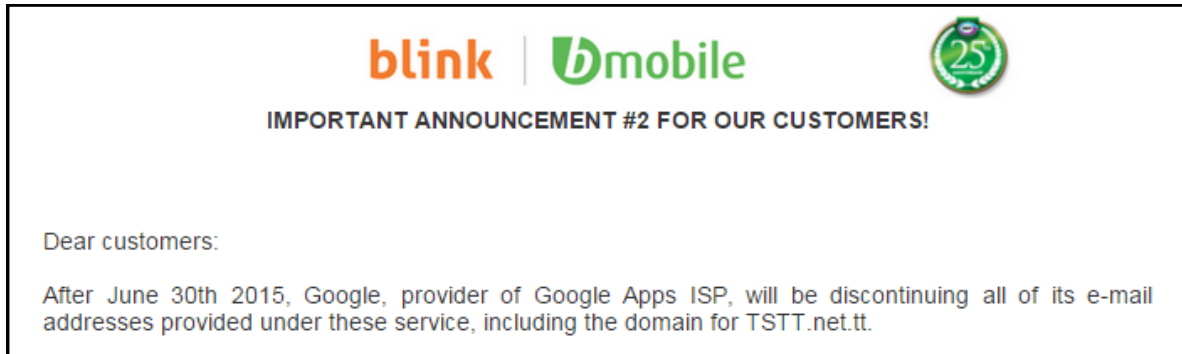
The solutions have been proposed over the years but have never gained real currency but it may be that because of the deliverability issues currently plaguing the industry that they will be seriously examined. While we speak of diversification away from the oil and gas industry, it is the very same industry which will provide the resources for this diversification and therefore we need to ensure its sustainability.

Ms Helena Inniss (Energy Consultant Kronus GSL) holds a BA Geography and Geology (UWI Mona), MSc Energy Studies from University of Dundee (CEPLMP). Former Director of Resource Management – Ministry of Energy and Energy Affairs

GSTT NEW EMAIL ADDRESS - thegstt@gmail.com

Geos,

Our long-standing internet provider Blink (TSTT) has announced that they will be discontinuing the use of their domain (tstt.net.tt). As such the official email address of the Geological Society of Trinidad and Tobago (gstt@tstt.net.tt) will not be able to receive or send emails after June 30th, 2015. We apologise for the inconvenience this change may cause.



We have now established a new email address, a bit more aligned to our current website as well. The new official email address of the Geological Society of Trinidad and Tobago is :

thegstt@gmail.com

Please send all email correspondence to thegstt@gmail.com from now onwards.

GSTT Secretariat

GSTT seeks SEG Affiliation



Society of Exploration Geophysicists
The international society of applied geophysics

The Geological Society of Trinidad and Tobago continues to reach out to international geological and geophysical societies to expose our members to the latest developments worldwide and to seek out opportunities for collaborative work.

In May 2015 the GSTT approached the Society of Exploration Geophysicists (SEG) to be instilled as an Affiliated Society. The GSTT annually participates in the SEG Distinguished Lecturer Program, coordinating and hosting such visits to Trinidad and Tobago. We also actively support the SEG Student Chapter at the University of the West Indies, St. Augustine Campus.

To fulfil all official requirements to be instated as an Affiliated Society of the SEG, the **GSTT is required to gain the signatures from twenty (20) Active SEG members of Trinidad and Tobago**. In liaising with SEG headquarters the GSTT understands that most SEG members in Trinidad and Tobago currently hold Associate SEG membership but can easily upgrade such membership to Active status at no additional cost. SEG Associate members can upgrade to Active status by updating their educational profile, years of experience, and training. SEG Active status allows a member to vote in elections, to be elected as an officer, petition to committees, sponsor applicants for membership and publish affiliation with the SEG.

The GSTT encourages all SEG Associate members to **upgrade to Active status**, so that the GSTT can officially be instated as the first Caribbean based Affiliated Society of the SEG.

To upgrade your SEG membership visit: <http://www.seg.org/membership/current-members/upgrade>

3D Seismic Data Enhancement Processing Of North West District in the Southern Basin Of Trinidad & Tobago.

Terrell Dhanpaul* and Samuel Ragbir*, Petroleum Company of Trinidad and Tobago.



Project Overview

A reprocessing seismic project was recently undertaken to enhance the quality of an existing seismic dataset. The main purpose was to generate a PSTM (Pre-stack Time Migration) volume which will improve the structural and stratigraphic imaging, improve on the continuity of reflectors and improve on the seismic resolution whilst preserving amplitudes which will be used for advanced studies. From detailed analyses, some of the inherent problems of the dataset included the presence of acquisition footprints, migration artifacts, relatively low bandwidth, as well as, the low signal to noise ratio in the data. Many technologies are available in the geophysical industry today to deal with some of the persistent problems highlighted that sometimes exist in seismic data. This paper seeks to describe some of the methodologies and techniques that were very beneficial in resolving some of the issues of the seismic volume.

Acquisition Parameters

Some of the acquisition parameters and geometry (Figure: 1) are given below:

- Receiver line orientation: 28 degrees
- Receiver line interval: 300m
- Receiver interval: 50 m
- Source line orientation: 118 degrees
- Shot line interval: 500m
- Shot interval: 50 m
- Bin size: 25×25m
- Number of channels: 3360
- Trace length: 8 sec
- Sample rate: 2 ms

Problems Encountered

Acquisition footprint

Variations in the offset and azimuth distribution from bin to bin can lead to undesirable effects on the reflected signal. In the shallow part of a seismic section, only small offset traces contribute to a stack. Therefore, the shallow part of seismic section is more susceptible to footprint problems because the number of small-offset traces almost always differs from bin to bin because of the acquisition geometry (Figure: 2).

Migration Artifacts.

Migration artifacts will always go into a dim amplitude zone. Ideally if the edge of a fault is well defined, then with the proper imaging velocity, those swings should focus in one location. In the presence of noise and not fully resolved velocities, the migration swings may not focus. Even with the proper velocity field, seismic data can suffer from these artifacts due to the migration swings going into a dim zone (Figure: 3).

