



Full-wave Imaging for Fractured Reservoirs ION Solutions Drive Strategic Drilling Decisions

SEGMENT	Land Acquisition, Advanced Processing
REGION	Sichuan, China
TECHNOLOGIES	VectorSeis® digital full-wave sensors, acquisition planning, advanced processing

THE CHALLENGE

Naturally fractured reservoirs are inherently difficult to image and productivity from wells in these fields varies significantly. Surface culture and obstructions add to the imaging challenge.



Southwest Gas, a subsidiary of Sinopec, had been actively developing a region north of Chengdu, called Sichuan, for many years. Gas production in this region comes from reservoirs located between 2,500 and 6,000 meters. Most would be characterized as tight gas sands. Due to natural fracturing within the reservoir rocks, the productivity of individual wells can vary significantly, even within the same field and geologic horizon.

Detecting subsurface fractures isn't the only challenge in Sichuan. One of the larger structures, known as XinChang, sits beneath an area having significant natural and man-made obstructions. Parts of the area are densely populated. Several highways and railways, as well as a network of pipelines and rivers, cut across the XinChang field. As a result, seismic acquisition systems must be flexible and reliable to ensure the HSE requirements of both seismic field workers and nearby residents.



Sichuan, China: Several highways and railroads, as well as a network of pipelines and rivers, cut across the field, making acquisition challenging.

THE SOLUTION

End-to-end full-wave seismic program including VectorSeis® digital multicomponent sensors, survey design and acquisition planning, advanced processing and interpretation.



VectorSeis sensors and the land acquisition system being prepared for deployment.

To accurately characterize fractured reservoirs, combinations of advanced survey design methods, acquisition technologies, and processing techniques are necessary. Southwest Gas began to evaluate the potential for full-wave imaging techniques in the Chengdu region in 2003. After conducting several geophysical analyses and pilot tests, Southwest Gas moved to broad deployment of a full-wave solution.

“We are convinced of the benefits of full-wave imaging in this area. The ION family of companies has the type of cutting-edge toolkit, the experienced personnel, and the collaborative approach we require. The raw data looks promising.”

Xu Xiangrong
President
Southwest Gas Company
Sinopec



The application of the full-wave solution in this case involved Southwest Gas as the E&P operator, ION as the technology and imaging services provider, and BGP as the owner of the full-wave equipment and the provider of field acquisition services. The seismic acquisition platform utilized a 6,000 station (18,000 channel) system configured for full-wave recording using 3C VectorSeis sensors. Ultimately, nearly 100 million traces of data were acquired.

In 2006, GX Technology, a subsidiary of ION, was awarded the data processing and interpretation contract. A full suite of processing and interpretation steps has been applied to extract high-resolution seismic images and to resolve subtle properties within the reservoir zones, including an analysis of shear-wave splitting and fracture patterns.

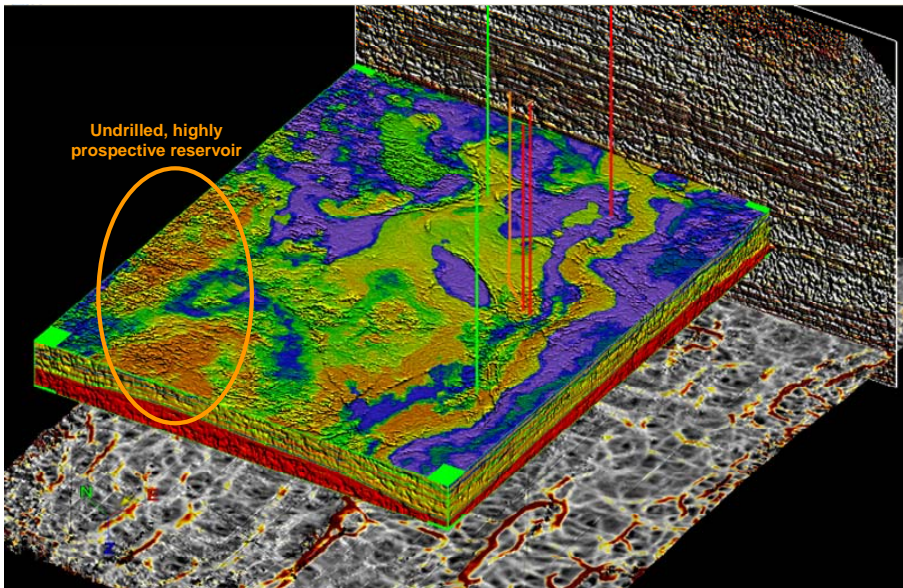
THE RESULTS

Improved subsurface images help optimize strategic drilling programs

By focusing on operational details like survey design, sensor deployment, and source optimization, all with the full-wave strategy in mind, BGP recorded densely sampled data that has yielded spectacular results. The raw, pre-stack data showed significant improvement in signal-to-noise ratios.

Results from the processing and interpretation show the value of employing anisotropic processing at XinChang. The quality of the seismic data in both the P and S domain is outstanding, making it well suited to mapping the structures and to detecting subtle features, such as faulting, in the subsurface. In addition, the shear-wave data recorded by VectorSeis is proving to be highly useful in detecting natural fracture patterns and intensity, as well as the discrimination of sands and shales.

The combination of these data, made possible through an integrated approach to full-wave seismic survey design, acquisition, and processing, is allowing ION and Sinopec personnel to identify the next round of highly prospective drilling targets in the XinChang structure.



When combined with other attributes derived from the full-wave methodology, details observed in this type of display can be correlated with other measured physical trace attributes and enhance the ultimate interpretation of the data.

We would like to thank Sinopec for permission to show these results.



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