



The Hammer

Newsletter of the Geological Society of Trinidad and Tobago

August 2004

P.O. Box 3524, La Romaine, Trinidad and Tobago W.I.

www.gstt.org

UWI Petroleum Geoscience Programme

On Wednesday 2nd June, 2004, The University of the West Indies held a formal opening of the new facilities for the Petroleum Engineering / Geosciences Program and in recognition of the first graduating Petroleum Geoscience Class. Guests of honor included Mr. Eric Williams, Minister of Energy and Energy Industries and Mr. Franklin Khan, Minister of Works and Transport. At this function, the President Mr. Fazal Hosein received a token plaque of appreciation on behalf of Mr. Victor Young On for his efforts on the Steering Committee of the program. Congratulations to Mr. Victor Young On, geophysicist at Petrotrin for his valuable contribution on behalf of the Geological Society of Trinidad and Tobago. The society would like to say thank you Victor for your efforts. Also receiving a plaque of appreciation was Mr. Wayne Bertrand, President Operations, Petrotrin for his sterling contribution in initiating this program and for his yeoman efforts in making this program a success. Other members of the society receiving plaques of appreciation were Mr. Clement Ramroop of Petrotrin, Mr. Donald Charles of bpTT, Ms.

Allison Dupigny of British Gas and Mr. Brian Baptiste of EOG Resources.

On behalf of the Geological Society of Trinidad & Tobago I would like to thank them all for their valuable contribution to development of the Geosciences. Regards
Fazal Hosein

President

GSTT Annual Family Day

Our Third annual Geological Society of Trinidad and Tobago (G.S.T.T) Family Day was held on the 18th of January 2004, at Petrotrin Camp, Pointe-a Pierre.

It began as a sunny day with the children starting off the activities which included races such as egg and spoon and sack races to name a few. There was good food and great company. The heavy downpour after lunch failed to dampen our spirits and we continued with our activities as planned. The adults took part in activities such as musical chairs and an exciting game of cricket. Everyone had a great time, especially the little ones in the rain.

To those who supported and attended this venture, we thank you for making this event possible and successful.

We hope to see more of you for a better and bigger family day in 2005.

Lorez des Vignes

On the Calendar

This column features upcoming events and sessions hosted by the GSTT locally or international events that would be of interest to the membership of GSTT.

For further information on any of the events contact the Secretariat Administrator, Nazreen Mohammed at gstt@tstt.net or call 868-679-6064.

Upcoming events

➤ **Local**

The GSTT is expected to be hosting a myriad of different events throughout the calendar year. These would include technical sessions as well as several social events. Members will be notified via email or you can also visit the society's website at www.gstt.org.

➤ **Look out for the upcoming "Geos who could cook and entertain 2" on Saturday 4th December 2004. See advertisement on page 6.**

➤ Also be on the lookout for the Society's Annual Dinner and Dance carded for November 13th 2004. Details will be made available soon.

➤ **International**

AAPG Prospect and Property Expo

The AAPG will be hosting its annual Prospect and Property Expo from September 14th to 16th 2004, at the George R. Brown Convention Center in Houston Texas. Please visit the AAPG's website at www.aapg.org for further information.

AAPG International Conference and Exhibition

The AAPG will be hosting its annual International Conference and Exhibition from October 24th to 27th 2004, in Cancun Mexico. The theme of this year's conference is "Petroleum Industry in the 21st Century: Technology, Business and Frontiers". The schedule promises this event to be an interesting one. Further information is available online at www.aapg.org.

THE SOCIEDAD VENEZOLANA de INGENIEROS GEOFISICOS (SOVG)

The SOVG cordially invites you to the XII Venezuelan Geophysical Congress to be held in Caracas, Venezuela, from the 14th to the 17th November 2004. Further information is available on the SOVG's website at www.sovg-ve.org.

PAST TECHNICAL SESSIONS

The GSTT hosted three Technical Sessions since our last issue of the Hammer. However, be sure to attend future sessions as you get a chance to relax and learn

something at the same time, not to mention the delicious eats and drinks. Notification of future sessions will be sent out to you via email, you can also check the GSTT's website at <http://www.gstt.org> for information. To host a Technical Session, please contact Mr. Fazal Hosein at fhosein@tstt.net.tt or call (868)682-8491.

