Company’s borehole geophysics solutions in the exploration and development of oil&gas fields

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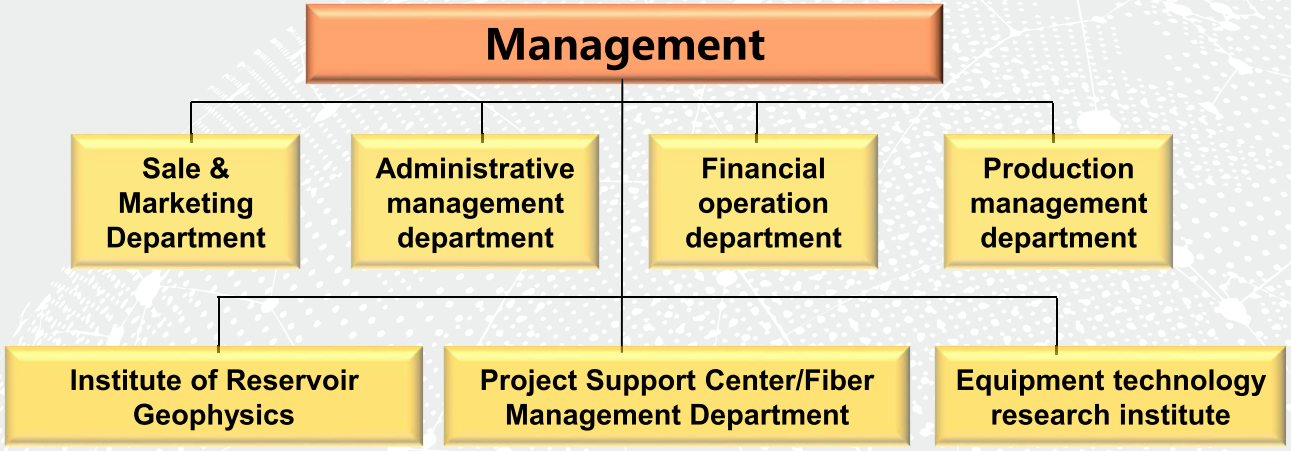
ABOUT US

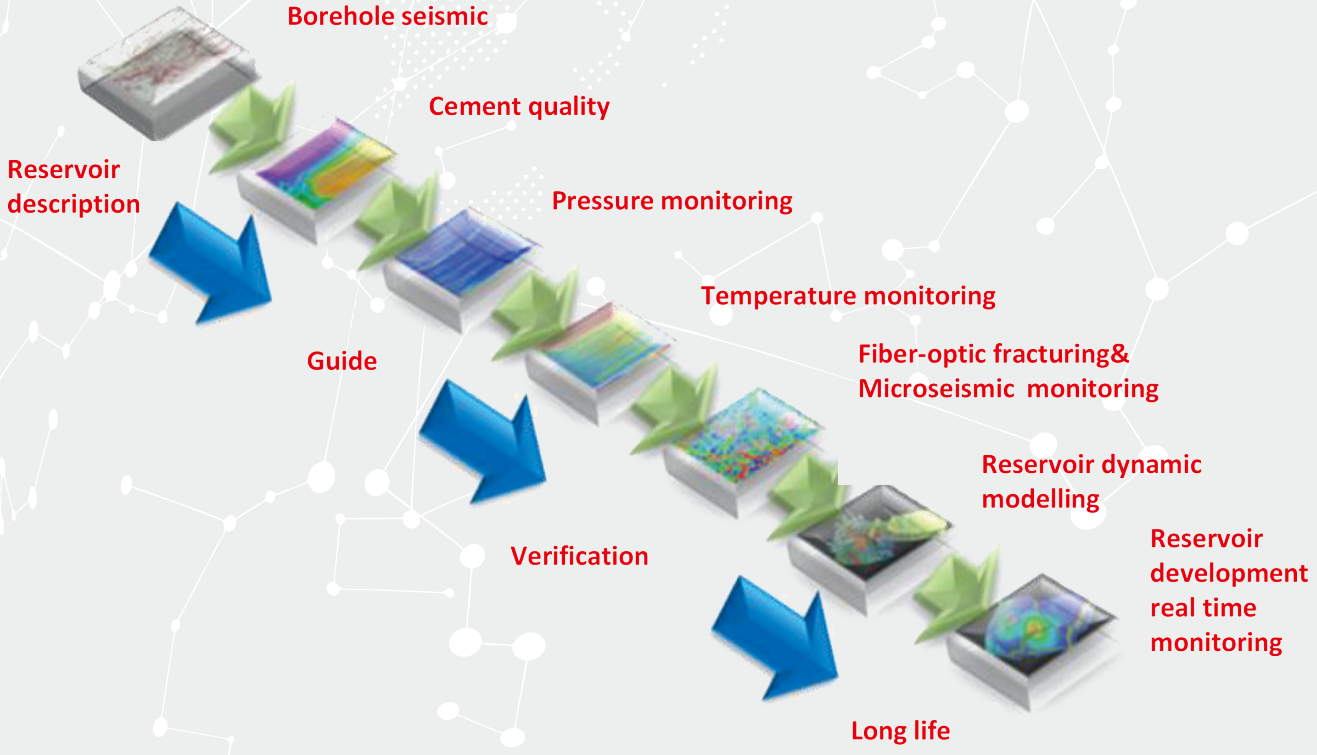
Who Why Are

There are 181 employees, 152 engineering and technical personnel (86%). The division has built a flat organizational structure of 'four departments, two research institutes and one center', and has hired high-end talents and experts (2 academicians, 1 national special expert, 1 Changjiang scholar), enhancing the strength of the scientific research team (4 technical consultants in the field of optical fiber sensing).



What Can We Do

The main business includes borehole seismic, borehole-surface joint exploration, uphole survey, optical fiber sensing system development, downhole deployment tool development, optical fiber fracturing & production dynamic monitoring, downhole optical fiber engineering monitoring, gas storage /CCUS monitoring, etc., accelerating the growth of fiber optic intelligent reservoir geophysics business in Company.



Reservoir static fine description – Zero offset VSP

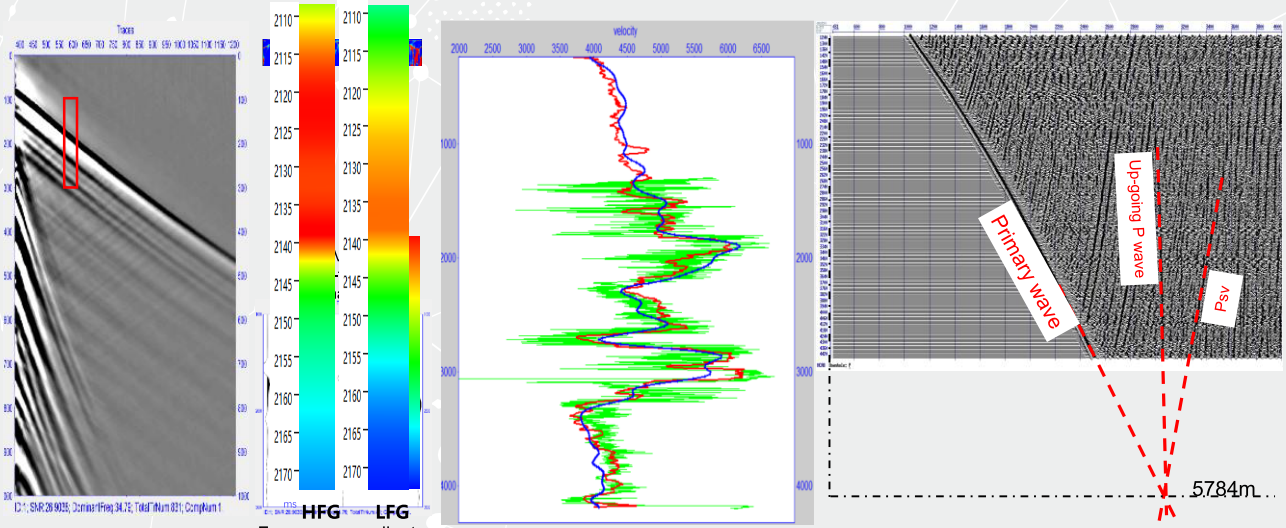
Challenges

Seismic image cannot match the geology information due to the lateral anisotropy, existed small faults and the inconsistent reflection characteristics caused by the sedimentary facies variety; During drilling, there are errors between the actual depth and predicted depth of target layer; How to identify and eliminate multiples? How to improve the accuracy and resolution of seismic images through geophysical parameters driven processing?

Solution

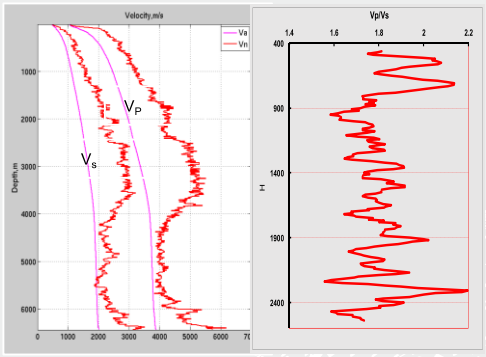
Zero offset VSP's data recorded by Distributed acoustic sensing （DAS）-VSP or conventional geophone is a bridge between geology, logging and seismic data. The corridor stack of Zero offset VSP can be used to do the calibration at the well site, which makes the seismic data match the drilling logging, and geological information. Accurate time & depth pairs can be extracted from Zero offset VSP, and predict the target layer location by using the accurate velocities and VSP calibration. Multiples can be identified easily in VSP data if it develops in the area. Q factors, TAR values, anisotropic parameters and other geophysical parameters extracted from VSP data are used to drive surface seismic processing to improve accuracy and resolution. DAS-VSP data with high resolution is beneficial for velocity analysis of thin layers and frequency gradient attenuation analysis, directly for development work.

