

# Enabling Cost-Effective Sweep Efficiency with DAS-VSP

## Deepwater, Gulf of Mexico

Offshore brownfield exploitation generally involves operating in remote, environmentally sensitive areas that have geologic basins with complex overburden, structure and stratigraphy.

In these geologically challenging areas, Ocean Bottom Node (OBN) seismic acquisition is the technology of choice for a number of reasons; the most important being its ability to capture a high quality seismic image, which is critical for characterizing time-lapse response of the reservoir.

Due to the high acquisition cost, many mature reservoirs using an OBN approach for time-lapse imaging are surveyed several years apart, resulting in the missed opportunity to effectively manage and understand the reservoir.

To eliminate this risk, a supermajor operating in the Gulf of Mexico contacted the OptaSense team with the goal of identifying a low-cost alternative that would enable comparable or better quality seismic surveys at more frequent intervals.

### Rethinking borehole seismic

Technology plays crucial role in providing the information to make sound exploration decisions. Given the complexity and high cost of deepwater development, there is great value in being able to identify the best spots to drill wells and manage production methods for field exploitation. This skill hinges on generating an accurate picture of the subsurface. Seismic technology lies at the heart of this process and was a key research priority for our client.

Vertical Seismic Profiling (VSP) has long been considered a possible solution for deepwater seismic imaging; however, high cost and practicality have made it unfeasible for many operators. Since the introduction of Distributed Acoustic Sensing (DAS) VSP technology, these concerns have essentially been eliminated.

### Putting DAS to the test

Concept testing for the low-cost, on-demand DAS-VSP solution included several aggressive objectives, one being surveying reservoirs lying below thick salt formations which are notoriously challenging to image. Additional

objectives included demonstrating repeat DAS acquisition using multimode fiber, acquiring DAS on active production and injection wells, and providing quick on-demand service for time-lapse monitoring of sweep efficiency.

To meet these objectives, OptaSense recommended running their DAS-VSP borehole seismic acquisition service, capable of acquiring 2D, 3D and 4D VSP data, and the fourth generation ODH-4 DAS interrogator unit (IU) for its unmatched imaging and measurement performance.

### Background

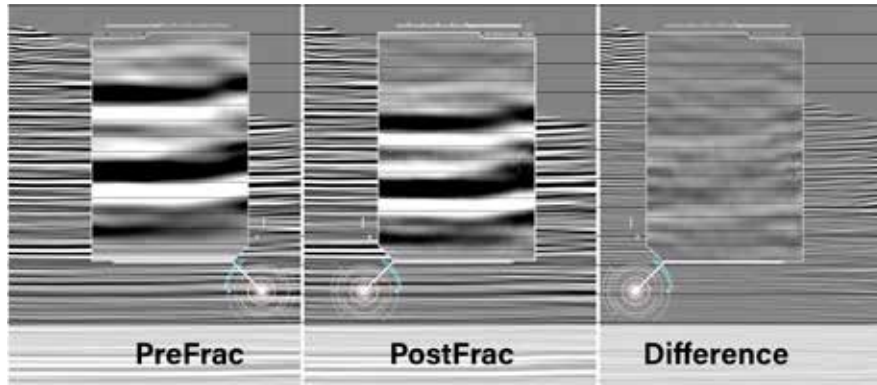
- Deepwater, Gulf of Mexico
- Mature field
- Sweep efficiency monitoring
- Subsalt imaging
- Deviated wells

### Solution

- OptaSense ODH-4 interrogator unit
- OptaSense DAS-VSP borehole seismic acquisition
- OptaSense DAS-VSP producer and injector well monitoring
- OptaSense DAS-VSP 4D time-lapse monitoring
- OptaSense unmanned DAS-VSP service

