Fast track seismic processing can give operators critical information that enables timely decision making during tightly scheduled drilling programs. Such was the case for one operator working in the Mississippi Lime play in Oklahoma. As manager of the project, ION implemented its innovative field QC and refraction statics solution, known as Rio, to ensure data integrity and quick preparation of an accurate, processing-ready dataset. On this 3D multicomponent survey using wireless nodes, Rio technology was used to find and quickly correct geometry issues and calculate near-surface models during acquisition. Front end processing of the fast track volumes was 50% faster using Rio, which ultimately helped to expedite the cycle time for generating preliminary seismic images. The information gave the client the early insight to effectively reposition costly wells, and even cancel one, saving $8M.
Fast-Track Processing During Acquisition Optimizes Mississippi Lime Drilling and Completions

**Client:** HighMount Exploration & Production LLC

**Challenge:** Process preliminary post-stack time-migrated seismic volumes at regular intervals during acquisition of a 178 sq. mi. 3D multi-component survey in north-central Oklahoma, to get ahead of a fast-paced, three-rig drilling program.

**Solution:** Deployed ION’s new Rio service, in which a field technician used portable hardware to harvest acquisition data at 25%, 50%, 75% and 100% of the total survey volume, and specialized software to run advanced geometry QC and refraction statics.

**Result:** Expedited front-end processing of fast-track volumes by roughly 50%, reduced cycle time for final survey processing by at least one month. Enabled the client to cancel one well saving $8 million, modify other wells, and optimize completions.

**REVISITING A COMPLEX CONVENTIONAL PLAY**

In late 2011, when HighMount E&P leased over 67,000 largely contiguous acres in north-central Oklahoma, industry interest in the Mississippi Lime was undergoing a resurgence. Although more than 14,000 vertical wells had been drilled over the past 50 years in this conventional carbonate play, oil production had often been marginal and many believed the Lime was basically tapped out. Over the past decade, however, the application of modern horizontal drilling and multi-stage hydraulic fracturing technologies had begun turning things around.

By 2009, 20 horizontal wells had been drilled and completed in the play, demonstrating its economic viability and sparking a flurry of new activity. Within one year of entering the Mississippi Lime, for example, HighMount had drilled and fracture stimulated 30 horizontal wells. An early multi-company study estimated recoverable oil and condensate resources of 1.3 billion barrels.

While the play is conventional and the structure is low-relief, the geology is, in fact, highly complex and challenging. Porosities vary from only a few percent to more than 40% in the Mississippi Lime. The formation consists of brittle marine carbonates and interbedded chert reservoirs, which have been subjected to multiple episodes of faulting and fracturing. Some rocks are extensively fractured. For example, HighMount measured 4,000 fractures along one 5,000-ft lateral alone. While natural fractures can enhance productivity, crossing an unmapped fault while drilling could kill an entire well. In addition, some targets produce high water volumes, requiring operators to drill costly disposal wells. For a number of reasons, therefore, economics in the play have been inconsistent.

To better map faults and fractures, avoid geohazards and water infiltration, reduce risks and, hopefully, increase economic oil production, operators began shooting 3D seismic. “Similar to unconventional shale plays, operators started drilling as soon as they acquired acreage, driven by the time value of money,” says Paul Constance, Chief Geophysicist, HighMount E&P. “For many companies, seismic is somewhat of an afterthought, especially when they have a lot of well control. However, well data alone cannot define the complexity of the subsurface. For that you need the help of 3D seismic.”

**ACCELERATING FRONT-END QC WITH THE RIO SYSTEM**

When Constance joined HighMount in the fall of 2012, he immediately began making plans to acquire the industry’s first multi-component 3D seismic survey in the Mississippi Lime. He engaged ION Geophysical to conduct the survey because of its strategic focus on multi-component acquisition. Together, he and ION designed the BuffaloHornSCAN project—a 178 sq. mi. survey over HighMount’s acreage in Noble, Pawnee and Payne counties, Oklahoma. The main objectives were to provide high-quality structural imaging for geohazard

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avoidance, to better characterize rock properties and natural fracture systems, and to optimize drilling and completion decisions.

“Obviously, I would rather have had this data before we started drilling,” Constance adds. “But since we had three rigs running at the time, I told ION that fast-track processing of preliminary seismic volumes at regular intervals during acquisition was absolutely essential for us to catch up with—indeed, to get ahead of—our drilling program.”