Results

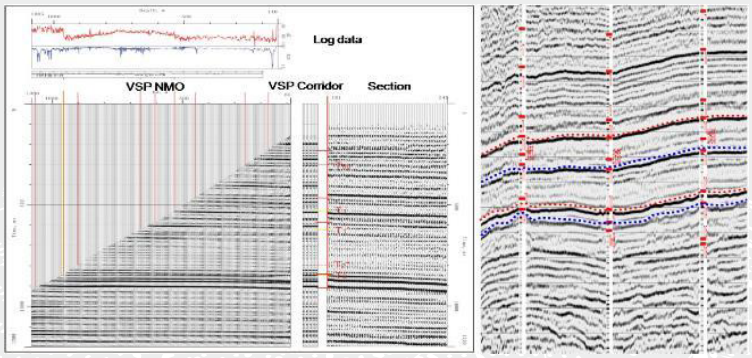


DAS-VSP data | Frequency gradient attenuation analysis | Layer(1m) Velocity by DAS | Depth prediction ahead bit

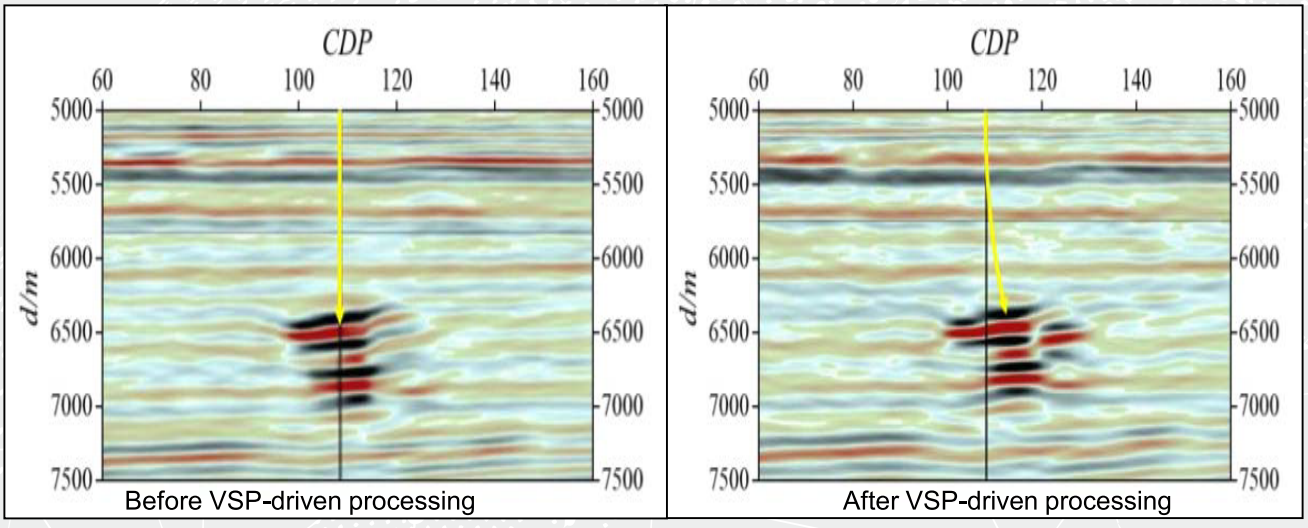
Reservoir static fine description – Zero offset VSP



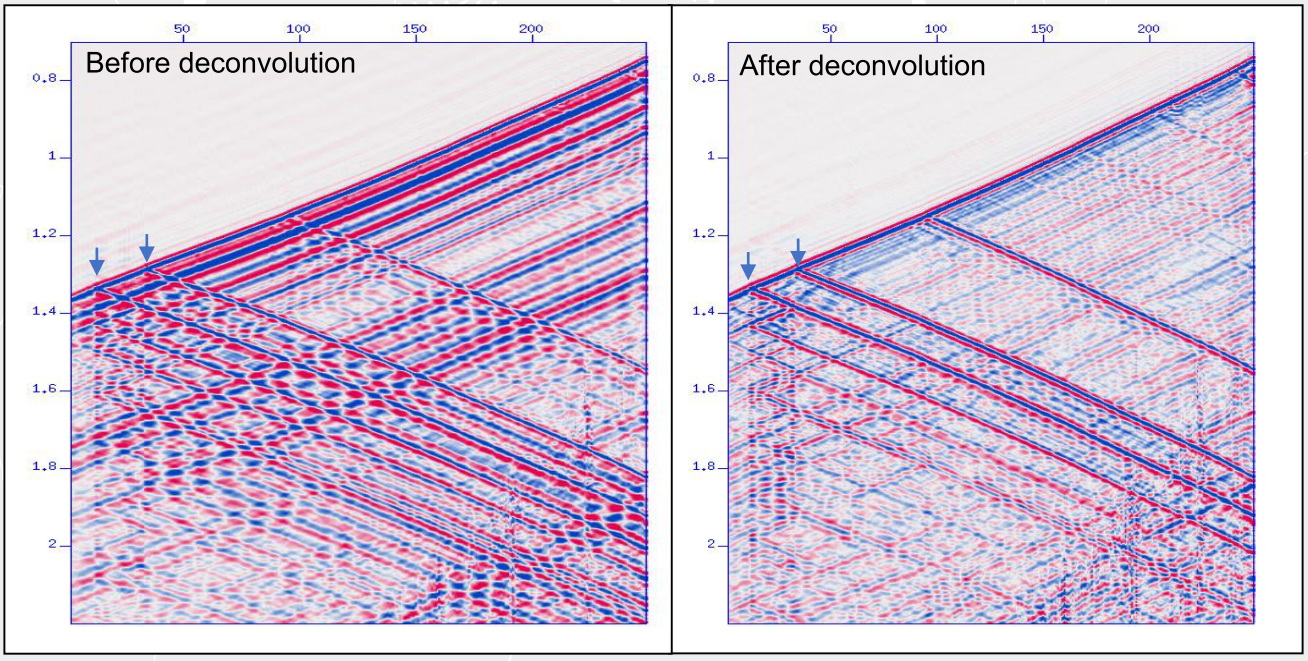
Time to depth relation and velocity



Calibration seismic data with VSP and logging



Driven seismic processing with geophysical parameters extracted from VSP



Multiples identification and attenuation

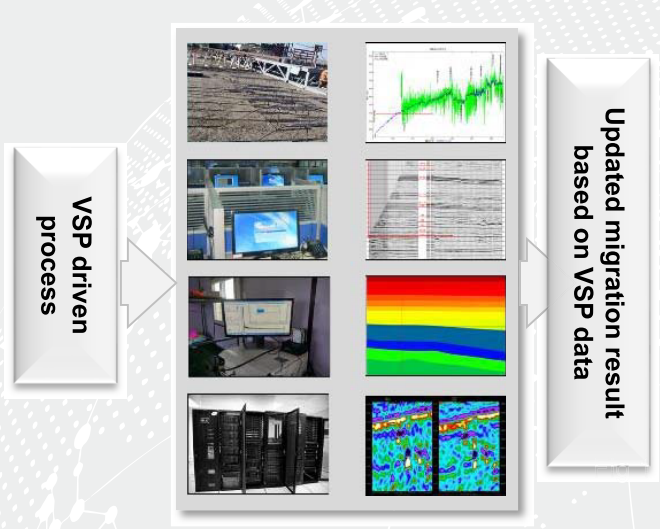
Reservoir static fine description(carbonate)
- Zero-offset VSP guide drilling

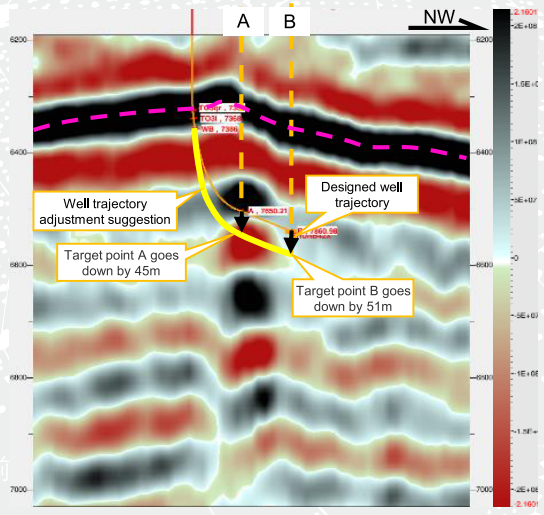
Challenges

For fractured-vuggy carbonate reservoir, as the target becomes complicated gradually, the conventional geophysical methods can not satisfy the exploration and the drilling success rate becomes lower and lower if only based on surface seismic data.