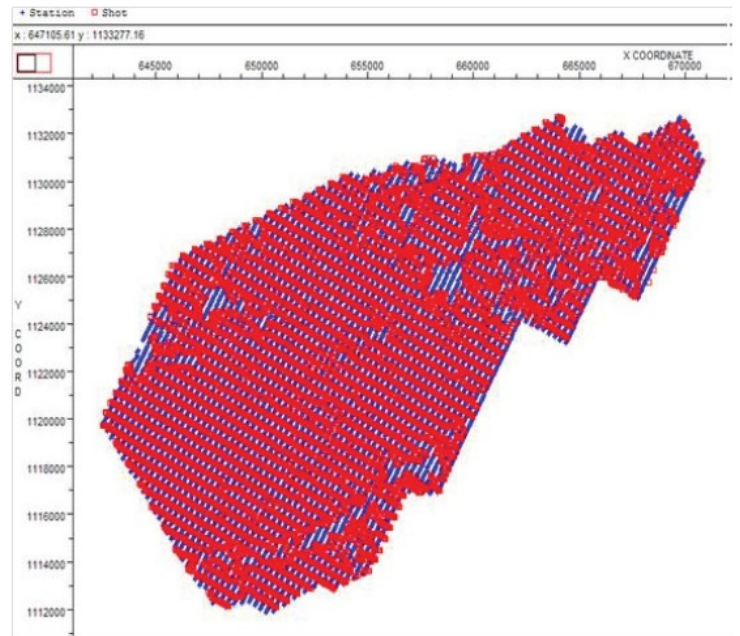
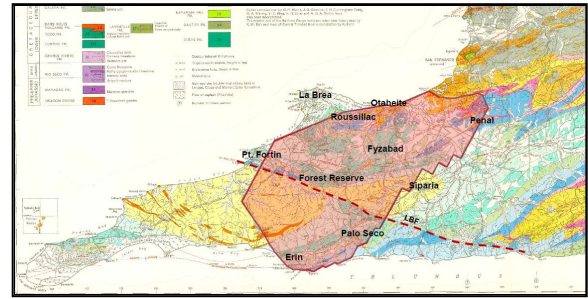


Figure 1: Geometry Layout

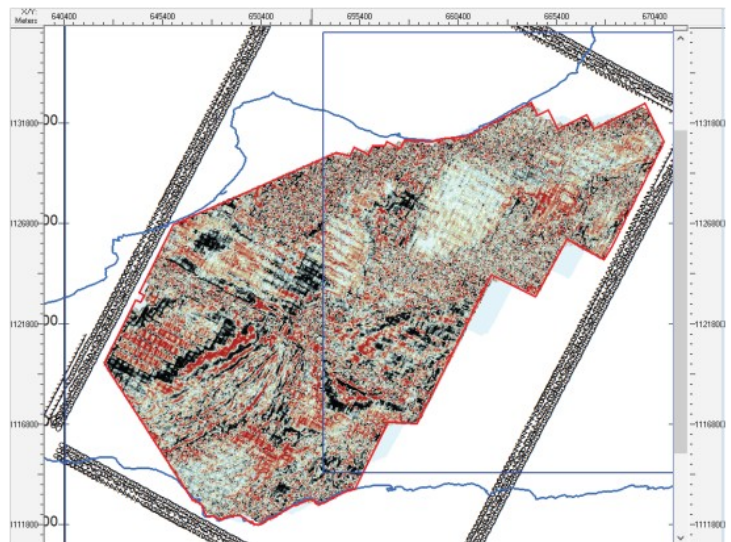


Figure 2: Shallow Acquisition Footprint

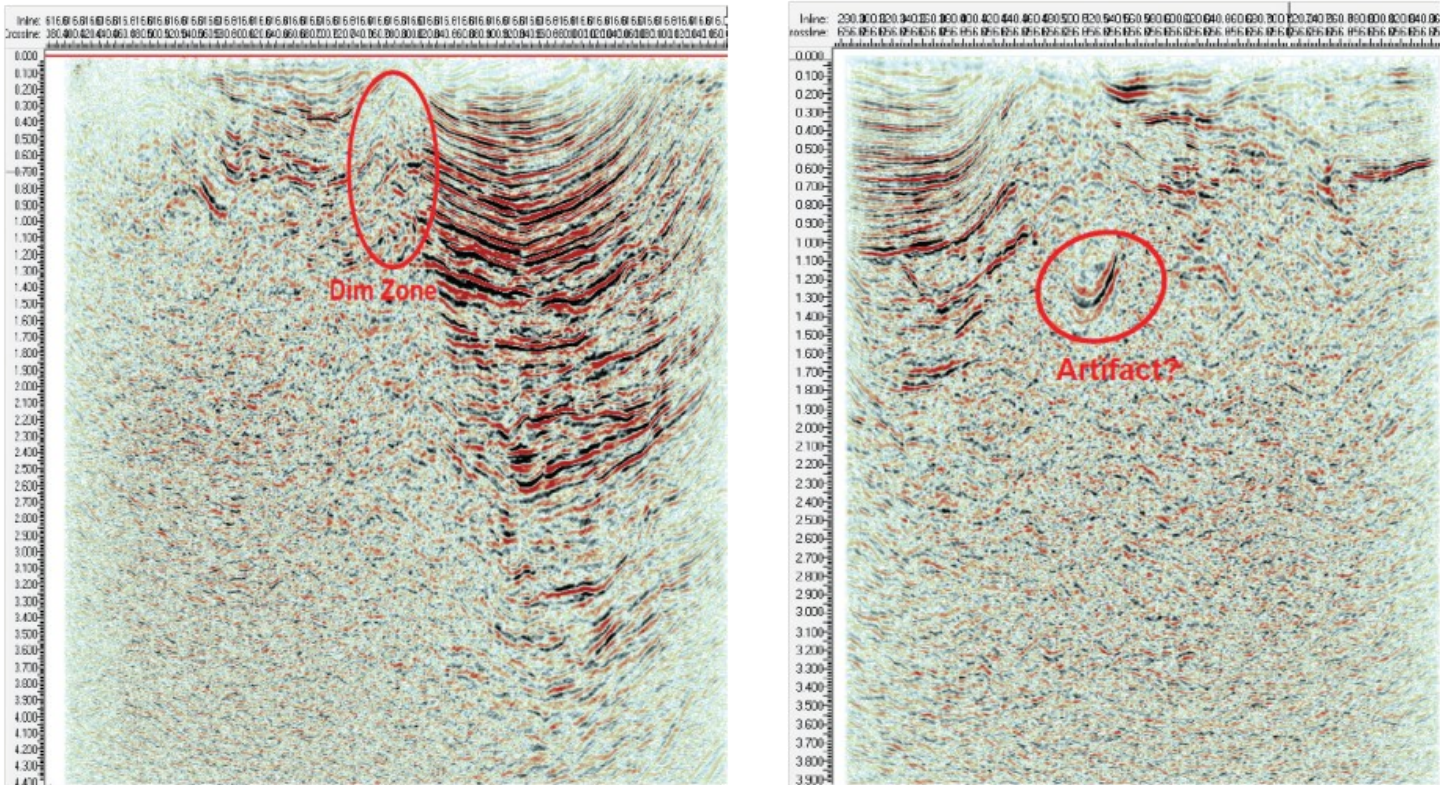
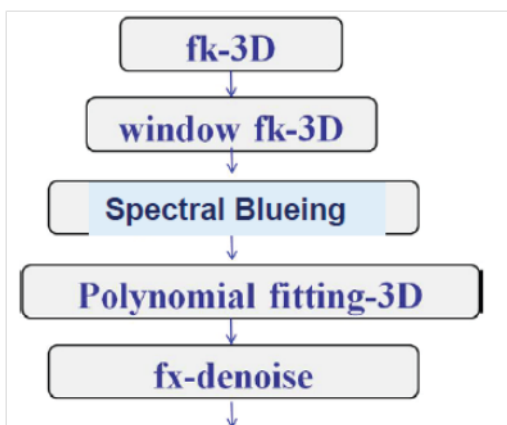