- ***“Seismic Inversion: Why we should work on the Impedance Domain? The value of working on the Impedance Domain ”***, presented by Mrs. Rosemarie Ramkhelawan, Geophysicist, BP Houston, on Tuesday March 16th, 2004. The presentation discussed how the impedance domain allows you to use the rock properties of layers to define reservoir parameters, instead of using the contrast in rock properties between layers. She showed the seismic inversion workflow and looked at various examples of well to seismic impedance ties. She also examined the value of AVO in the impedance domain.
- ***“ Ichnofossils in the Manzanilla Formation: What’s in a name?”*** presented by Mr. Steve Jeetan, Geoframe and Deployment Manager, Schlumberger, on Tuesday March 16th, 2004. This presentation was based on unpublished field work conducted in the Claxton Bay area. The data was presented to assign the ichnotaxonomic names *Ophiomorpha nodosa* and *Thalassinoides suevicus* to the fossil burrows found in the area.

Parametric tests was performed to check whether different organisms created the trace fossils found and to reconstruct the paleoenvironment.

- ***“ Overview of BP’s Field of the Future Distinctive Technology Program”***, presented by Dr. Andy Leonard, Sedimentologist, BP on Wednesday March 31st, 2004. Field of the Future (FOTF) is a distinctive BP technology programme that is applying digital technologies to every aspect of oil field operations - from reservoir to export - to increase production and reduce capital and operating costs. Field of the future combines new technologies, new business processes and real time data to create a fast, streamlined approach to reservoir and facilities optimization.
- ***“Deep Marine Shelf Margin Processes and Deposits in Eastern Offshore Trinidad”***, presented by Dr. Leslie Wood, Research Scientist and Lecturer at the University of Texas at Austin on Tuesday April 27th, 2004. She discussed the documentation of the region using 10,000 sq. km of 3-D seismic and data from nearly 200 dropcores, in an effort to understand the morphologic character and the basin evolutionary models. Such understanding included documenting the interaction of tectonics, sea-level and marine processes in development of deep marine depositional systems,

understanding the development, distribution and impact that gas hydrate has on margin evolution and quantitative analysis of submarine slope and basin architecture to reduce uncertainty in hydrocarbon exploration and development and design models for predicting reservoir/seal character in deep marine system. In addition, she showed a 3-D visualization cartoon that enabled us to view the seafloor and deeper strata as never before, examining enormous deep marine channels, catastrophic debris flows and scours and multi-tiered mud volcanoes rising over 150 meters above the sea floor.

- ***“Sick on Sulphur- Formation to Excavation of Pocellanite Deposits”***, presented by Mr. Hasley Vincent, Geologist at the Ministry of Energy and Energy Industries, on Tuesday July 13th, 2004. Hasely spoke about the sulphur emissions in the Chatham area, Southwest Trinidad. The discussion reviewed the chronology of events surrounding the occurrence, which provided the opportunity to observe the ‘real time’ formation of porcellanite deposits. The association of porcellanite deposits with lignite was examined by the mapping of the gross depositional environment associated with five porcellanite outcrops (four in the Southwest Peninsula and one in Fishing Pond). That exercise confirmed the association of porcellanite outcrops with lignite beds, supporting the existing theories

for the formation of these spectacular rocks.

- ***“The Application of Geomechanics to Wellbore Stability and Fault Seal”***, presented by Dr. Chris Ward of Geomechanics International, Houston Texas, on Tuesday July 27th 2004. The presentation covered design considerations for life of field wells, data requirements, and the process of building a geomechanical model for well bore stability and fault seal issues. He touched on quantitative risk analysis methods in determining the value of additional data acquisition and also showed a brief case study on deepwater field development to demonstrate the process. He also talked about the importance of knowing about the seal integrity of reservoir bounding faults.
- ***“Seismic on Demand- Permanent Seismic Monitoring of the Valhall Field, Norway”***, presented by Mr. Olav Barkved Geoscientist of BP Norway, on Wednesday August 4th, 2004. Mr. Barkved gave a wonderful presentation of the field-wide permanent array combined with the seismic source at the Valhall Field in Norway. He discussed the installation and operation of the system and gave examples of images, showing how reliable the 4D responses are on production induced changes of the reservoirs in the field.