Solution

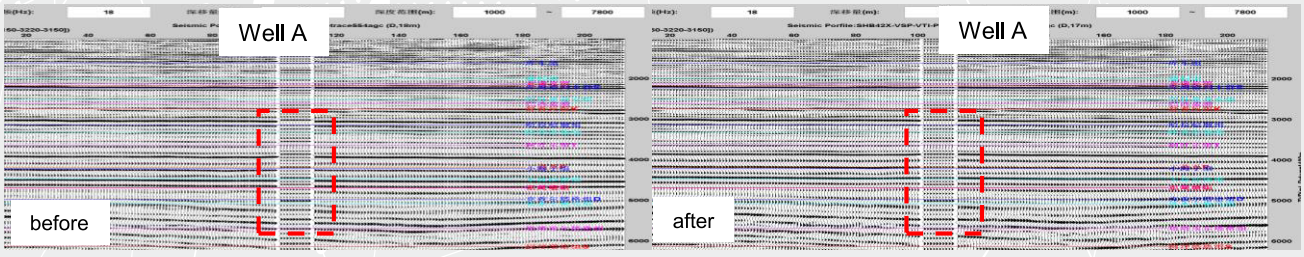
Accurate geophysical parameters extracted from Zero offset VSP data are used to drive surface seismic processing, predict formation information ahead of bit and provides timely drilling target location to guide the well trajectory adjustment.



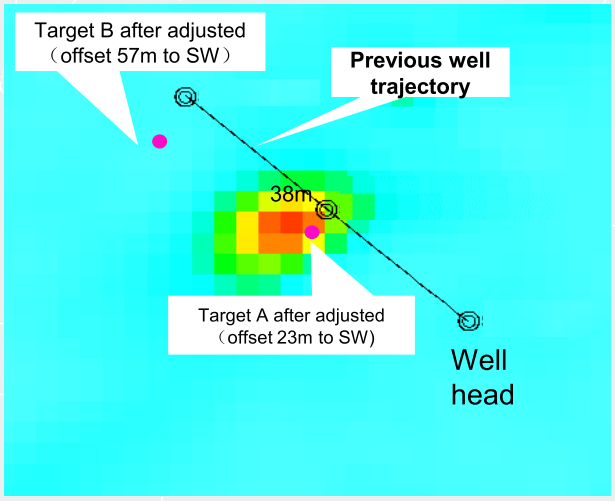


Target adjustment

Results



Depth domain calibration comparison between before and after VSP driven seismic processing

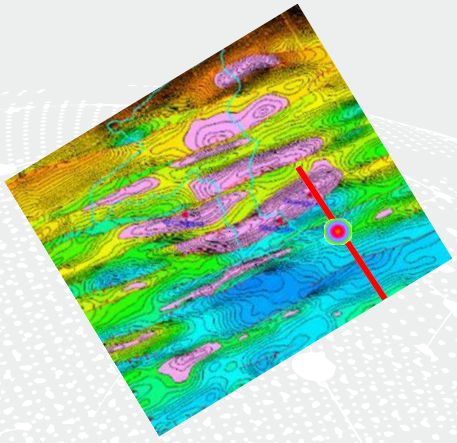


Target locations comparison between before and after VSP driven seismic processing.

Reservoir static fine description(Deep sandstone)
- Walkaway VSP reservoir identification and prediction

Challenges

For complex lithologic reservoirs, it is difficult to identify deep gas bearing sandstone, and conventional seismic cannot satisfy the exploration.

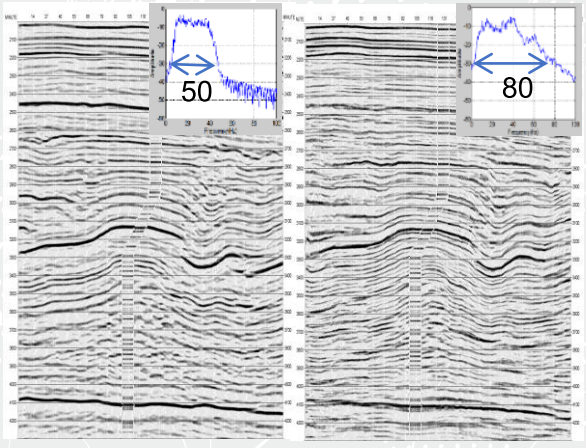


Walkaway VSP geometry

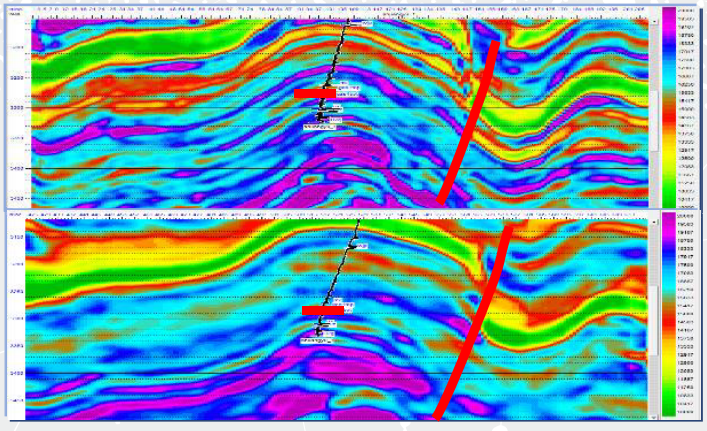
Solution

DAS Walkaway VSP with high-precision image of borehole vicinity structure is combined with attribute analysis to analyze the gas bearing property of the target layers.

Results



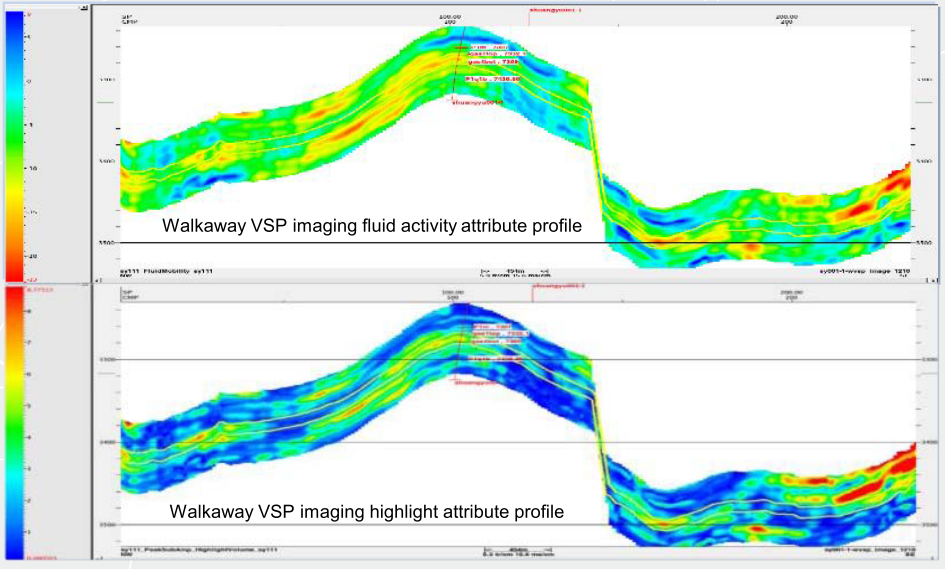
Seismic image (left) and VSP image (right)



Walkaway VSP inversion profile (up) and Seismic inversion profile(down)

Walkaway VSP imaging profile has high resolution; The vertical variation and horizontal distribution of reservoir impedance in walkaway VSP inversion profile are clear.

The Walkaway VSP imaging highlight attribute profile shows the indicative characteristics of favorable reservoir gas bearing.



Reservoir distribution and gas bearing anlysis

Reservoir static fine description(Thin sandstone body)
- Walkaway VSP reservoir identification and prediction

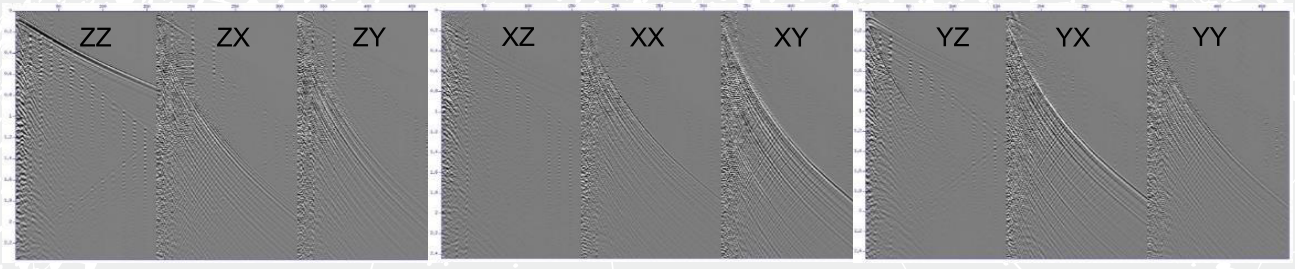
Challenges

For complex lithologic reservoirs, it is difficult to identify thin sandstone body, especially superimposed sandstone body or the sandstone boundary unclear.

