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## Meeting the Challenge—Seismic for Deep Exploration and Production Using New OBC Technology

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### Abstract

As the oil industry extends exploration and production to ever deeper plays in offshore areas, for example in the Gulf of Mexico and West Africa, some significant challenges must be overcome in order to provide seismic data that is as useful as the data currently acquired for shallower targets. This paper will outline some of the major challenges and progress towards solutions.

The most significant challenge for deep target acquisition is the very weak, low frequency nature of seismic returns from greater than 10,000 m depth. The uplift from new state-of-the-art acquisition systems and techniques are compared to conventional marine streamer acquisition.

A full scale experiment was conducted in the Gulf of Mexico using a new 4C MEMS-based OBC acquisition system to provide an apples-to-apples comparison of several different air gun source techniques specifically designed to improve depth of penetration. The test also addressed methods to maximize the capture of weak, low-frequency reflection signals.

Data examples show that this new OBC technology provides significantly better deep (> 10,000m) data than conventional streamer. At very low frequencies the ambient noise level controlled the recoverability of the reflection data. For all techniques, Deep Tow; Tune on Bubble; Simulated Over/Under; Acoustic Blanket, the brute stacks produced similar results in the deep section when compared prior to source signature processing. The Acoustic Blanket technique provides promise for modifying the source signature for conventional air gun arrays.

### Introduction

Traditional seismic data acquired via streamers is generally deficient in frequencies below 10 hertz. Among the issues associated with low frequencies are how to record them and how to get them from the field recording to the final stacked sections and data volumes.

Low frequency content is of special interest when imaging deep targets and for inversion. Earth filtering acts as a high-cut filter. As target depths increase, the high-cut filtering becomes more pronounced. At large target depths, the earth filtering can reduce the recoverable frequencies to less than 20 Hz.

Issues that limit our ability to preserve low frequency content are the energy sources, the recording equipment and the ambient noise environment. Of these issues, the recording equipment is probably the most tractable problem. Traditionally, most marine recordings attenuate low frequency signals at a rate of 12 to 18 dB/octave for frequencies below 10 Hz. The recent generation of acquisition system filters allow signals down to 1 or 2 Hz to be recorded without attenuation.

Reducing the low frequency attenuation point is not a cure all; because not attenuating the low frequency content can allow significant ambient noise into our data volumes. In some cases, the low frequency ambient noise can dominate the dynamic range of the acquisition system and for far offsets the ambient noise can be more powerful than the seismic energy sources.

The ambient noise environment can dictate the low frequency that is recoverable from an air gun source. An important question is how to modify existing air gun arrays to allow more recoverable energy in the seismically important frequency band.

### Comparison of Deep Imaging

Figure 1 is a prestack time migration, PSTM, of recent vintage, 2D streamer data that was acquired in the Gulf of Mexico by RXT for GX Technology. For this data set, the 3-dB point of the total low-cut filter is approximately 8.3 Hz. The total filter response is a combination of the sensor, the analog instrumentation filter and the digital instrumentation