Figure 3: Migration Artifacts

Final Workflow & Technical Suggestions



Item	Combination of algorithm	QC
1.Improve S/N	fk-3D, RNA-3D, 3D-Polynomial fitting fx-denoise	Stacked section
2.Remove migration-artifacts	time -window fk-3D	Stacked section
3.Attenuate footprint	fk-3D,3D-Polynomial fitting	Stacked section & time slice
4.Increase resolution	Inverse-Q filtering Spectral Blueing	Stacked section & spectrum

Final QC Workflow

3D Frequency-Wavenumber Filtering

f-k 3D filtering can suppress noise and the geometry footprint from a 3D stack volume, assuming that the structures are not too complex. Data is processed in overlapping time space windows, these windows are merged before being output. Dip filtering was tested from 3 ms/trace to 30 ms per trace, with a value of 24ms/trace being used (Figures: 4 (a) and (b)).

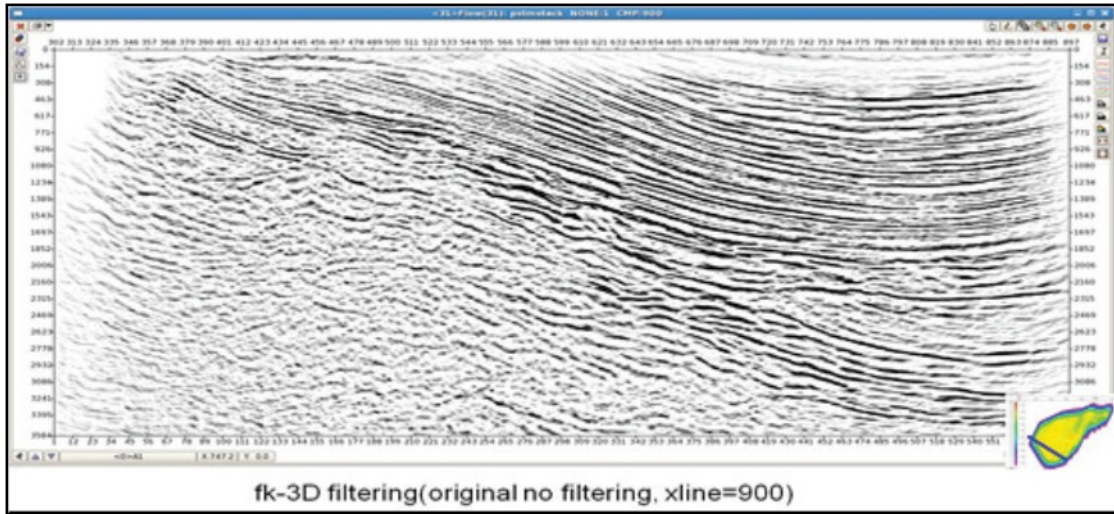


Figure 4a

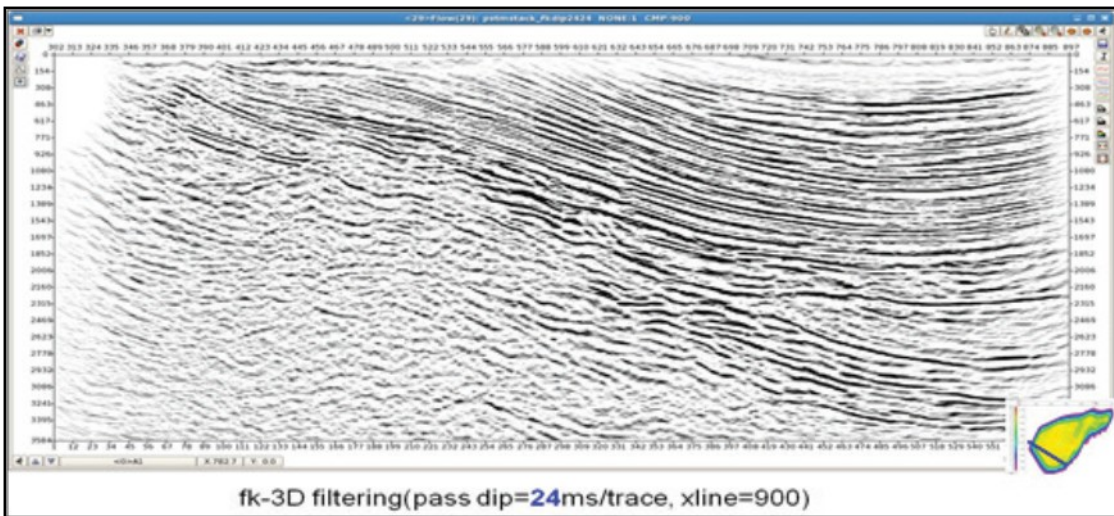


Figure 4b

3D Random Noise Attenuation

3D Random Noise Attenuation is used to enhance coherent events relative to random noise. The random noise attenuation process is an f-x-y filtering technique that automatically selects the range of dips to enhance based on the dips in the data. The recommended size of the data windows varies with the data's structural complexity. Each window should contain only a limited number of dips and be fairly constant in terms of noise character, frequency content and dip directions. f-x Denoise is a similar algorithm that can be used to enhance the signal in the f-x domain. Results are shown in Figure:

Figure 5a

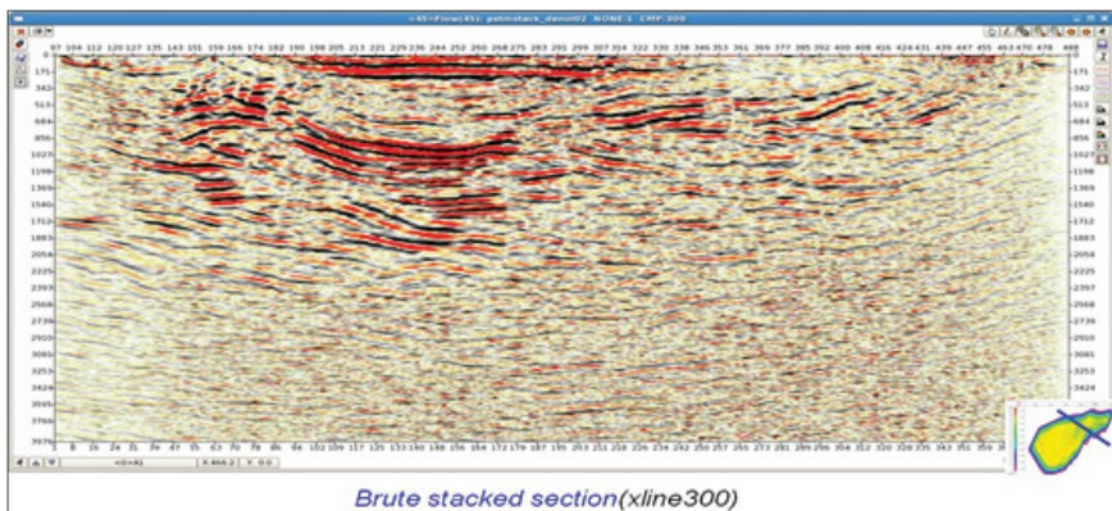


Figure 5b

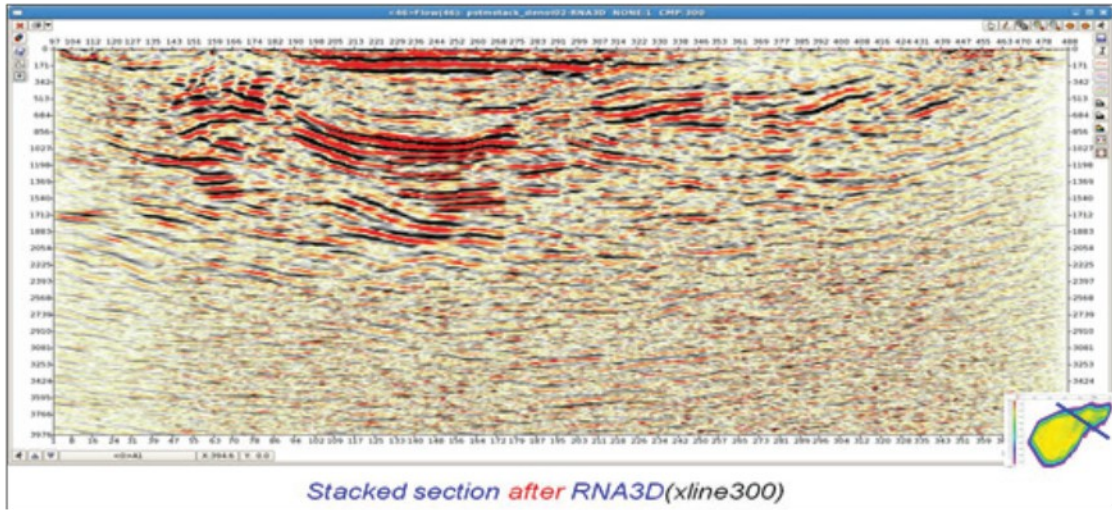
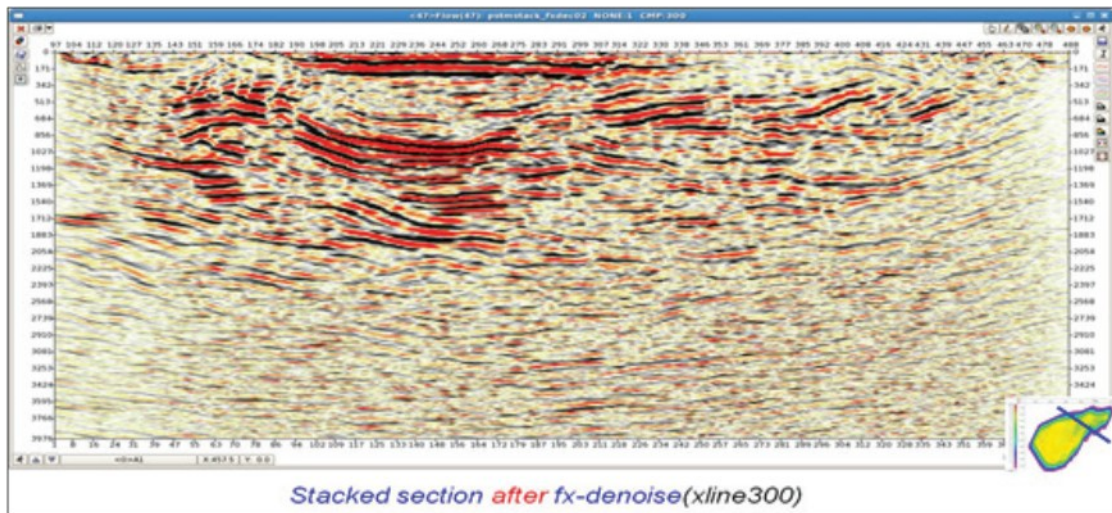


Figure 5c



Time-Windowed Frequency-Wavenumber Filtering

Time-windowed f-k 3D is a kind of constrained f-k 3D. The theory is the same as f-k 3D, the difference is that time-window f-k 3D uses a constrained time-window (Figure: 6).