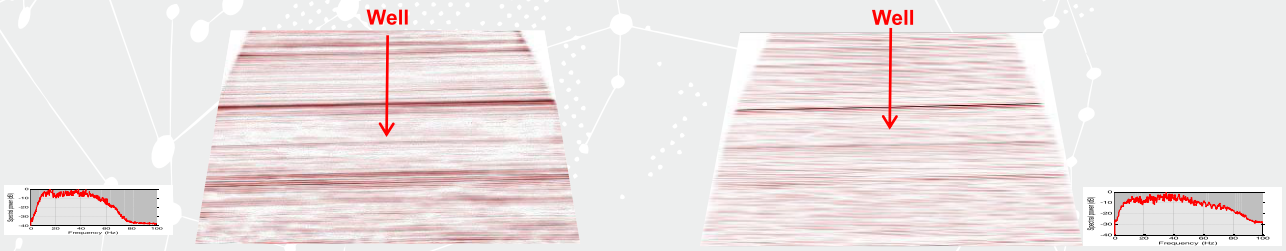
Solution

Walkaway VSP is designed using three kinds of vibrators: P-wave, vertical S-wave and parallel S-wave. The thin sand layer is accurately characterized by the joint inversion of P-wave and S-wave, and the sandstone boundaries are clear, which meet the exploration requirements.

P-wave & S-wave vibrators



9-C record

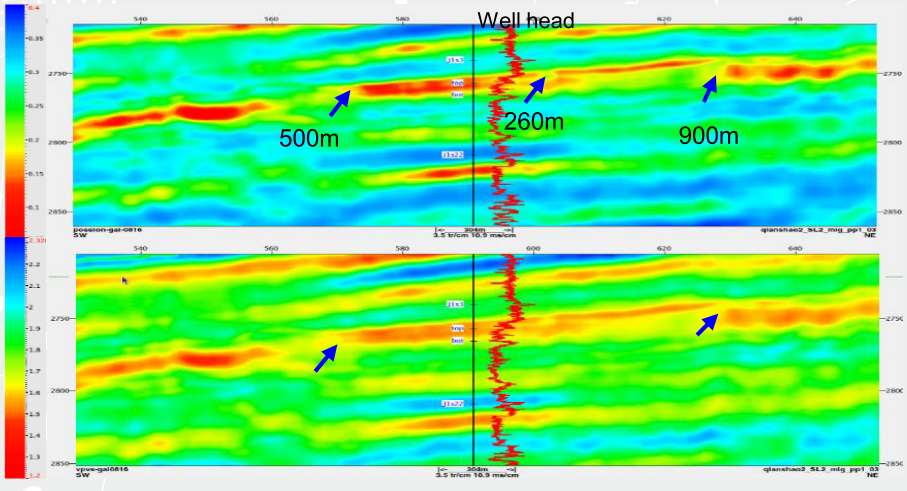


VSP image （P-wave and S-wave)

Results

The P/S wave velocity ratio and Poisson's ratio are oil and gas indication attributes. In this case, they are characterized by low value in the target layers.

And this characteristic extends 900 meters in the northeast direction, and extends about 500 meters in the southwest direction.



Poisson ratio inversion (up) and P/S wave velocity inversion （down)

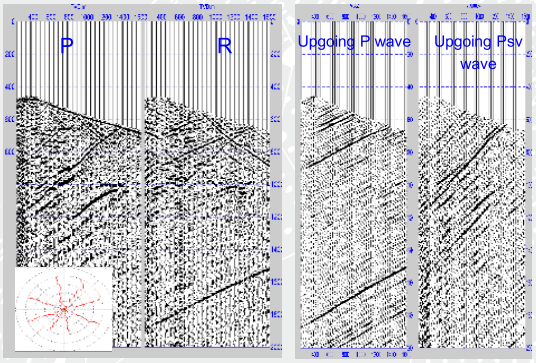
Reservoir static fine description(well trajectory optimization)
- Walkaway VSP guide drilling

Challenges

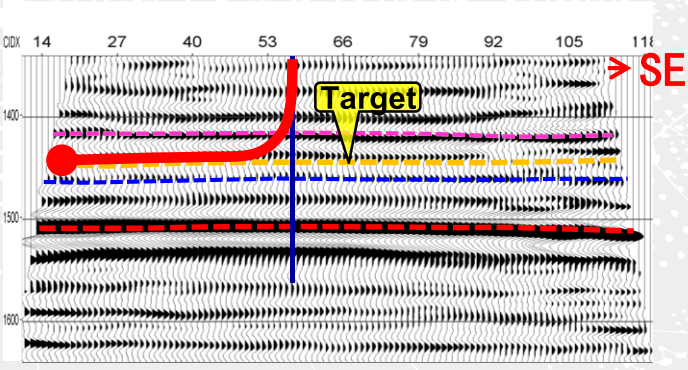
With the development of oil-field productivity construction and drilling technology, more and more horizontal wells are required. However, in some areas there are lack of seismic data or the well spacing are too big, and the reservoir prediction accuracy can not satisfy current horizontal well development.

Solution

Walkaway VSP recorded by DAS-VSP or conventional geophone , with one or multiple lines, can effectively avoid the influence of shallow weathering zone and surface environmental noise. It can finely describe the stratigraphic structure in a certain range, get clear image for the regional structure, small faults and thin-layer reservoirs, which can provide accurate key information, such as dip angel, dip direction and small faults, to guide horizontal well trajectory design and optimization.



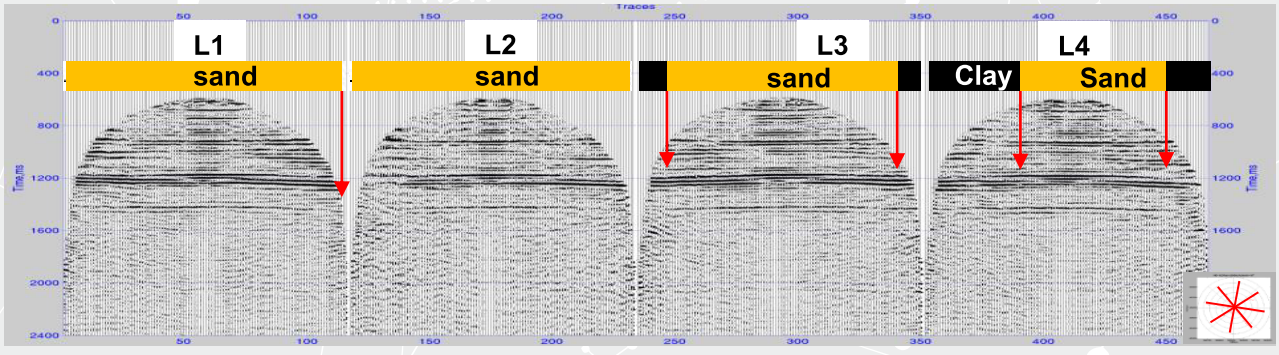
After deconvolution and remove down going Psv wavefield separation



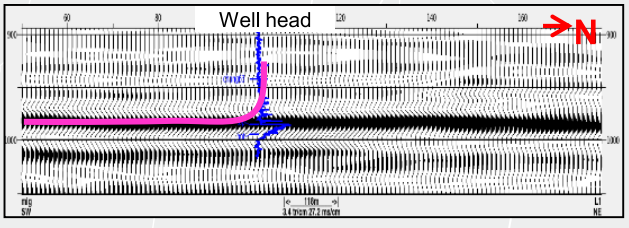
Walkaway VSP guide horizontal well trajectory adjustment

Result

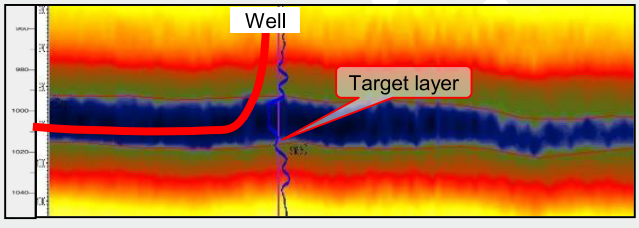
For the thin-layer reservoir areas lacking 3D seismic data, the lateral distribution of reservoir is described by Walkaway VSP imaging. It can effectively help to optimize wells design for horizontal wells and directory well, and improve the drilling success rate.



Multi-azimuth Walkaway VSP image to identify lateral sand boundary



Reservoir favorable azimuth imaging by Walkaway VSP to identify sand layer lateral distribution



Walkaway VSP guide horizontal well trajectory design

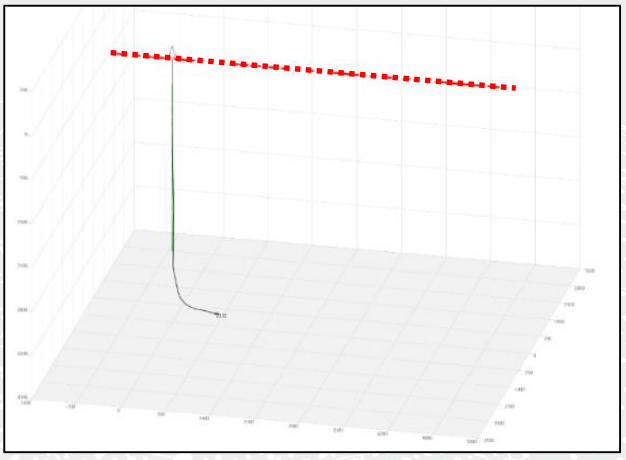
Reservoir static fine description(Shale)
- Walkabove VSP guide drilling

Challenges

For shale gas, it is gradually facing ultra-thin, very shallow or deep shale reservoir. Conventional seismic cannot meet the requirements of horizontal well exploration, the drill success rate is quite low based on normal seismic data.

