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3-D next Signal Hill step

Urban Seismic Shoot Successful

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Completing a successful seismic operation in the Long Beach/Signal Hill oil field was possible thanks to community awareness, improved cable-less technology, environmental sensitivities, and a willingness for crews and the city to find common ground. No pun intended.

Seismic data acquisition projects can be thorny deals to put together and apply – especially in highly populated urban areas.

Toss in even a soupçon of environmental sensitivity, and the challenges begin to mount.

If you're contemplating a venture in a crowded urban environment in California, for instance, you might be justified in running in the opposite direction - right?

Not necessarily.

Particularly if you're an operator who is recognized for your good-neighbor status in the community.

And if you're also equipped with a seismic data acquisition system that operates sight-unseen, which is about as unobtrusive as it gets.

That's the can-do message emanating from those involved in a recently completed successful 2-D seismic shoot in the Long Beach/Signal Hill oil field.

Eighty percent of the field is found in Signal Hill, which is a two-square mile community of 10,000 residents, surrounded by the 50-square mile city of Long Beach and its half-million residents, according to Dave Slater, executive vice president and chief operating officer of Signal Hill Petroleum. Long Beach is home to the remaining 20 percent of the oil field.

Signal Hill Petroleum operates the majority of the field where it currently produces 2,800 bopd. Production from the next largest operator stands at 300 bopd.

For the seismic operation the company contracted for Fairfield Industries' Z Land™ nodal seismic data acquisition system.

Long Beach/Signal Hill qualifies as one of the giant fields in the United States, having kicked out more than one billion barrels of oil to date. Slater noted it has the highest recovery per surface square foot of productive area of any field in the world.

“We estimate there’s up to two billion barrels of oil still in place,” Slater said. “Modern seismic technology has not been applied to most of the Los Angeles Basin, and the issue has been how to conduct seismic operations in this very dense urban environment.”

Like a Good Neighbor…

The company attempted to conduct a 3-D survey over the LB/SH field in 2006, but it was nixed early on owing to concerns from the citizenry about the effects of the seismic vibrators.

It was back to the drawing board to carefully formulate a plan that would fly.

“In this area, most fields are behind a wall, but we’re spread out,” said AAPG member Dan Hollis, vice president for geophysics and technology development at Signal Hill subsidiary Seismic Imaging Solutions, which operated the recent Z Land survey.

“We have wells in parking lots, commercial centers, empty lots next to homes, so we’re very into the community,” Hollis emphasized. “We’re very conscious about being very neighbor friendly – that was the whole driving paradigm.”

Slater noted they earlier acquired some seismic data in the area using a conventional industry contractor — and quickly learned the difficulty in working in an urban area and managing cables.

They re-grouped to evaluate what was essential to success in seismic operations in a citified environment. Due diligence on available equipment and technology ultimately convinced them to zero in on Fairfield’s system given that its continuous recording Autonomous Recording Unit (ARU) is 100 percent free of external cables and other external components.

“This particular field locale is one of the challenging types of environment we had in mind when developing Z Land,” said Steve Mitchell, Fairfield’s vice president and division manager. “The dense urban conditions and our Z Land system essentially were meant for each other.”

Signal Hill pulled together its plan to conduct the LB/SH program and presented its case for the survey to the powers-that-be.

Besides the expected dialogue with an array of public officials, the company hosted a public demonstration of a vibrator shaking the ground for an audience comprised of city council members of the two cities involved.

“In the end it was, ‘Well, is that all there is to it?’” commented Serge Rambaud, sales manager for the Americas at Fairfield.

The Passing Parade

Once the public officials and private property owners were on board, two permits were acquired from each city, including the expected public works permit.

But this is California, where the ordinary sometimes takes on a unique twist.

The other required piece of paper was a special events permit. In essence, it was – don’t laugh – a parade permit for the vibrators to vibrate down the streets like a slow moving parade.

Prior to the survey, Signal Hill prepared a professional brochure explaining details of the project in a manner the layperson could understand. These brochures were distributed to residents and others in the survey locale.