Figure 6a

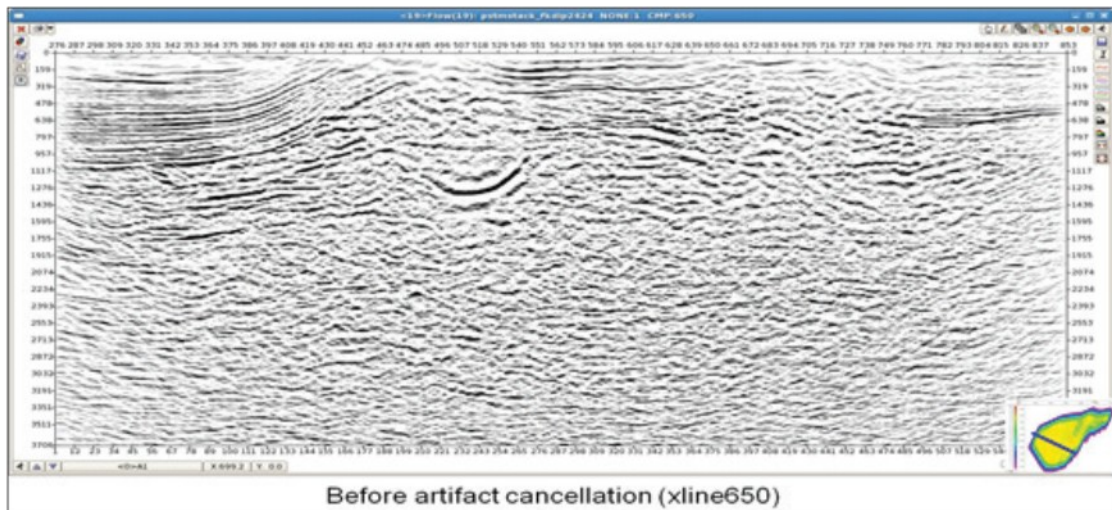
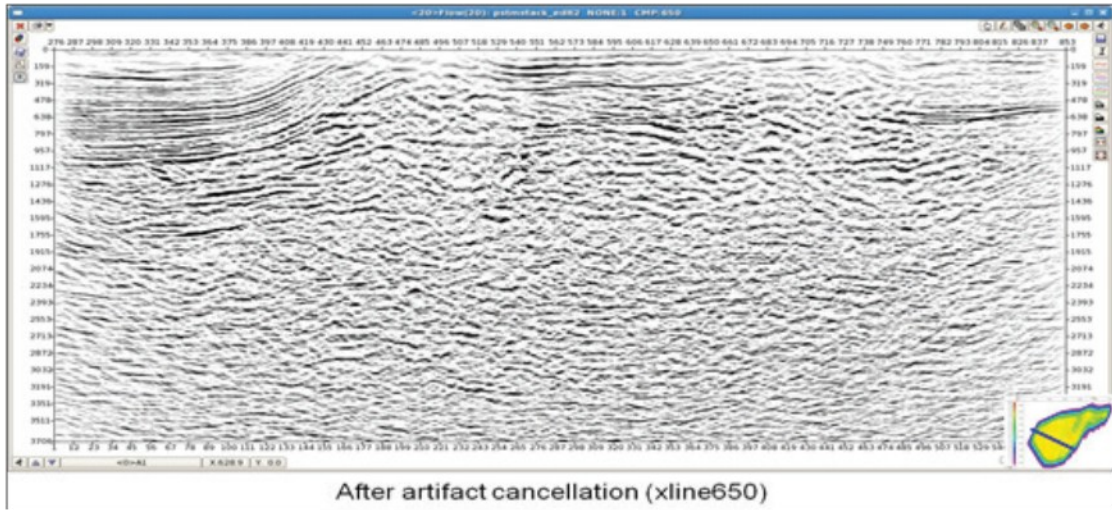


Figure 6b



3D-Polynomial Fitting Technique

This method can reduce the distortion of amplitudes and it can deal with non-horizontal and flexural seismic events at the same time. It also improves the resolution of seismic data commendably (Figure: 7)