### Results

- Leveraged existing multimode fiber to provide on-demand VSP acquisition and monitoring
- Successfully acquired VSP data across the entire wellbore, including those positioned subsalt
- Successfully acquired VSP data on actively producing and injecting wellbores at a lower cost and with no interference
- Performed quality 4D time-lapse seismic monitoring with favorable economics
- Enabled timely repeat surveys to provide a cost-effective method to monitor sweep efficiency
- Reduced cost and HSE exposure by enabling unmanned VSP



Quality, high resolution 4D seismic data

The ODH-4 provides a 6 dB improvement in signal-to-noise ratio over its predecessor—delivering the highest fidelity VSP measurements available. In addition to higher quality seismic imaging, the ODH-4 offers increased sensitivity, finer spatial sampling (1.02m) and finer spatial resolution of (4.02m gauge length) to capture high-caliber image resolution.

### Subsalt imaging

Oil and gas is commonly trapped subsalt, or near salt flanks. Incidentally, imaging near and below the large salt structures is naturally problematic for any surface or OBN seismic program.

One of the best known methods to properly image these areas is a VSP survey, which enables access to these obscure locations. However, these wellbores commonly have high deviation and high entry to access costs, making the use of conventional geophones unfeasible.

The ODH-4 IU instead transformed the operators existing fiber optic cable attached to production casing into an array aperture to acquire VSP data across the entire wellbore.

### Multimode fiber acquisition

By retro-fitting our DAS technology to pre-existing multimode fibers, OptaSense provided permanent, on-demand DAS-VSP access at no extra cost to the operator.

Although DAS was originally developed for single-mode fibers, most legacy fiber optic installations are multimode. By continuously pioneering the evolution of DAS technology, OptaSense has proven quality DAS measurement can be acquired on either single-mode or multimode fiber—enabling

on-demand acquisition of quality seismic surveys from wellbores with existing fiber.

### VSP acquisition on active production and injection wells

With OptaSense DAS-VSP borehole seismic acquisition service, the operator successfully acquired VSP data on actively producing and injecting wellbores during acquisition operations. Such a practice would be unthinkable with geophones.

In some cases, a mature field may not have suitable placement for, or the existence of, an observation well. This can impact an operator's ability to monitor production, as well as optimize future well placement.

Our DAS-VSP eliminates the requirement of observation wellbores for VSP imaging, while providing on-demand, direct monitoring of production and injection zones.

This ensures operators receive the subsurface insight required to control current operations and optimize future placement of injector and producer wells. OptaSense DAS-VSP also provides the ability to acquire data on active wellbores without shutting in operations—resulting in greater VSP imaging coverage at favorable economic costs.

### On-demand 4D time-lapse

Due to cost, 4D VSP acquisition at shorter intervals may not be feasible. However, the OptaSense DAS-VSP service is flexible, quickly mobilized and offers favorable economics for repeat acquisition monitoring.

Through the use of our DAS-VSP 4D time-lapse service, the operator effectively monitored conditions throughout the reservoir over time—increasing recovery, optimizing cost, reducing risk and extending the life of the field.

### Unmanned VSP services

Manned operations for recording instruments can amount to significantly increased risk and cost depending on the duration and location of the program.

Through the use of a suitable internet connection OptaSense can provide unmanned VSP services through remote monitoring of OptaSense equipment and data. This significantly reduced cost and HSE exposure for our client by reducing lodging, substance and day rates for an onsite operator, in exchange for a daily remote monitoring fee.

### Exceeding expectations

The quality of the DAS-VSP acquired using our ODH-4 IU surpassed our client's expectations. This included data collected on multimode fiber, actively producing and injecting wellbores and those positioned subsalt.

Imaging objectives for 4D reservoir monitoring continues to be successfully met and our client is looking forward to expanding DASVSP service for regular time-lapse monitoring of their asset.

In just a short period of monitoring, our client is moving forward with DAS-VSP service as an integral part of sustainable field development. They have realized added value with the service's seamless application and the capability to remotely monitor the equipment and program.

Our client highly advocates the installation of fiber optic cables for new offshore wells, and utilizing existing fibred wells to take full advantage of DAS for VSP acquisition.