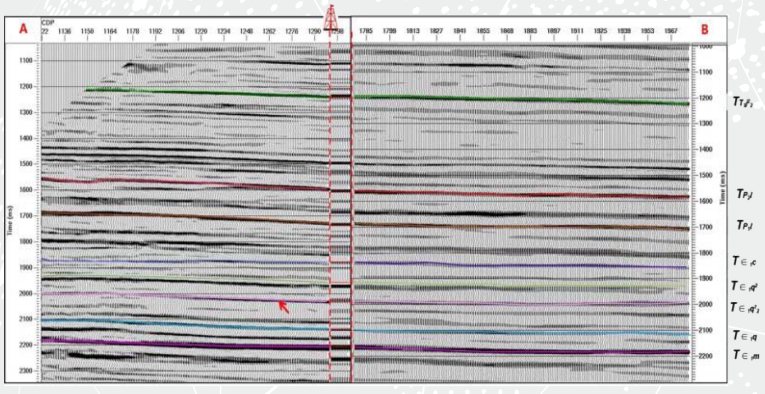
Solution

Walkaway VSP imaging in depth domain is used to clearly map the small structures near the well and horizontal section of the reservoir. Combined with logging information and geological model, the velocity model is updated in real time to provide formation dip prediction.



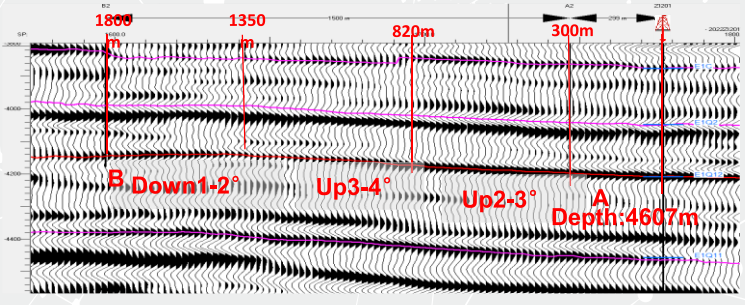
Walkabove VSP geometry

Results



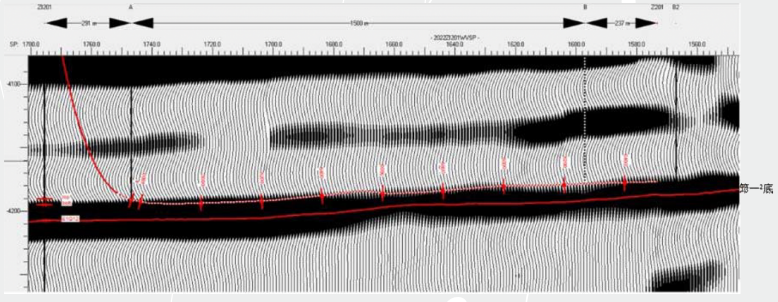
Walkaway VSP corridor stack Surface 2D offset profile

During the Walkabove-VSP acquisition peocess, the ground surface was simultaneously deployed with geophones to receive. The zero-offset VSP has the same correspondence with the new surface seismic two-dimensional offset profile and the Walkaway VSP profile level calibration layer, which ensures the accuracy of targeting.



Walkabove-VSP imaging trajectory advices

VSP data was used to build velocity model. The logging, geological model and real drilling geology layers information are integrated to constrain the optimization of the velocity model. And the imaging is updated accordingly to predict the dip angle of target layers ahead of bit.



Walkabove-VSP SWD real-time adjustment

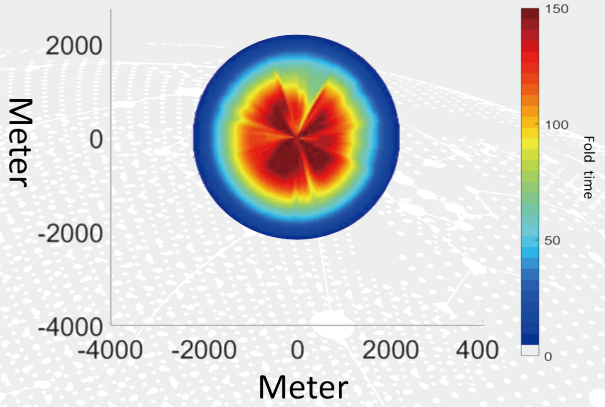
Reservoir static fine description(Prediction of residual oil)
- 3D VSP imaging

Challenges

During oilfield development, the difficulties, such as micro-amplitude structure identification and that connectivity of oil-bearing sand bodies is unclear, restrict the progress in each time oilfield development.

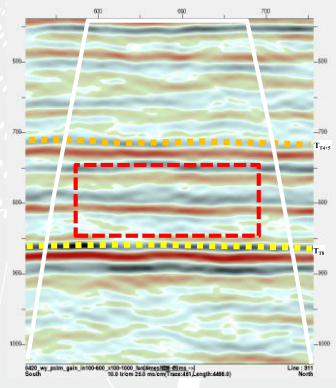
Solution

Deploying optical fiber or large conventional geophone array in one or multiple wells (outside the casing for new well, inside the casing for old well), the structural details is described by high-precision VSP imaging; and it can obtain the low sequence fault and reservoir phase change regulation, which is used for development.

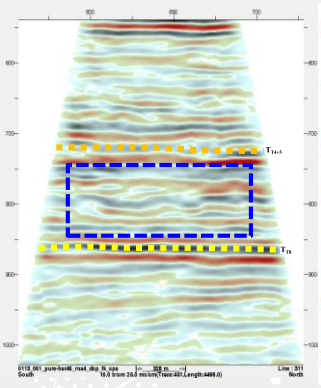


Fold of 3D-VSP

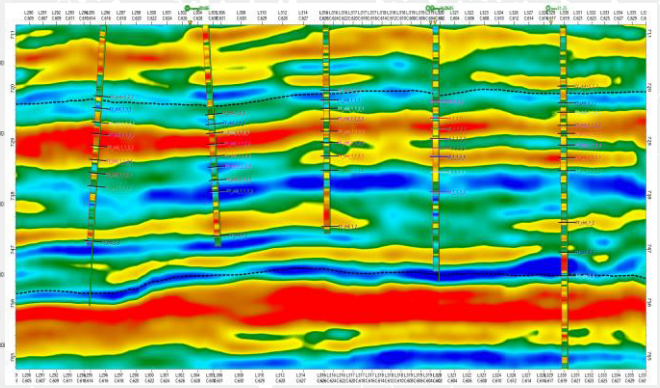
Results



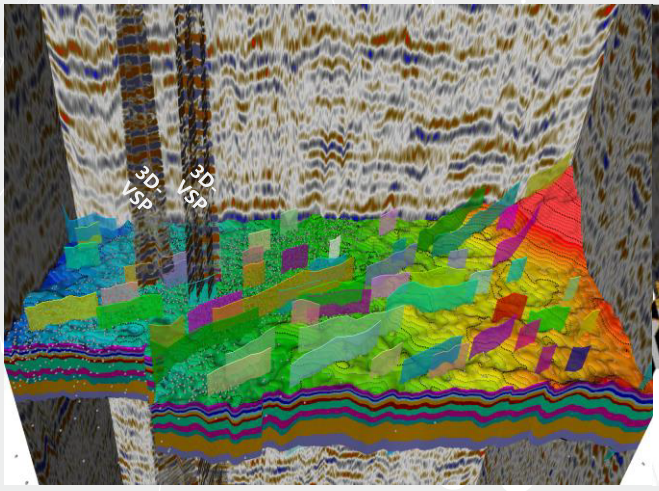
Surface seismic (Inline)



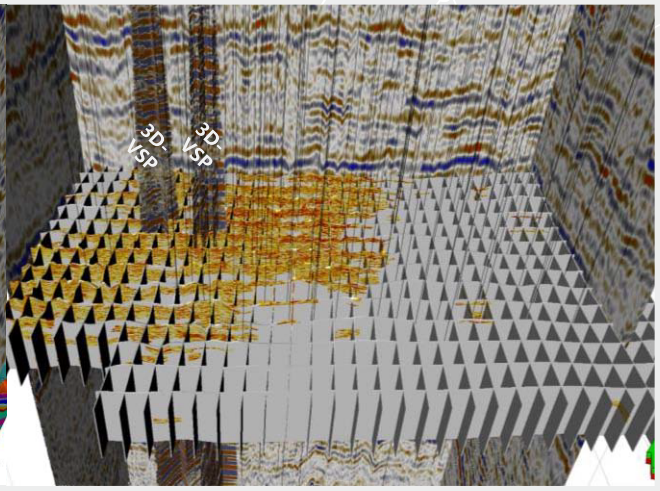
3D VSP (Inline)



Comprehensive analysis diagram of 3D-VSP imaging inversion



3D Structure model

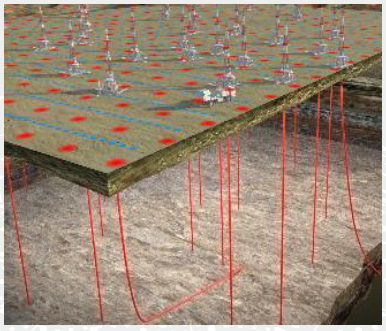


3D Raster plot of the oil saturation model

Reservoir static fine description(Complex geological bodies)
- Joint borehole-surface survey

Challenges

As the development of oil and gas exploration, the demand is extending towards refinement and diversification. Multiple-wave is developed, and seismic imaging accuracy is seriously affected; and some complex area, the conventional surface seismic can not satisfy the development.