PAST FIELD TRIPS

Point Radix Field Trip – This trip of 14 people to the Point Radix peninsula of eastern Trinidad examined sandstones of the Trinity Hill Member of the Lower Gros Morne section of the Pliocene Moruga Formation. The day started hot and dry and the trip started at the mouth of the Ortoire River on the northern side of Point Radix, for those who collect shells this beach was literally covered with them. Having arrived at near low tide, the wave cut platform was exposed, allowing easy access to the outcrop, that normally one had to walk in the water to visit. Those with shoes however got them wet. Firstly, the Trinity Hill Sandstone was examined, present were fairly robust *Ophiomorpha*, cross-bedding and cut and fill structures suggesting a lowshore face environment. Also visible were a number of vertical faults with small vertical displacements and even horizontal slickensides, that are probably related to the Point Radix fault zone. The rest of the section consisted of thinly bedded siltstones and claystones with minor sands. A few resistant sands formed projections into the sea, one of which will be featured in the 2005 GSTT calendar. Climbing some of these sand beds proved challenging for a few members but with help all got over safely. Reaching the third sand projection, we could not proceed further without endangering life and limb, and the official trip came to an end. The weather then changed and began raining, cooling us down as we walked back to the bus taking back memories, photos and most importantly rocks, back home.

Paria Field Trip – unfortunately this trip got off to a bad start when most persons who

had indicated they were attending, did not turn up or call to indicate they were not attending. However, with the 10 people who did turn up it was the start of what turned out to be a very enjoyable day. We arrived at Blanchicuesse and drove to a point where the maxi had to stop and began walking. Glimpses of the geology peeped out from the roadway and bushes at the side of the road. A number of overturned folds were the first seen. Walking uphill through the forest was very refreshing, until the first hill was reached, most struggled to reach the top of the first hill. The second hill was the steepest and even those who thought they were fit had to stop and catch their breath. Finally we reached the coast and every one started taking photos, after resting and eating lunch we walked east along the beach rounded a headland and saw Church Rock, the arch at Paria Bay (used on t-shirts by the GSTT). This touched off another frenzy of photo taking. From here we walked to the falls where we all had a refreshing dip or tried fishing with some success. From there it was back to the beach, hopped on to a boat for a sail back to the bus. Four people decided they were fit enough to walk back and did so with less problems than going there in the first place.

Curtis Archie

FEATURE ARTICLE

Increasing seismic resolution using spectral blueing and colored inversion: Cannonball field, Trinidad

*Gregory Blache-Fraser**, bp Trinidad and Tobago
Jeremy Neep, bp Trinidad and Tobago

Summary

High-resolution seismic data is needed for development of the TP65 sand, which is the main reservoir of the Cannonball field. The TP65 sand consists of two sand units: a high net-to-gross unit above a lower net-to-gross unit. Spectral blueing has been applied to the original seismic data over the field to increase the seismic resolution. The improvements in resolution were quantified by wavelet estimation at the field discovery well and show that the usable seismic bandwidth has been increased by 20Hz. Colored inversion of the blueed seismic data has allowed more detailed correlation to the sand units in the well compared with the inversion of the original seismic data. Attribute analysis shows the areas where the two sand units are being separated or where only the upper sand unit is present. There is also better definition of a channel feature and of small-scale reservoir features, including the gas-water contact.

Introduction

Field Description

The Cannonball field is located in the Columbus Basin, approximately 35 miles offshore of the southeastern tip of Trinidad. The TP65 pay sand is a predominantly very-fine to fine grained, moderately well sorted, clean quartz sand deposited in a suite of shallow marine environments. Non-reservoir intervals consist of mudstone and silty mudstone deposited in nearshore marine to offshore environments.

There is well control in the reservoir where the Iron-Horse-1ST-1 well discovered 289 ft of gross pay in a single

reservoir interval at a depth of 12,334 ft. The TP65 rock properties in the well are good (N/G 79%; Porosity (avg.) 18.5%; Permeability (avg.) 265 mD calibrated to cores over this interval. A gas/water contact (GWC) is predicted at 13,000 ft using evidence from structural mapping and seismic amplitude/flatspot interpretation.

Seismic data

Seismic analysis is the principle method used to identify and quantify the hydrocarbon reserve potential of the Cannonball TP65 Sand. The seismic mapping of the Cannonball field was completed using the 1992 3D seismic survey after reprocessing in 2003. The reprocessing flow included 48ms Tau-P DBS, DMO, V (z) PSTM, HiRes radon demultiple, stack, 48ms DAS, RNA and modified residual migration.