In areas where the ARUs (frequently referred to as nodes) couldn't be placed on a public right-of-way and private property had to be used, Hollis noted the landowners were very receptive. This meant the crew could find soil everywhere necessary – even in this urban setting that essentially has more concrete than dirt.

This access to terra firma was crucial to the project, which was a kind of "now you see them, now you don't" operation.

The ARUs are buried beneath the ground's surface. The operator drills an eight-inch hole where he places these self-contained easy-to-handle units, covering them with a couple of inches of soil.

It's a smooth operation given that the 4.7-pound ARUs each boast a height of only six inches and a five-inch diameter. There's a five-inch detachable spike on the bottom.

The complete absence of cables and other external components is visually pleasing, but the advantages of the system extend far beyond the visual in such a congested urban setting.

"The biggest impact of this system is that with no cables, there's no troubleshooting of the equipment," said AAPG member Hilario Camacho, vice president of earth sciences and exploration at Signal Hill. "You just lay out the nodes and get the sources going, and we got the survey done in a short time.

"It was great, very good," Camacho exclaimed.

Another plus in having absolutely no cables is that cables present a trip-and-fall hazard, which can be particularly problematic in this kind of crowded, busy environment, Hollis pointed out.

He noted also they restricted the operational hours in the populated areas to reduce the impact of the survey on the local citizens.

Seismically Sensitive

Over the course of the program, Seismic Solutions acquired 11 miles of 2-D seismic data in 12 days.

"We had 200 ARUs here, with 150 to 180 deployed on any one line," Hollis said. "We had four lines, each about two to four miles long, and all four lines were shot using a point source/point receiver methodology – the prospect included a total of 678 receiver points and 465 source points."

The four buried lines of ARUs were deployed along the sides of city streets with one line bisecting Long Beach Airport taxiways and runways, Rambaud noted. The lines were shot one after the other.

"At the end of the day, we had to pick up the ARUs quickly, download the data and QC it and redeploy the next morning so we didn't lose any time," Rambaud said.

The entire program was implemented using VibroSeis® technology. Because southern California is particularly sensitive to seismic disturbances, it was decided to reduce the output of the vibrators. To compensate for the lower output and regain the lost signal to noise ratio, the vibrators performed a series of 18 sweeps per vibrator point.

"Each sweep individually is very good in terms of noise trends and noise analysis," Camacho emphasized. "This is very important in this area."

Fairfield currently is processing the acquired data.

The program earned an A-plus rating even while acquisition was ongoing.

“On the Willow (street) line we saw a shallow bright spot near a well we were drilling, but it had not been tested by the well,” Camacho said. “This bright spot anomaly basically will be a follow-up well on a different location.”

Slater noted they refer to the just-completed 2-D project as their pilot phase project.

“The next phase will be 3-D acquisition over a portion of the field using the Fairfield system,” he said. “Our ultimate objective with the seismic at Signal Hill is to get at the two billion barrels we think are still in place.”

A ‘Complex’ Reservoir

Even with plenty of seismic, the midnight oil likely will be burning.

The LB/SH field sits along the Newport-Inglewood fault zone, which is the major fault system running through the Los Angeles Basin. The associated folding, faulting, thrusting, etc. create a highly complex geologic scene.

“We’ve done a lot of conventional analysis of this field through subsurface mapping,” Slater said. “That has opened our eyes to how complex the reservoir is.

“In the standard mapping process, we’ve generated dozens of fault picks in well logs,” he said, “but we can’t connect the dots because there’s not enough data to get the orientation as to where the faults are going.

“Understanding the faulting and compartmentalization is going to give us targets to drill where there’s oil that hasn’t been drained.”

The LB/SH field currently produces principally from the Pliocene, and the productive section in the field is 10,000 feet thick. The largest sandstone within that 10,000 feet is perhaps 20 feet thick, according to Slater, who noted there are hundreds of interbedded sandstones and shales within the section.

“The average well depth is about 5,000 feet, and the deepest production now is about 10,000 feet,” Slater said. “We haven’t found the bottom of production yet.

“Absent the seismic data, we’ve done everything we can to understand the very complex subsurface picture,” Slater said. “That’s why we’re so motivated to pursue the 3-D data acquisition.”

Photos, video courtesy of Fairfield Industries.