Multi-well DAS VSP Joint borehole-surface seismic

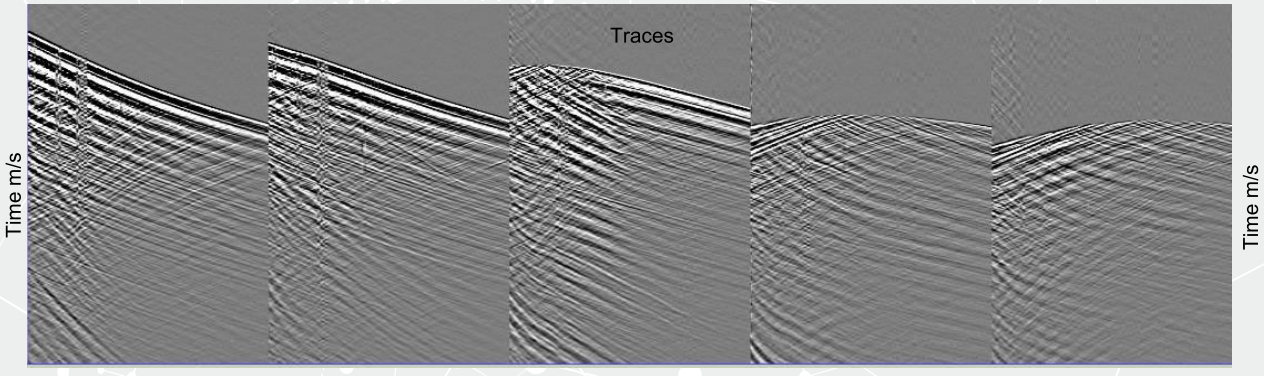
Solution

In 3D surface seismic area, one or multiple wells are chosen to implement VSP integrated with surface seismic by using Companys' DAS system. Interval velocities, TAR / Q factor, anisotropic parameters, seismic wavelet, VSP corridor stack, multiples and other related geophysical parameters are extracted from VSP data to drive the high fidelity and high resolution processing of surface seismic to improve the seismic image resolution.

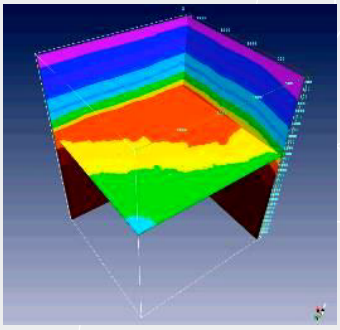
Advantages

Compared with surface seismic, the cost of VSP integrated with surface seismic is low; more accurate geophysical parameters are extracted from VSP data, such as shallow Q, seismic wavelet, seismic multiples, spatiotemporal variation TAR value, anisotropic parameters, velocities; combined with geology modeling, optimized velocity fields for PSDM are established, which make the PSDM image more reliable; The result of VSP driven surface seismic processing is with higher fidelity and resolution, which provides reliable data for increasing reservers and production in the oilfield.

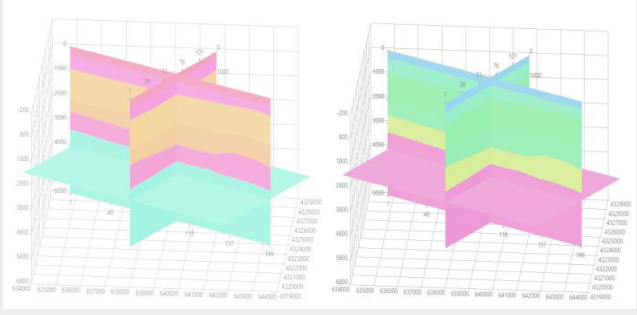
uDAS VSP technique has advantages of high density, high efficiency, whole well observation and multi well simultaneously observation.



VSP integrated with surface seismic raw data recorded by DAS system

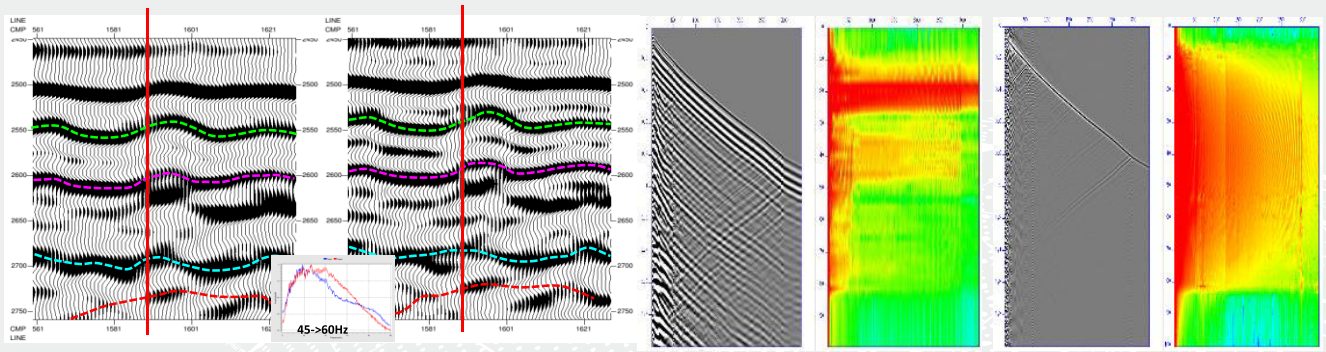


Q model building.



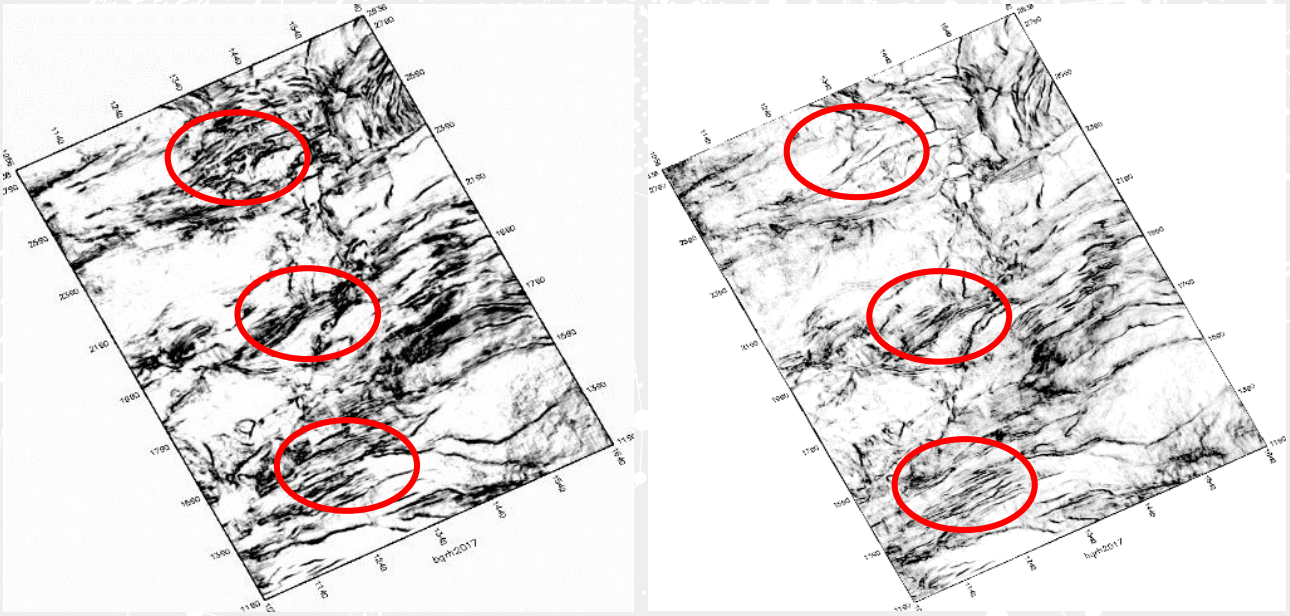
Anisotropic parameters: Epsilon (left), Delta (right)

Reservoir static fine description(Complex geological bodies)
- Joint borehole-surface survey



Conventional PSTM VSP driven PSTM

Seismic wavelet extraction and application
Comparison before(left) and after (right) DECON



Joint borehole-surface by uDAS
Conventional processing (left), VSP driven processing (right)

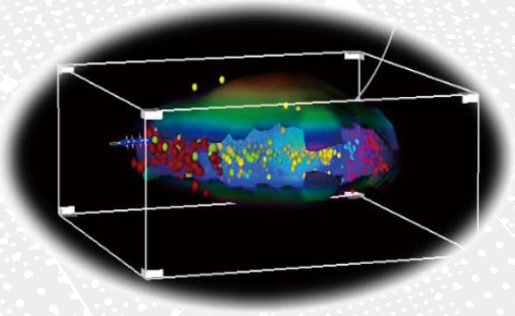
Unconventional oilfield reservoir stimulation
- Real-time microseismic monitoring

Challenges

During the development of unconventional oil and gas fields, such as tight sandstone and shale gas, stimulated reservoir volume is a preferable method to stimulate the reservoir to improve the output of oil and gas. However, how to evaluate the effect of reservoir stimulation, guide fracturing program adjustment on site in real time, reduce engineering risk such as casing deformation, and evaluate the artificial fractures network have always been challenges for reservoir stimulation during unconventional oil and gas exploration.