The overall data quality is good, allowing mapping of seismic reflectors across faults and around fault tips, even at depths of greater than 13000 ft. However, the faulting pattern in the main Cannonball fault block suggests that there are several sub-seismic faults within the segment. Within the main field segment, one synthetic fault can be imaged using seismic data, but based on attribute lineation, smaller offset faulting may exist within the segment. Resolving these small faults is important for field development and well location. Seismic evidence indicates that small faults and a possible stratigraphic pinch-out of the sands up-dip to the southeast may also provide an important trapping element.

Benefits of improved resolution include reduction of uncertainties in following areas:

- Improved definition of an incised channel feature and compartmentalization within the field.

Method.

The main tools used in this paper for increasing seismic resolution are spectral blueing and colored inversion. Spectral blueing matches the mean seismic spectrum to the well reflectivity spectrum over a user-defined bandwidth and can be used to design operators to boost the amount of high frequencies in seismic data. Colored inversion is a simple and fast technique to invert band-limited seismic data to relative impedance (Lancaster and Whitcombe, 2000).

Spectral blueing was first applied to generate a higher resolution reflectivity dataset. Colored inversion was then applied to convert the original and higher resolution reflectivity data to relative impedance. Relative impedance volumes will allow much easier interpretation and correlation with the Cannonball reservoir sands.

The workflow used to generate and analyze the benefits of increased resolution seismic data was as follows:

- 1) Estimate wavelets from well-seismic tie using the Ironhorse-1 well to determine the seismic phase of the reprocessed data. This showed that the phase was around 40 degrees so the reprocessed data was then zero-phased by applying a constant -40-degree phase rotation.

- Reservoir presence and resolving the upper and lower sand units.
- Identification of 'sub-seismic faults'.
 - 2) Design a spectral blueing operator to match the mean seismic spectrum to the mean reflectivity spectrum and extend the seismic spectrum to around 60Hz (Figure 1).
 - 3) Apply the operator from step 2) to the zero-phase seismic data and re-estimate the seismic wavelets from the new higher resolution seismic volume. As a further test of the optimum seismic resolution, wavelets were also estimated from the Ironhorse-1 upgoing VSP corridor stack.
 - 4) Invert both the original and higher resolution seismic data using colored inversion.
 - 5) Generate attribute maps on all inverted seismic datasets to determine the benefits of increased resolution for stratigraphic and structural interpretation.

Results.

The results of spectral blueing, using the operator in Figure 1, show that increasing the seismic bandwidth improves the resolution of the two main TP65 sand units (Figure 2). The trough event from the top of the lower unit can now be interpreted on the higher resolution seismic.

New wavelet estimates from tying the higher resolution seismic data to the Ironhorse-1ST-1 well are shown in Figure 3. The seismic bandwidth has increased by 20 Hz at -15dB down after spectral blueing. The wavelet from tying to the VSP corridor stack contains

frequencies out to 90Hz. The VSP data has the optimum seismic resolution geology.

The seismic data after colored inversion is shown in Figure 4. It is much easier to resolve the individual units within the TP65 sand on the higher resolution inversion and to correlate the inversion to the gamma-ray log in the well. The channel feature in the top sand is now well resolved.

Attribute maps from the inverted datasets were generated using a horizon picked on the zero crossing on the inversion. Increasing the seismic resolution has separated the individual trough responses from the upper and lower TP65 sand units (Figure 4). This results in smaller amplitudes on the attribute maps where the two sands are being resolved (Figure 5). Similar areas in both attribute maps indicate areas where only the top sand unit is present. There is also better definition of the channel feature and of small-scale reservoir features within the main reservoir field. The gas-water contact is more clearly defined.

Conclusions

The techniques used in this paper have increased the seismic resolution over the Cannonball field by applying spectral blueing and colored inversion to the existing seismic data. The amount of

because the seismic waves have only passed one-way through the overlying

frequency enhancement has been calibrated by tying the higher resolution seismic to the Ironhorse-1ST-1 well. Spectral blueing has increased the usable seismic bandwidth by 20Hz. The optimum seismic resolution was also determined by tying the well to the Ironhorse-1ST-1 VSP corridor stack.

