Lessons Learned from the World's Largest Continuous onshore, offshore and Transition Zone 3D Seismic Survey

Guillaume Cambois, Saif Al Mesaabi, James Cowell, David Arnold, Mohamed Boukhanfra, Saeed Al Karbi, Mohamed Mahgoub, Khalid Obaid

ADNOC

Abstract

In 2017 ADNOC decided to cover the entire Abu Dhabi Emirate, onshore and offshore, with high-resolution and high-fold 3D seismic. Acquisition of the world's largest continuous seismic survey started in late 2018 and at time of writing completion is 100% for onshore (one year ahead of schedule), 94% for offshore and 35% for transition zone (TZ). Data processing is well under way and the first delivered 3D cubes have already been interpreted, leading to a series of well publicized discoveries. Now is an opportune time to review the status of this gigantic project and draw preliminary lessons.

The survey started with 3 crews (2 onshore and 1 TZ), grew to 7 (3 onshore and 4 offshore) and is now down to 3 (2 offshore and 1 TZ). All the land crews used the same design and recorded full-azimuth, far offset (6.2km), high-fold (1,922), high-resolution (12.5x12.5m bin) surveys. The source points were single 80,000 lbs. vibrators sweeping the 1.5-120 Hz frequency range in 18 seconds. Most of the offshore is acquired with the nodes-on-a-rope method, again leading to full-azimuth, far offset (6km), high-fold (2,400), high-resolution (12.5x25m bin) surveys. For the last field to be acquired, two node crews are combined for an ultra-dense survey (9,600-fold for 12.5x12.5 bin). The TZ crew uses nodes offshore and onshore, and is probably the largest nodal crew ever assembled (36,000 units).

Processing is challenging if only for the sheer volume of data: the projected number of traces acquired is close to 2 trillion, corresponding to 28 petabytes. So far our largest pre-stack migration involved 120 billion traces, which we believe to be a world record. But noise and multiples are the main challenges in Abu Dhabi. We have implemented elaborate sequences to deal with them. In particular we have introduced up/down deconvolution offshore, which was a first in such shallow water environment. All data are pre-stack time and depth migrated. Full waveform inversion is used to unravel the overburden, which is quite complex in Abu Dhabi with karstic collapses and meandering channels. Offshore we have also experimented with the use of near-field hydrophones to obtain a high-resolution image of the near-surface.

Comparison with legacy data shows a massive improvement in deep imaging, which was one of the main objectives of this survey. The basement can clearly be interpreted, while it is hardly visible on legacy data being covered with high energy multiples. A thorough analysis demonstrated that increased offset is the main reason for the uplift. The large fold and the low frequency sweep also help recover signal down to 3 Hz. This extends the bandwidth in the low frequencies by one to two octaves compared to legacy data, which tremendously benefits structural interpretation and stratigraphic inversion.