Figure 7a

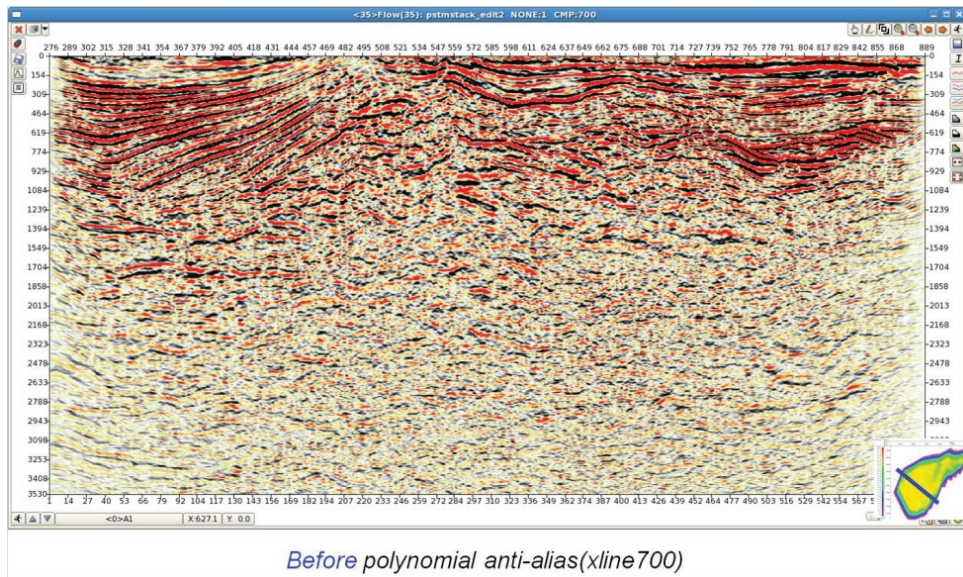


Figure 7b

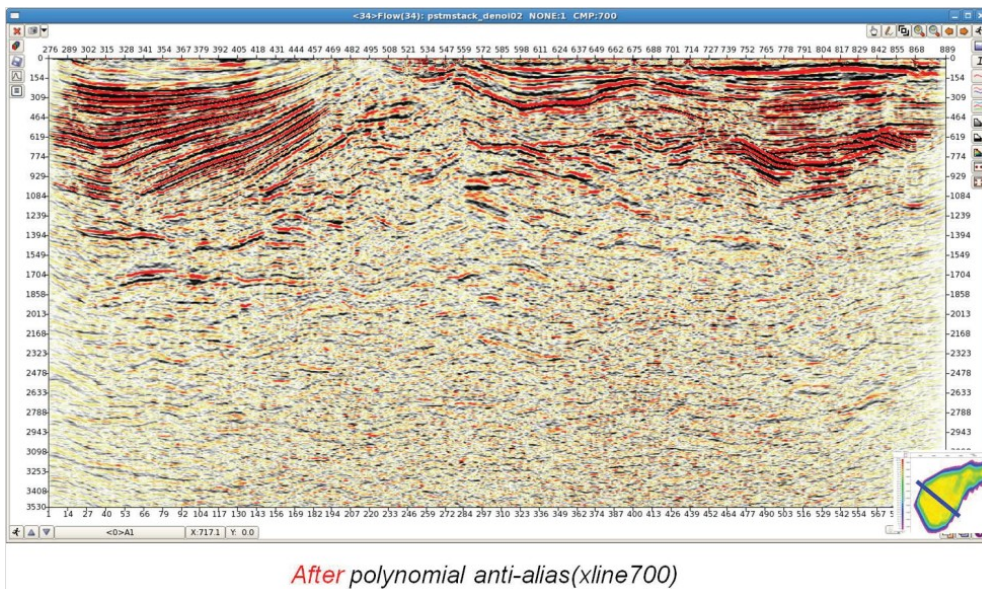
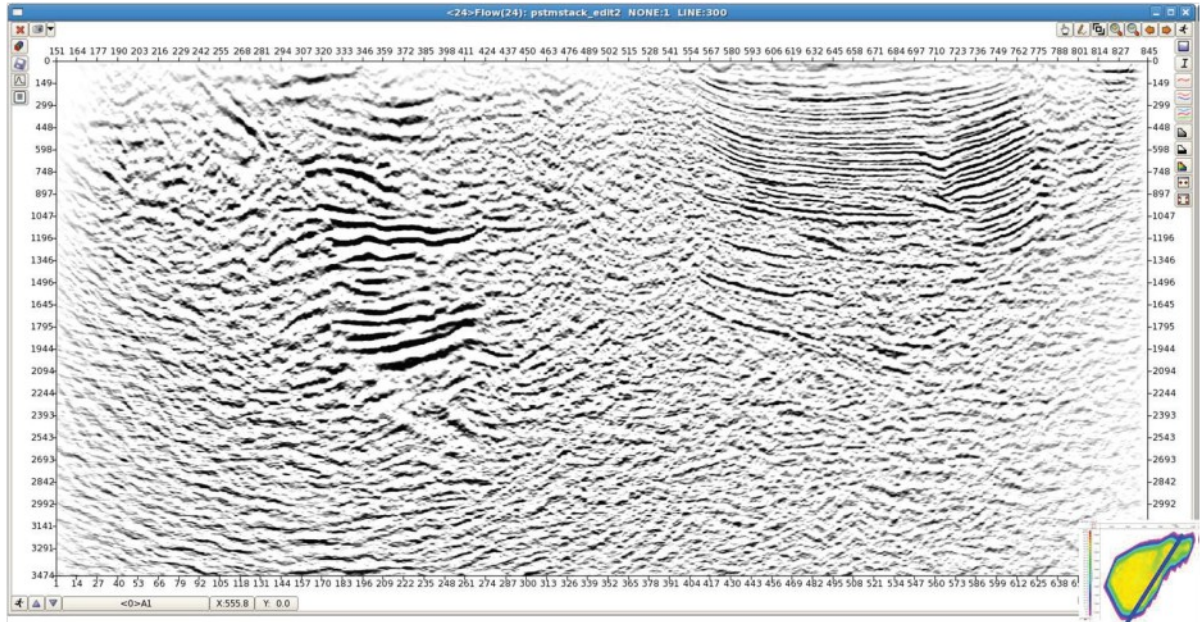