Colored inversion of the blued seismic data has allowed better correlation to the sand units in the well compared with the inversion of the original seismic data. The high-resolution inversion allows the individual units to be resolved. Attribute analysis shows the areas where the two sand units are being separated or where only the upper sand unit is present. There is also better definition of a channel feature and of small-scale reservoir features. The increased information about reservoir presence will prove very valuable during field development.

References

Lancaster, S. and Whitcombe, D., 2000, *Fast-track 'colored' inversion, 70th Ann. Internat. Mtg: Soc. of Expl. Geophys., 1572-1575.*

Acknowledgements

We would like to thank BPTT for permission to publish this paper. Seismic Spectral blueing software from ARK CLS Limited was used in this analysis.

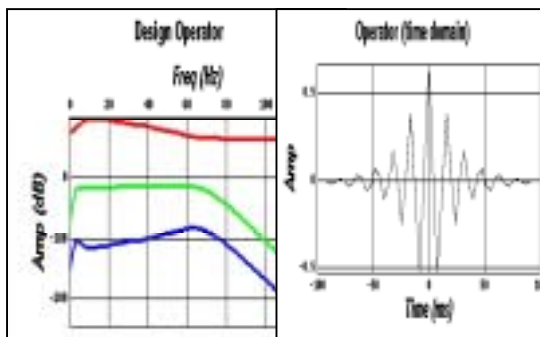


Figure 1: Mean seismic spectrum (red) and mean well reflectivity spectrum (green). The spectral blueing operator (blue curve) was designed over 4-60Hz to match the mean seismic spectrum to the mean well reflectivity spectrum.