A fast-track is an initial post-stack time-migrated 3D seismic volume used primarily for fault and structural interpretation prior to final pre-stack time or depth migration processing and inversion. Fast-track volumes provide preliminary, if not rudimentary, views of drilling areas to assist operators in making critical decisions under time pressure. A key factor in the time required to generate a fast-track is the front-end data processing, which can be delayed when geometry issues arise during acquisition. Equipment may not be deployed where intended; changing surface conditions may require crews to adjust locations, and equipment can malfunction.

“If geometry problems aren’t solved up front, all subsequent steps in the processing flow will suffer,” explains Dave Cunningham, ION’s Rio Product Manager.

ION developed the new Rio system from its proven Millenium refraction statics technology, used throughout the industry for over 30 years. Recently ION added highly efficient, automated in-field geometry QC technology to accelerate front-end processing.

“The Rio system supports any land or ocean bottom fixed receiver survey, regardless of the contractor. Since 2011, Rio has demonstrated its value in the field on eight ION surveys. These were mostly nodal acquisition systems in shale plays—from the forested hills of Pennsylvania and West Virginia, to farm and ranch lands in Wyoming and Oklahoma, and agricultural areas in Mexico. Each survey had unique geographic challenges, geometries, and near-surface issues. For these projects, Rio was brought in either during or following data acquisition to quickly generate clean, processing-ready data sets much faster than previous tools and methods.

For the 178 sq. mi. BuffaloHornSCAN multi-component survey, ION used INOVA’s Hawk nodal system to acquire the data, which included roughly 90,000 source points and 60,000 receiver points. At approximately 750 million traces, it was ION’s largest survey yet to deploy the Rio system in the field and to pre-process preliminary fast-track volumes during seismic acquisition. A Rio technician was present when shooting began in early 2013 and returned four more times to harvest field data when survey volumes reached 26%, 50%, 75% and 100%.
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OPTIMIZING DRILLING AND COMPLETION DECISIONS

After performing geometry QC and refraction statics, which required only a few days, ION processed each fast-track volume and delivered it to HighMount for interpretation within two or three weeks of field data collection—roughly 50% faster than a conventional fast-track. “Delivering fast-tracks during acquisition meant ION had to run the entire survey volume four times,” says Constance. “But that saved a considerable amount of time on the front-end and reduced total cycle time for the project. The Rio system made that possible.”

According to Cunningham, for the fourth fast-track the Rio technician was able to deliver the remaining 25% of field data to ION’s processing center within 36 hours of final data acquisition. All QC and statics on the 100% fast-track were completed within 72 hours. Overall, using the Rio system ION reduced turnaround time on final processing of the BuffaloHornSCAN survey by at least one month, compared with conventional methods.

High-quality fast-track seismic processing enabled HighMount to better understand structural issues in the Mississippi Lime and avoid geohazards. “The results were excellent,” says Constance. “Fast-track seismic data provided very good images of both major and minor faults that could have had an impact on drilling and completions.

“For example, we were literally about to spud a well when I received the first fast-track. Within 30 minutes, I cancelled the well. If we had drilled it, we would have crossed a 150-ft fault and missed the target completely. It’s hard to determine the economic value of a decision like that, with so many variables involved. What I can say is that the well we cancelled would have cost $8 million dollars. And that was just one of many wells we modified.”

By obtaining 3D multi-component data during acquisition, in addition to cancelling wells, HighMount was able to reposition previously planned wellbores, extend the length of certain laterals to reach otherwise stranded acreage, fine-tune subsequent drilling plans, avoid small faults and optimize completions to stimulate only zones with sufficient porosity and hydrocarbons. “At roughly $100,000 per stage,” Constance adds, “cancelling a completion due to good fault imaging not only saved operating costs but improved overall productivity.”

The BuffaloHornSCAN project is just one of many 3D ResSCAN multi-client surveys managed by ION’s GeoVentures group and imaged by ION’s GX Technology group. Although HighMount E&P designed and initiated the project, other Mississippi Lime operators participated shortly afterward. Since then, ION has deployed the Rio system for in-field QC to enable fast-track processing during acquisition of the multi-component GroundHogSCAN family of projects in the Marcellus Shale, where operators have gained similar time and cost benefits.
ABOUT ION

ION Geophysical Corporation is a leading provider of geophysical technology, services, and solutions for the global oil & gas industry. ION’s offerings are designed to allow E&P operators to obtain higher resolution images of the subsurface to reduce the risk of exploration and reservoir development, and to enable seismic contractors to acquire geophysical data safely and efficiently.

To learn more about how ION helps oil & gas companies and seismic contractors solve their toughest imaging and operational challenges, visit us at iongeo.com.