Figure 7 (a) before and (b) after PFT

Inverse Q Filtering & Spectral Blueing

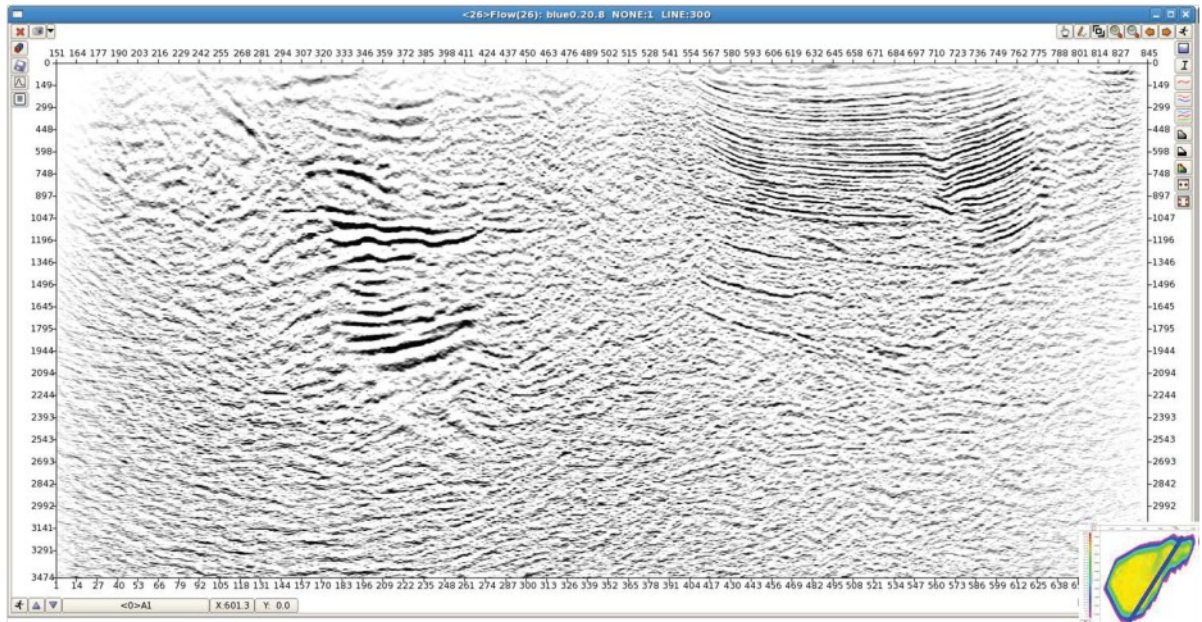
To compensate for the earth Q-filter (attenuation due to high-frequency loss and travel time), time variant phase and amplitude compensation is applied using a Futterman frequency constant Q model of earth attenuation. Prestack or stacked data can be compensated for depth and laterally variable Q. Compared with the routine deconvolution, the Spectral Blueing modeling deconvolution has better adaptivity for non-white noise reflection coefficient, with this method better results can be obtained in the processing in which the residual wavelet was compressed so the resolution was raised (Figure: 8).

Figure 8a



Spectrum blueing(original no filtering, inline=300)

Figure 8b



Spectrum blueing ($\alpha=-0.2, \beta=-0.8$, inline=300)

Figure 8 (a) before and (b) after Inverse Q & Blueing

Final Results:

Figure 9a

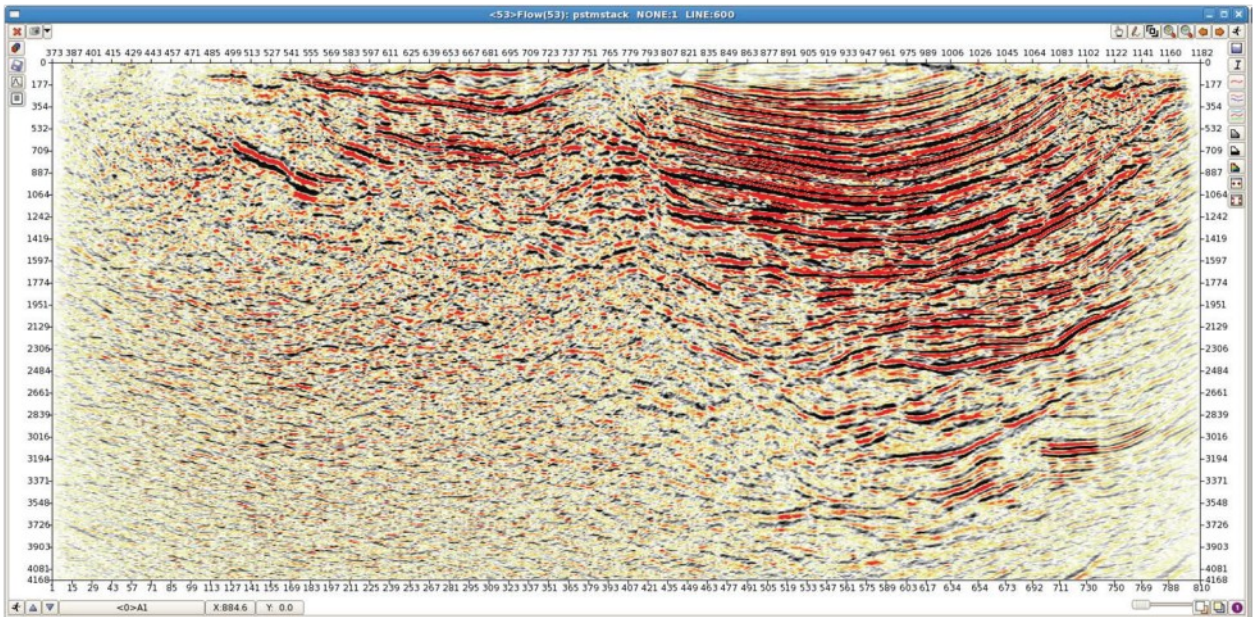


Figure 9b

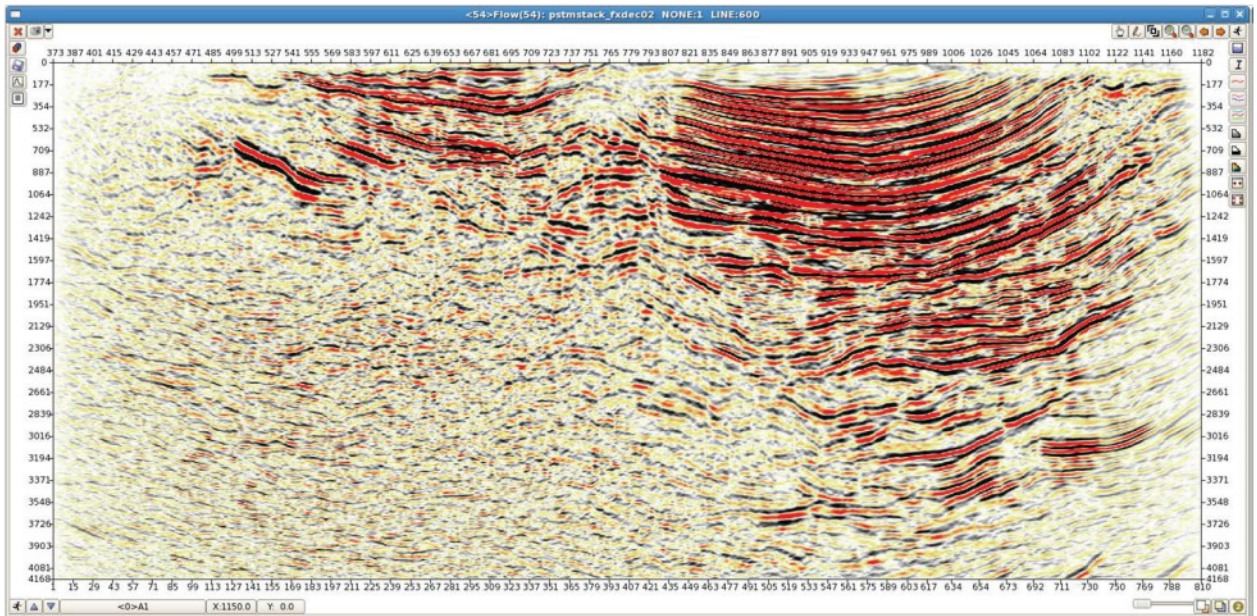


Figure 9 (a) before and (b) after Final Stack

Conclusions

The application of various post processing algorithm tools for this project have proven very effective in enhancing the final PSTM volume. However, limitations still exist during this process because of sparse recording in the initial acquisition, low S/N ratio in some areas of the data contributing to horizontal amplitude variations and aliasing of wavelets during time domain enhancements.

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HOW WELL DO YOU KNOW YOUR WELLS?! Fill in the extended name and abbreviations respectively.

	Well Name Abbreviation	Extended Name
1	AQS	?
2	?	Apex Coora
3	AO	?
4	AV	?
5	?	Boodoosingh
6	BE	?
7	?	Wilson
8	PI	?
9	?	Congo River
10	FZ	?
11	P	?
12	LB	?
13	MDB	?
14	?	Siparia
15	DV	?



Pumping Jacks in the Barrackpore Oilfield, Southern Basin Trinidad

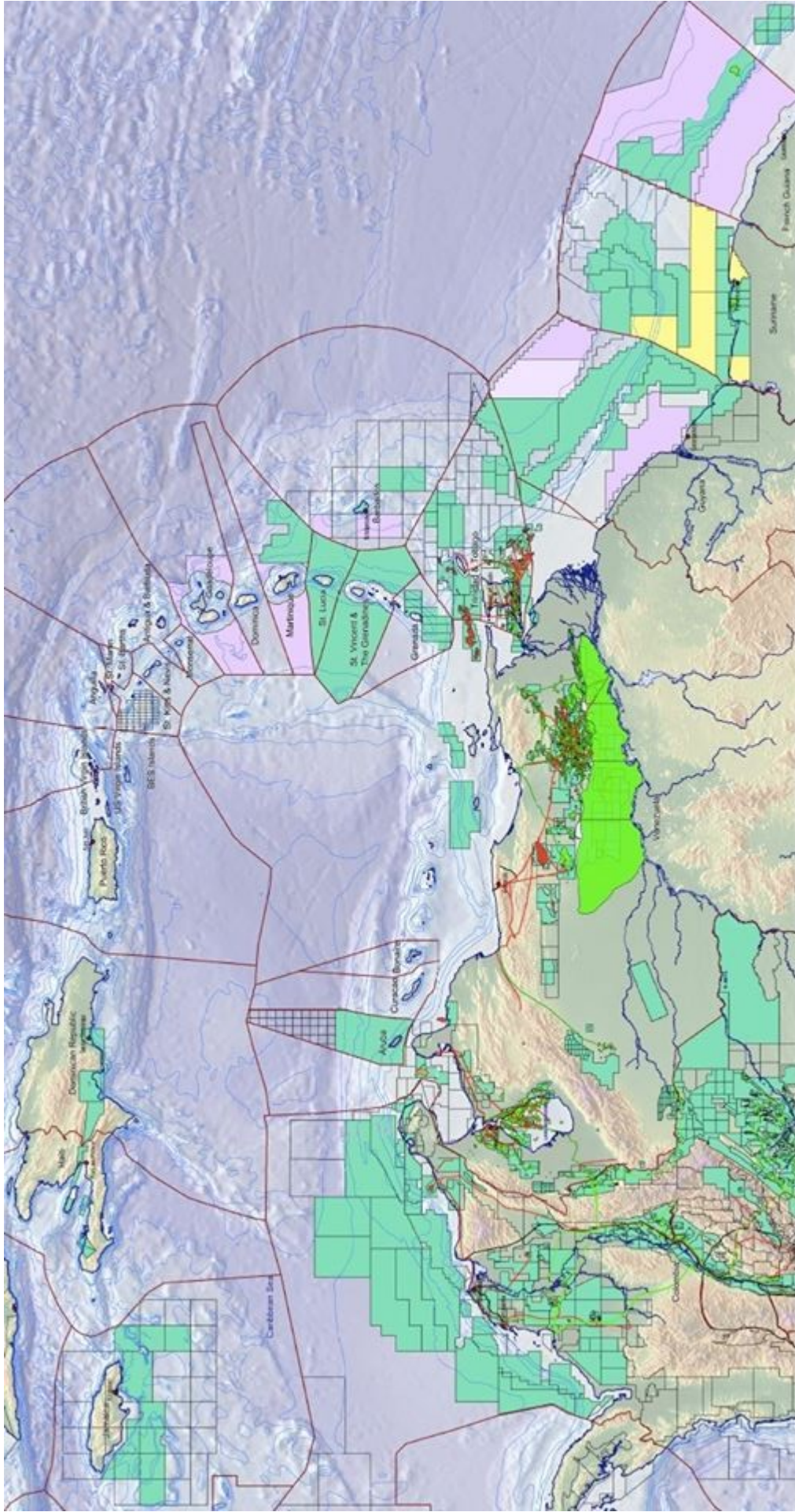
ANSWERS FROM OUR LAST ISSUE

WHAT TIME IS IT?

Fill in the missing eras, periods and epochs to account for the time from the deposition of our primary source rock to present day.

ERA	PERIOD	EPOCH
CENOZOIC	QUATERNARY	HOLOCENE
		PLEISTOCENE
	NEOGENE	PLIOCENE
		MIOCENE
		OLIGOCENE
	PALEOGENE	EOCENE
		PALEOCENE
		LATE CRETACEOUS
	MESOZOIC	CRETACEOUS

WHERE ARE YOU EXPLORING ?



Found something interesting in your area of study you wish to share with the geological community?
Please send to thegstt@gmail.com