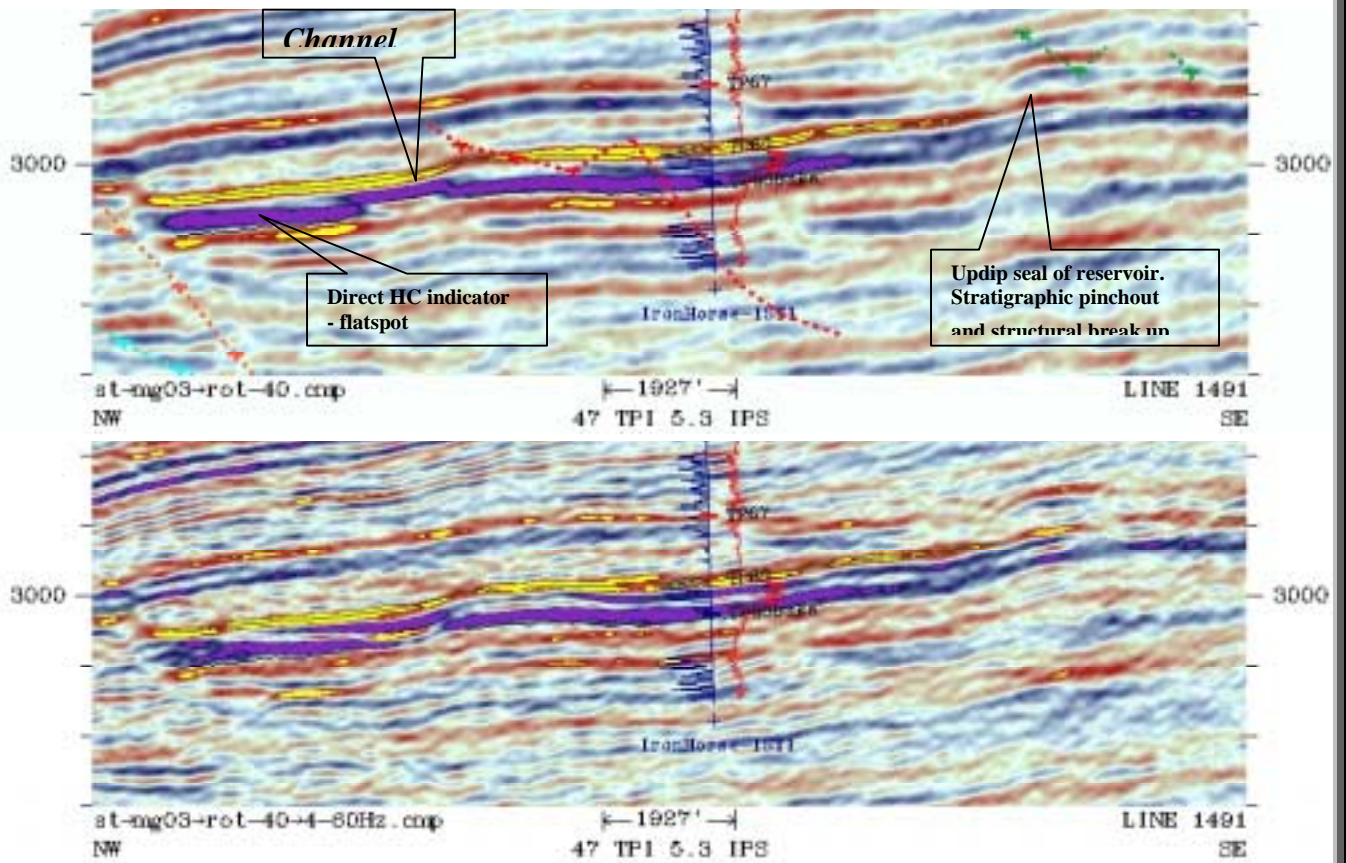
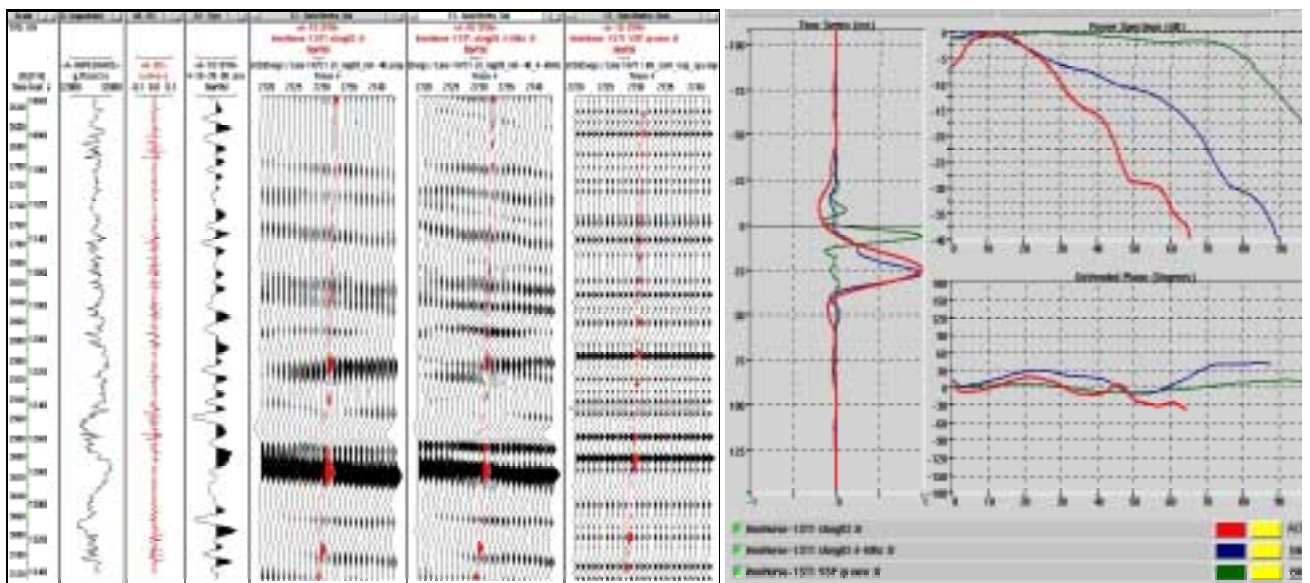


Figure 2: Upper section shows zero-phase seismic data and Ironhorse-1 GR (blue) and RT logs (red). Lower section shows results of applying spectral blueing operator from Figure 1.



