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Dual Sensor Streamer Acquisition & Processing in the Red Sea

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SUMMARY

The primary objective was to maximise the total bandwidth of the recorded data, particularly the low frequency signal returned from sub-salt structures, without limiting the higher frequency signal in the shallow section. Deeper cable tow (20 m), large source volume (6180 cu in), and long offsets (10 km) were combined with the dual sensor cable technology in an attempt to achieve this.

As part of the ongoing exploration efforts in the Red Sea and the evaluation of new and emerging seismic technologies, Saudi Aramco has acquired and processed 500km of 2D seismic data using the dual sensor streamer acquisition system. This is the first application of this new technology in Saudi Arabian waters.

The survey was designed with the aim of better imaging deep sub-salt structures and making a head-to-head comparison of the new dual sensor towed streamer technology with existing conventional hydrophone streamer data in the Red Sea. The primary objective was to maximise the total bandwidth of the recorded data, particularly the low frequency signal returned from sub-salt structures, without limiting the higher frequency signal in the shallow section. Deeper cable tow (20 m), large source volume (6180 cu in), and long offsets (10 km) were combined with the dual sensor cable technology in an attempt to achieve this.

The 500km of data were efficiently collected in 5 days, in two uninterrupted sequences of approximately 300 and 200 km in length, without operational downtime or incident. The two lines were acquired over existing long offset data recorded and processed by Saudi Aramco as part of a larger regional marine 2D acquisition program. Both lines matched the source positions and shooting direction of the previous data to provide as close a benchmark for the new technology as possible.

It is understood that the frequency bandwidth of data recorded exclusively with a hydrophone system is constrained by ghosting related to the tow depth of the streamer. A dual-sensor streamer, with both pressure and velocity sensors, can overcome this limitation. Data from the two sensors are combined to decompose the wavefield into up- and down-going parts, thereby eliminating the effects of ghosting and restoring the full data bandwidth. Figure 1, illustrates a shot gather from hydrophone only component (left panel) and the derived P-UP component is shown on the right panel. Note that the receiver ghost is clearly eliminated after the dual sensor summation and wavefield separation process. This in turn benefits both penetration and resolution of seismic reflections, providing a clearer image of the subsurface, especially in challenging environments such as the Red Sea. It also allows a greater towing depth to minimize the effects of surface noises without sacrificing high frequency data to the ghost notches. Figures 2, and 3 depict the frequency spectra obtained from the hydrophone and the P-UP components, respectively. Note that the notching at 37-38Hz is filled in by dual sensor summation and wavefield separation process.

At the time of writing, data processing has progressed through the early stages of wavefield separation to create the up-going wavefield (P-UP) dataset. Further processing and testing continues with a focus on noise attenuation, and demultiple using the most appropriate high end techniques available.

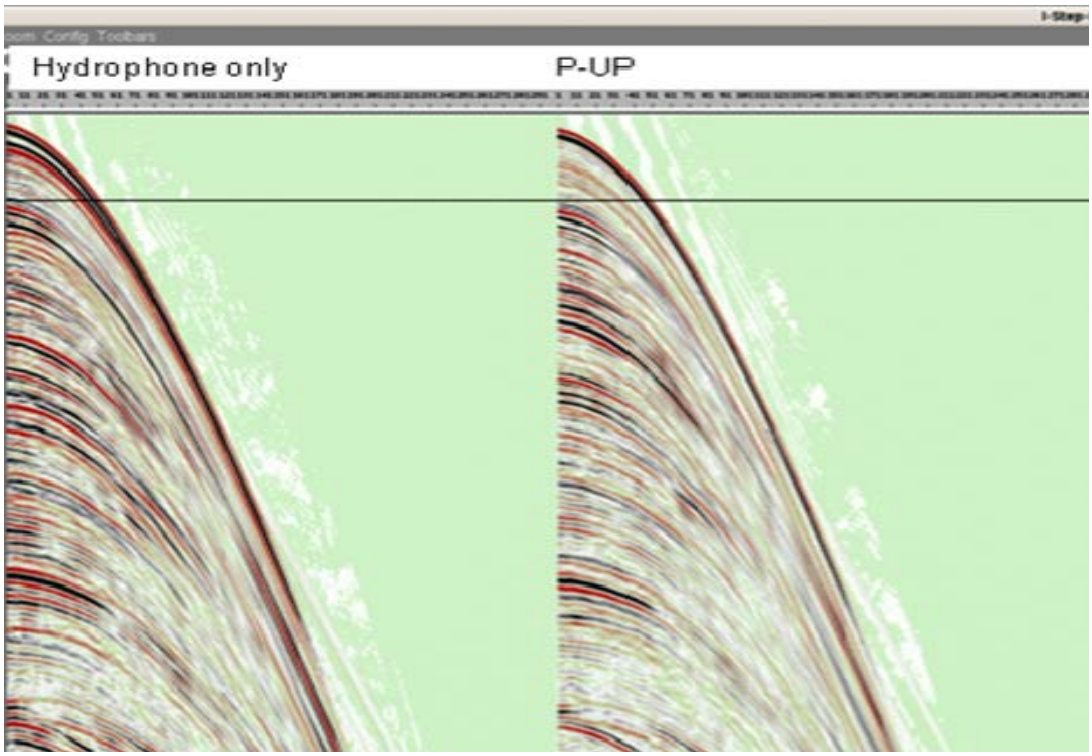

Figure 1 Example shot; left side – hydrophone only; right side – up going wavefield, (P-UP). Note streamer ghost is completely eliminated after the dual sensor summation and wavefield separation process.

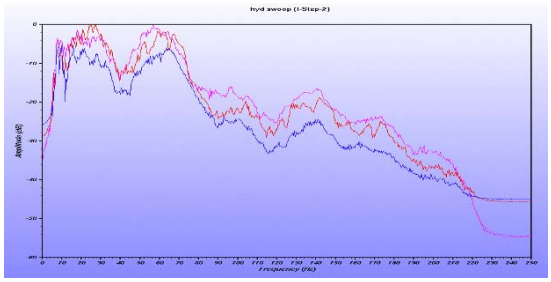

Figure 2 Spectral analysis window of Hydrophone data taken from 3 shots along one line. Note notching at 37-38Hz

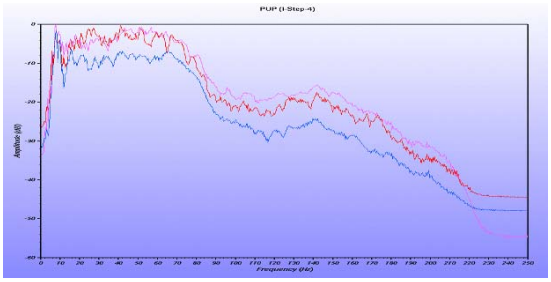

Figure 3 Same spectral analysis window of Up-going wavefield data, (P-UP), taken from 3 shots along one line. Note that the notching at 37-38Hz is filled in by dual sensor summation and wavefield separation process.

G Cambois et al: *"Dual-sensor Streamer Increases Data Bandwidth Leading to Improved Penetration and Higher Resolution,"* EAGE Workshop, Limassol Cyprus 2009