Solution

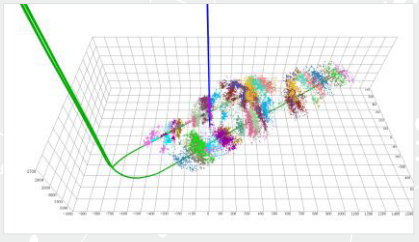
Microseismic monitoring is conducted when fracturing, and microseismic events information can be used to evaluate the fracturing effect, provide data support for fracturing programme optimization. Artificial fracture network orientation, length, width, height and in-situ stress direction are calculated by analyzing the attribute characteristics of microseismic events, such as spatial distribution, time sequence, magnitude, energy, and relative relationship between faults existed and microseismic events. It can calculate the stimulated reservoir volume, evaluate the fracturing effect, which provide data support for the design and adjustment of fracturing programme, especially real-time adjustment of fluid flow and sand content during fracturing, optimize the section space and cluster space.



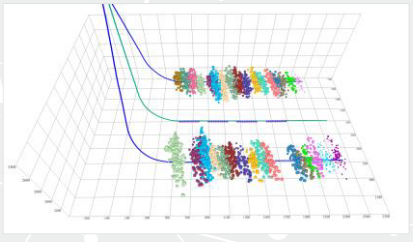
SRV（stimulated Reservoir Voluem) evaluation

Result

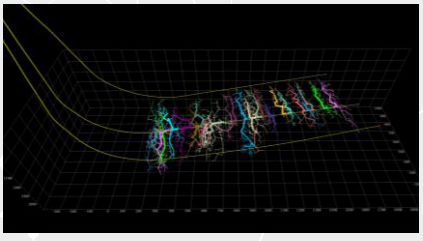
The company has completed thousands of microseismic monitoring production examples for wells, accumulated rich experience in acquisition, processing, and interpretation, and played a positive guiding role in unconventional oilfield gas development, effectively improving the effectiveness of reservoir transformation.



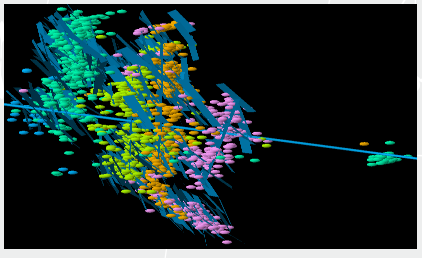
Geophone in vertical wells for microseismic monitoring



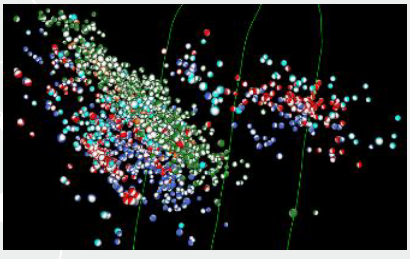
Geophone sliding in horizontal wells for microseismic monitoring



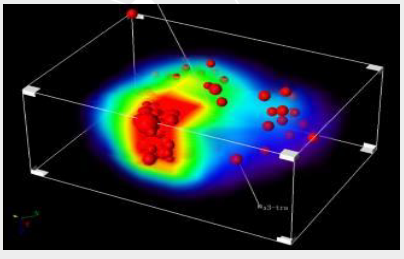
CFN modeling based on microseismic



DFN modeling based on microseismic



Focal mechanism inversion



SRV

Unconventional oilfield reservoir stimulation
- Geo-engineering integration based on microseismic

The integrated technique of microseismic, geological and engineering comprehensively analyzes and guides the optimization of fracturing engineering parameters by using the real-time results of microseismic monitoring, surface seismic and geological attributes of the development formation. It can significantly improve the unconventional oil and gas efficiency and production.

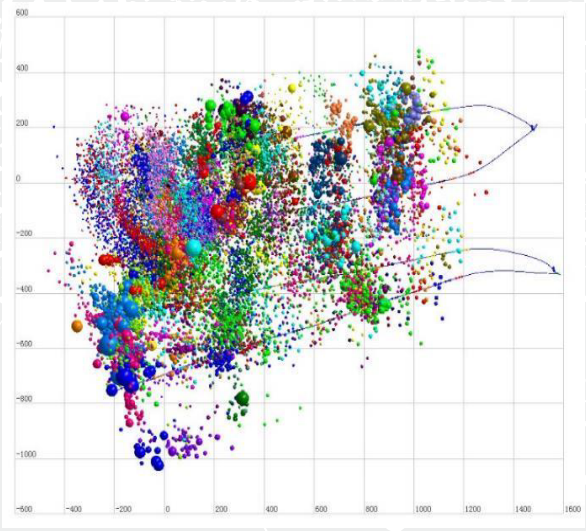
Challenges

During unconventional oil and gas development, due to the influence of complex geological conditions such as natural fractures and faults, engineering incidents often occur, such as drilling fluid leakage, low drill success rate, fracturing casing deformation and lack of fracturing effect evaluation, which seriously delay the progress and lower the efficiency.

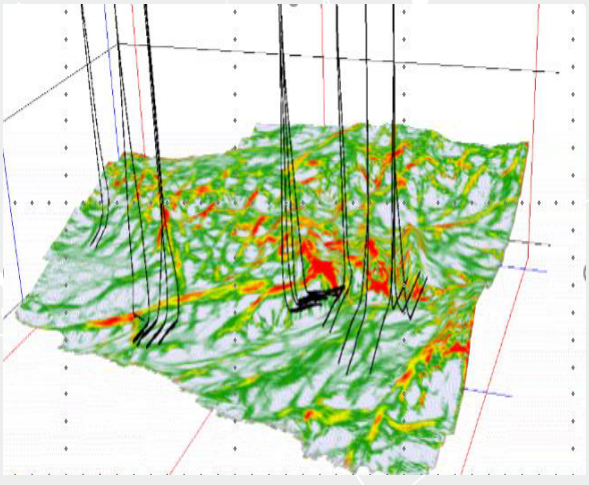
Solution

The unconventional integration processing technique is used to finely describe the attributes of ant body, curvature and Young's modulus of seismic data, improve the fracture identification rate and sweet spot area optimization, and adjust the horizontal well trajectory and fracturing section space. Microseismic monitoring technique is used to display the spatial distribution of artificial fracture network in real time. By analyzing the temporal and spatial characteristics of microseismic events, the casing deformation position is predicted on site, to guide the optimization of fracturing parameters, improve fracturing effect and reduce engineering risk.

By integrating seismic, petrophysical, logging and fracturing engineering data, interactive and comprehensive analysis greatly help decision-makers to make the right decision; The microseismic monitoring results is real-time displayed, showing the fracturing effect, timely guide to adjust engineering parameters, and effectively reduce the engineering risk; The microseismic monitoring technique based on crawler dragging geophone to horizontal section improves the positioning accuracy of artificial fracture network and greatly reduces the cost of multi-well fracturing monitoring on the same platform.



Microseismic events in tight sandstone



Target layer curvature attribute map

Result

In the development of shale gas and tight sandstone oil and gas in China, the integrated technique of microseismic, geological and engineering has greatly improved the effect of hydraulic fracturing and artificial fracture reconstruction, and effectively reduced the engineering risk and development cost.