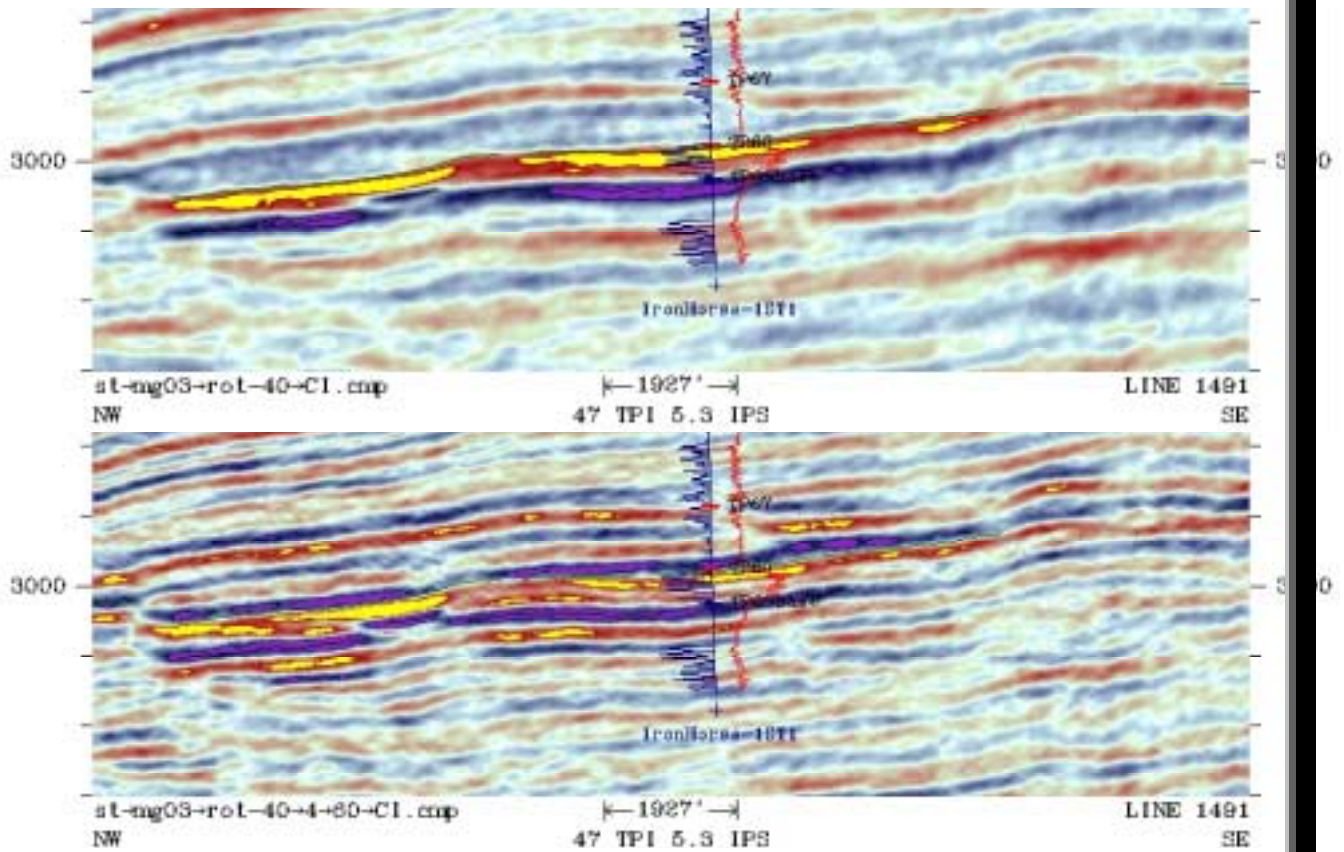


Figure 4: Upper section shows colored inversion of original seismic data without spectral bluing. Lower section shows results of inverting the higher resolution seismic data obtained from applying the spectral bluing operator. It is much easier to resolve the individual units within the TP65 sand on the higher resolution inversion and to correlate to the GR log (blue).

