

BS14

Broadband Surveys Conducted in Abu Dhabi, UAE

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SUMMARY

Abu Dhabi Company for Onshore Petroleum Operations LTD. (ADCO) has acquired and managed several broadband Single Sensor Single Source surveys in the Emirate of Abu Dhabi over the last two years. The survey objectives have varied from exploration to field development, so whilst some of the acquisition parameters has changed, the fundamentals required to record a broadband survey has been maintained regardless of the target. The key elements of acquiring a broadband survey are low frequency enhanced sweep, sweeping to a frequency above what has previously proved recoverable, effective noise attenuation to obtain good signal to noise across the full sweep bandwidth and a detailed and accurate near surface velocity model.

Introduction

Abu Dhabi Company for Onshore Petroleum Operations Ltd. (ADCO) has acquired and managed several broadband Single Sensor Single Source surveys in the Emirate of Abu Dhabi over the last two years. The survey objectives have varied from exploration to field development, so whilst some of the acquisition parameters has changed, the fundamentals required to record a broadband survey has been maintained regardless of the target. The key elements of acquiring a broadband survey are low frequency enhanced sweep, sweeping to a frequency above what has previously proved recoverable, effective noise attenuation to obtain good signal to noise across the full sweep bandwidth and a detailed and accurate near surface velocity model. These are discussed in more detail below:

Low Frequency enhanced sweep

Low frequency input requires the vibrator system to be managed at these low frequencies in such a manner to avoid causing damage to the vibrator itself and ensure that we consistent fundamental energy spectrum is input at each location. ADCO has been using the WesternGeco DX-80, 80,000lb vibes, which are designed for low frequency enhanced sweeps. However the vibrator performance varies from location depending on the characteristics of the ground at that location. Therefore it is critical that the ground conditions and their impact on vibrator performance is understood for all terrain to be encountered in the survey before recording can begin. As part of the survey scouting process, different terrain characteristics were identified and then calibration tests recorded with the vibrator operating on each of the terrain types found in that survey area. Once the calibration tests were analysed a low frequency enhanced or Maximum Displacement (MD) sweep was designed for the survey and fully tested on the different terrains before the production recording commenced.

The surveys have now been carried out over a large variety of terrain found in the Emirate of Abu Dhabi, sand, gravel and sabkha, with very little changes to the sweep used indicating there was a robust process in the sweep design to ensure consistency across all locations. The crew has used an 18 second sweep to allow sufficient time at the low frequencies and the high frequencies. It should be noted that the distortion is not just a feature of the low frequencies but that resonances at the mid-frequencies also have to be controlled. The sweep frequencies have started at 1Hz with the 3dB down point at 2.3Hz.

Noise attenuation

The three major noise modes that need to be dealt with in Abu Dhabi are coherent direct arrival source generated ground roll, coherent scattered source generated noise and non-source generated cultural noise.

The ground roll wavelengths in sand dunes that covers large parts of Abu Dhabi often contain short wavelengths that will alias unless it is uncommercial densely sampled. Therefore it is important that the selected noise attenuation process selected can deal with aliased noise and in this the Surface Wave Analysis Modelling and Inversion (SWAMI) techniques has been effective at dealing with any aliased noise in the data.

There are many features in and on the near surface that scatters any surface travelling noise including source generated ground roll and other cultural seismic noise. Scattered noise is a particular problem in sand dunes as essentially every slipface, small or large, scatters noise often scattering the energy multiple times around the source of the source of the energy. But trees, bushes, roads, pipelines, well heads walls and fence posts all scatter this energy. Therefore an effective scattered noise attenuation process is essential. During the course of these surveys two scattered noise attenuation techniques have been effectively employed, one technique is interferometry and the second is an extension of the SWAMI technique. In general the interferometry works better when there is a denser sampling of the surface wavefield and the SWAMI technique works better when there is sparser sampling.

Near surface modelling

The near surface is complex over large parts of Abu Dhabi and these complexities are often hidden by the overlying sand dunes. Highly variable sand depths, velocity inversions and rapid lateral velocity variations have all made near surface modelling very difficult in Abu Dhabi. The sampling of upholes can never be dense enough; the velocity inversions are invisible to refraction based techniques so the Surface Wave Inversion technique has been very powerful when coupled with Simultaneous Joint Inversion using all available data. The SWI and SJI data has been compared to uphole data with very good agreement with excellent areal sampling of the variations that is just not possible with upholes. This has proved invaluable for static corrections and retention of the high frequencies in time imaging and also for providing the velocity model for starting the depth imaging.

It should be noted that the depth that can be analysed using the SWI technique is dependent on the lowest frequency input, the lower the frequency the deeper the analysis can be. It has been found that the SWI technique can reliably image the first 150m of the near surface over large parts of the surveys acquired to date in Abu Dhabi.

Single Sensor Single Source (S4) Acquisition

It has been found that Surface Wave Inversion technique is important for noise attenuation and near surface modelling therefore it is important that we record the surface waves without attenuation in the field so they can be accurately analysed and utilized in processing. Any sort of receiver or source array will attenuate the surface waves often in complex and azimuthally variant manner that degrades their usefulness in the noise attenuation and near surface modelling.

Conclusion

ADCO has successfully managed and recorded broadband surveys across a wide range of topography found in Abu Dhabi over the last couple of years and its integrated combination of acquisition and processing technology has proved effective at increasing the bandwidth and quality of the final data.

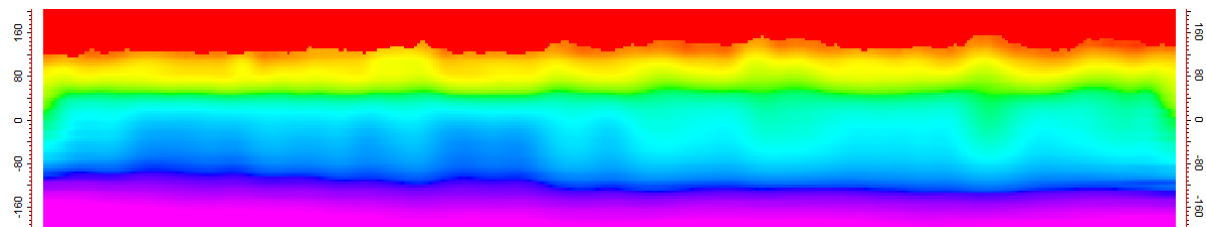


Figure 1 Near surface velocity profile from the SWI results

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