# Seismic enhancements in the northern basins of Brazil.

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## Abstract

In the Northern Basins off shore Brazil, a quantity of non-exclusive seismic data was acquired and processed about eight years ago. This dataset is widely accepted to be a good quality, but one that could be significantly improved by applying new technology now available.

This involves not only the application of conventional time and depth imaging algorithms themselves, but also data conditioning tools that precede the imaging stage, such as algorithms for attenuating multiple reflections of the water bottom as well as residual noise. The same also applies to subsequent Reservoir Characterization tools, such as Simultaneous Pre-Stack Inversion, that were not available in the past.

In this talk we will discuss the work that has been done in applying these new technologies to the datasets, the measure of success that we have had with these tools, and the additional plans and expectations we have to improve the seismic image of the Northern Basins using the new technology available.

## Introduction

In an arena of ever more readily and cheaply available compute power, it is possible to realize a large number of geophysical processes that could not previously be applied in practical day to day processing. This applies not only to the time and depth imaging algorithms themselves, but also to data conditioning.

For this reason the “shelf life” of processed seismic data is continually decreasing. Hence a seismic dataset that was last processed only a year or two previously may benefit from a complete reprocessing; a dataset that has not been processed for four years will almost certainly benefit from a full reprocessing; and a dataset that is already six or seven years old will without doubt be significantly improved by a full reprocessing from field data.

In figure 1 we see an example of the reprocessing work from the Northern basin.

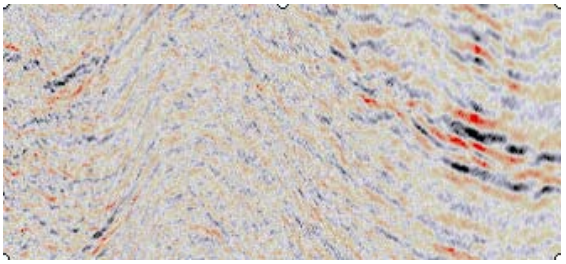

**Fig1**a; Image quality of the legacy data from 2001, using data processing technology available at that time.

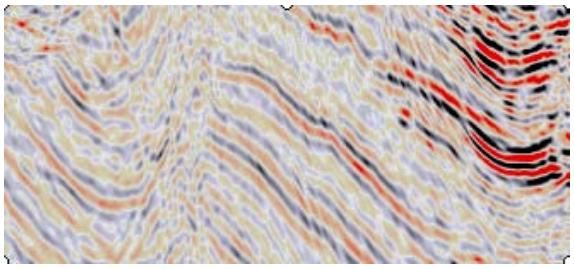

**Fig1**b; Image quality following a complete reprocessing in 2008. Note much improved clarity and Signal to Noise ratio.

## Enabling technologies

In both Time and Depth imaging, the objective is to produce flat, correctly positioned pre-stack gathers that will then ‘stack’ to form a clear image.
Both Time and Depth imaging require a correct velocity model to deliver an accurate image. This is derived from the data itself, by velocity analysis, and is increasingly achieved by automatic means.
In the case where the data is contaminated by residual multiple energy and noise, there is a very great probability that the velocity derived will be incorrect, as picking manually or automatically is complicated by noise and multiple trends. Consequently, the final image will also be incorrect.

Hence, enhanced preconditioning of the data will make the imaging step much more successful.

The technologies that enabled this include new tools for Noise Attenuation of both ambient and shot generated noise, such as Marine Swell and Seismic interference.
Following initial noise attenuation stages, it is now possible to apply a cascade of multiple removal processes that combine algorithms not previously available during the original acquisition and processing.

This is of course particularly important in areas with an irregular water bottom, such as we see in many areas off-shore Brazil. These processes include modeling processes, such as Surface Related Multiple Elimination,,combined with separation processes, such as Weighted Least Squares Parabolic Radon Transform. These can then be followed by other noise attenuation processes to remove residual multiple energy still remaining.

Following a careful reprocessing and conditioning of the data, we proceed with the imaging step and associated velocity model building. For a large grid of regularly spaced 2-D lines, such as we have in the basins off-shore Brazil, in order to create the depth migration velocity models in an efficient way and also maintain consistency between adjacent lines, we developed a methodology for creating a complete 3-D velocity model for the grid of 2-D lines.

Having completed the imaging step, it is then possible to proceed with Inversion and other more advanced measurements.

**Results**

The results of the reprocessing and depth migration so far have been very promising in what they have shown. The modern imaging algorithms available greatly add to the resolution and fault imaging in the dataset. This may be significant in understanding reservoir distribution and fluid flow through the basin.
Improved preservation of amplitude information was also seen, and in the final result we observe some interesting amplitude effects. Without additional analysis, it is too early to tell, but these may indicate fluid anomalies.

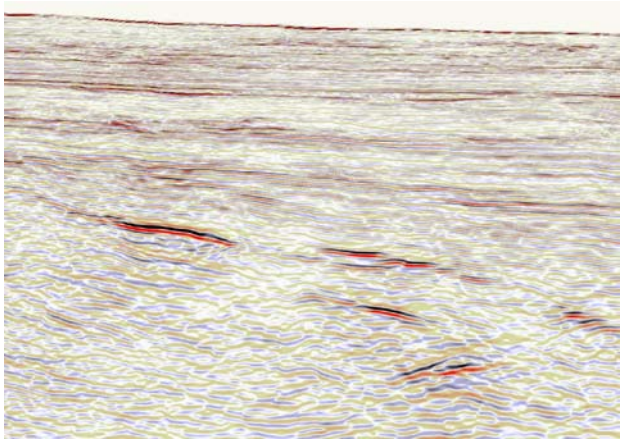

**Fig 2**; Some interesting amplitude information present on the new data.

**Conclusions**

As expected, the application of modern processing algorithms has significantly improved the data quality. The importance of careful pre-stack data conditioning, however should not be underestimated in terms of its impact upon the subsequent imaging step.

Additionally, careful amplitude treatment and imaging can facilitate the application of more advanced technologies.

The improved quality of the result due to the modern techniques applied has also led to better basement interpretation and therefore basin definition. This has allowed a new examination of petroleum systems and prospectivity of the basin which has created increased optimism for the exploration potential here.

We are investigating how additional measurements, such as Electromagnetics could be used to complement the newly worked seismic information and delineate the location of the basement in areas where the seismic reflectivity is challenged.

It is anticipated that this will establish a new geological model that will explain difficulties faced in past exploration as well as give guidance for the exploration in the future.