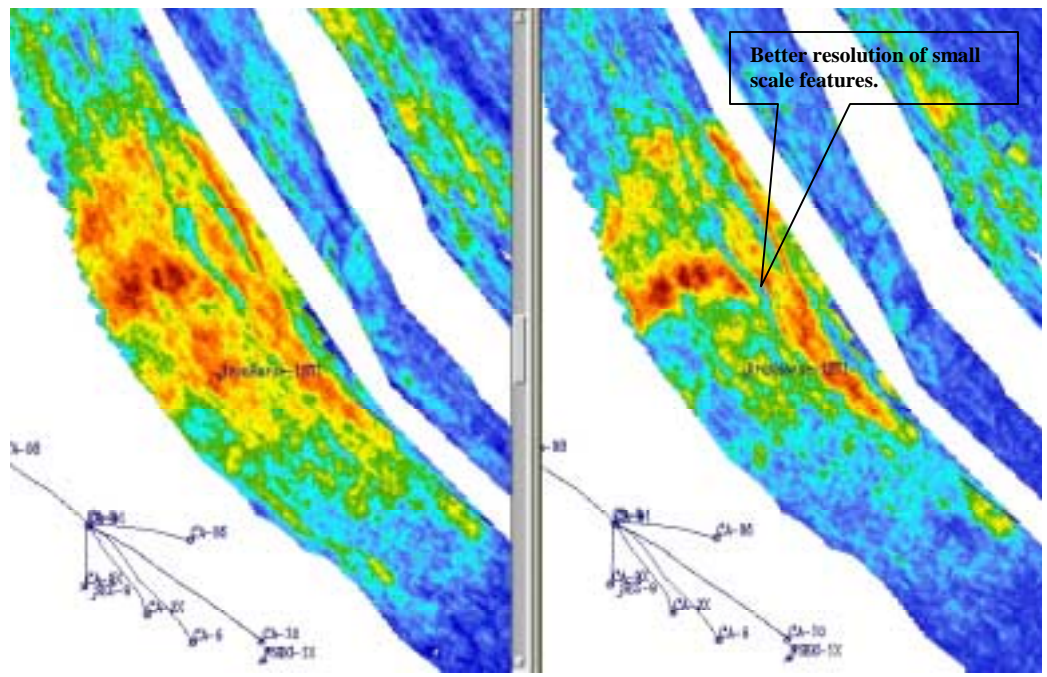


Figure 5: Attribute maps on colored inversion volumes shown in Figure 4. Attribute map from inversion of high resolution seismic (right) shows reduced amplitude in areas where the individual TP65 sands are being resolved. Original map (left) shows constructive interference between the two sand units. Both maps generated using same window and input horizon.

SOME HUMOUR

Total Immersion Geologists

Are you totally obsessed with geology? If so, then you are a total immersion geologist. Here are the 10 warning signs:

1. You judge a restaurant by the type of decorative building stone they use rather than their food.
2. You manage to turn any conversation into a discussion of geology, as in: “What did you think of that Superbowl game last night?” “I must have missed that conference. Who sponsored it? GSTT?”
3. You refuse to let nightfall stop your field excursions and continue looking at outcrops using the headlights of your vehicle.
4. You like rock music only because it’s called “rock” music.
5. You will try to claw through the water flowing in a stream to get a better look at the bedrock at the base of the channel.
6. You will walk across eight lanes of freeway traffic to see if the outcrop on the other side of the highway is the same type of rock as the side you’re parked on.
7. You name your children after rocks and minerals.
8. You’re not sure if you have children.
9. You view non-geologists as subhuman.

EDITORIAL NOTE

We hope you enjoyed reading this issue of the Hammer, covering the events and activities since the last issue. Hopefully we did a good job this time around in keeping you up to date in what the Society is doing. Thanks go out to Mr. Gregory Blache-Fraser and Dr. Jeremy Neep, both of BP Trinidad and Tobago for their very informative Feature Article on Spectral Blueing and Coloured Inversion (please visit <http://abstracts.seg.org> for further info.). Thanks also go out to Ms. Lorez des Vignes for her article on the Family Day and Mr. Curtis Archie for the field trip articles. The committee would like to urge the members of the GSTT to contribute in any way, articles, advertisements, information, pictures etc., anything that may be of interest to the geological society here in Trinidad and Tobago.

Any feedback or comments on this article are welcome as we try to continuously improve each issue. We welcome any ideas. Comments can be sent to Justin Smith at smitjw@bp.com. If you are interested in providing any contributions to GSTT’s activities either in the form of articles, technical presentations or ideas, please contact Ms. Nazreen Mohammed at (868)679-6064 or by email at gstt@tstt.net.tt

Justin Smith: smitjw@bp.com

Don’t forget to get your tickets for Saturday’s Geos who could cook and entertain 2. See advertisement on next page.



Members enjoying a game of windball cricket on Family Day



A pit stop during the Paria field trip



The lovely Paria Waterfall