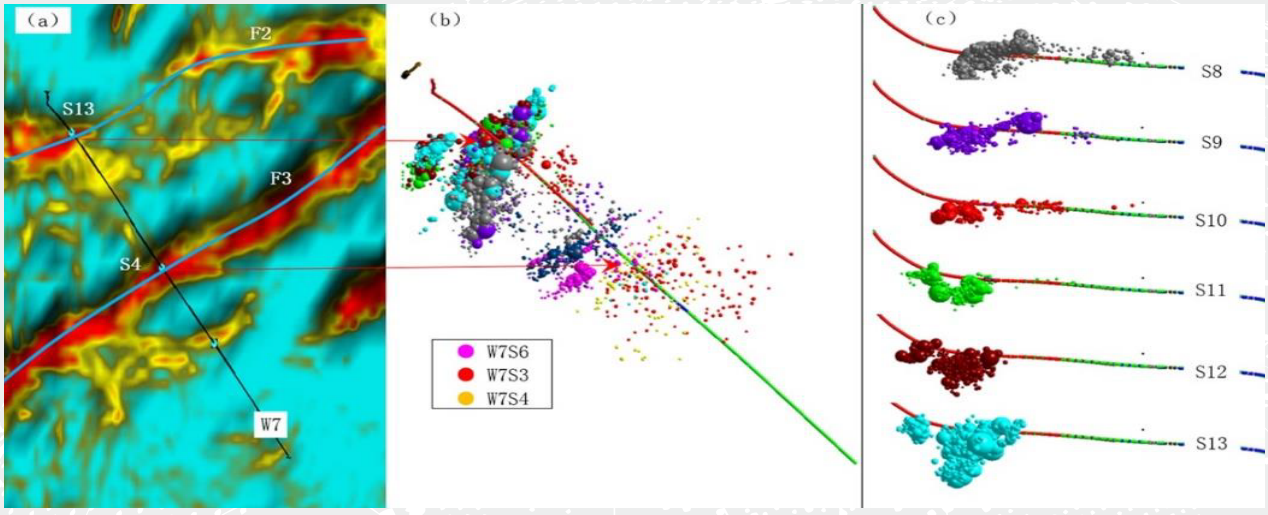
Prediction before drilling

Integrating geophysical results, geological understanding, fracturing operation parameters and microseismic events characteristics, comprehensively analyze the impact of rock physical properties (TOC, formation pressure) and natural cracks on fracturing operation, guide the selection of preferable fracturing area, optimize well trajectory design, improve drilling success rate.

Unconventional oilfield reservoir stimulation
- Geo-engineering integration based on microseismic

Optimization of fracturing parameter and real-time risk early-warning

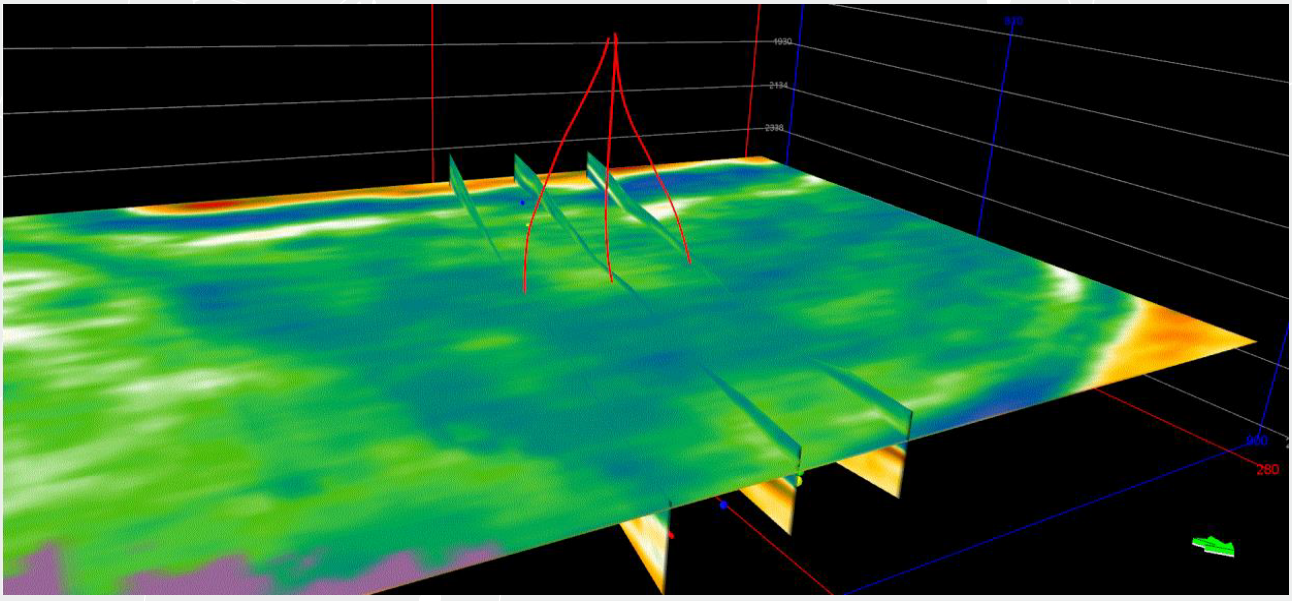
The artificial fracture network is displayed in real time. The attribute characteristics of microseismic events are analyzed on site, and the effect of parameter change is evaluated timely; Combined with geophysical attribute characteristics and fracturing parameters, early warning of engineering risk is put forward and it can improve the success rate of fracturing.



Casing deformation analysis by integration techniques

Post-hydraulic fracture evaluation

The relationship model of microseismic-3D seismic-construction parameters is established. Combined with the production information , we evaluate the reservoir reconstruction effect. Optimizing the sweet spot for reservoir reconstruction in the early development, adjusting well trajectory and well spacing, and predicting the shape of fracture network. In the middle and late period, we can accurately evaluate the artificial fracture network of fractured wells, optimize reservoir development scheme and main fracturing parameters.



Optimization of reservoir stimulation Areas and Horizontal Trajectory

Unconventional oilfield reservoir stimulation
- Optical fiber sensing monitoring in the same wellbore

Challenges

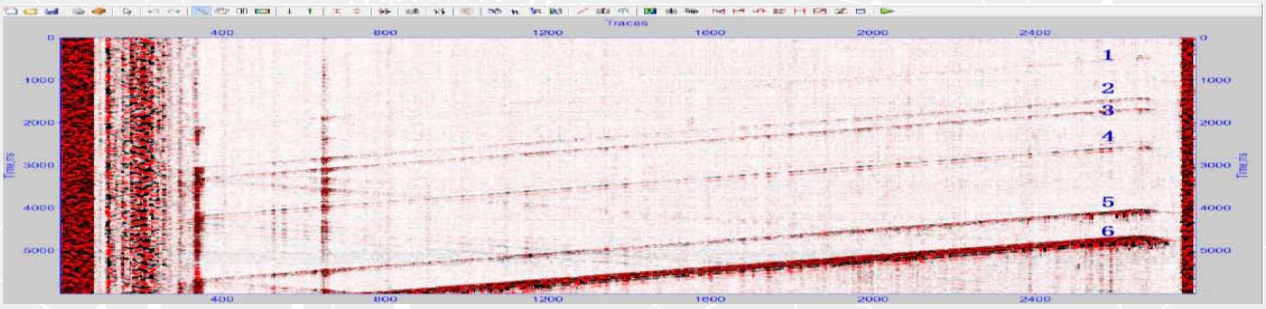
With the continuous development of unconventional oil and gas, how to optimize fracturing and attenuate noise cross-wells becomes more and more important.

Solution

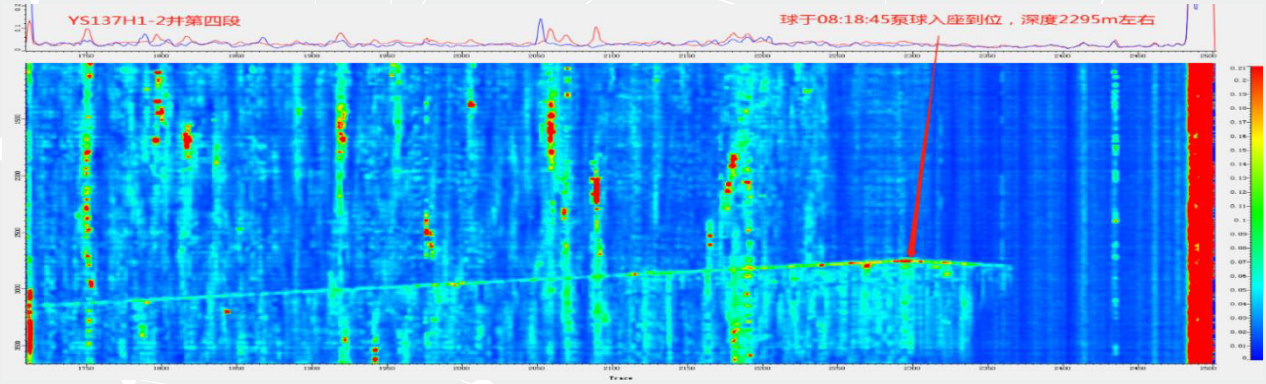
Distributed optical fiber acoustic sensing (DAS) is used to obtain downhole acoustic information; Distributed optical fiber temperature sensing (DTS) is used to obtain downhole temperature. Combination of DAS and DTS can be used to monitor reservoir stimulation progress. It can provide real-time changing regarding fracture opening, fluid injection and sand addition of each fracturing cluster, temporary plugging, guide fracturing operation.

Results

1. Downhole condition monitoring. By deploying a permanent optical fiber outside the casing, the bridge plug slip sealing, bridge plug loss hand, perforation and other actions can be monitored during the bridge shooting process, and the pitching position and bridge plug sealing effect can be monitored during the fracturing process to prevent the waste of resources caused by engineering problems.
2. Real-time monitoring fluid injection. Establish the relationship between acoustic energy and fluid injection, quantify the sand injection volume of each cluster, define the dominant fluid injection cluster, and timely adjust the fluid injection strategy according to the fracturing situation of each cluster.
3. Evaluation of temporary plugging. Compare and analyze the fluid flow status of each cluster before and after temporary plugging. If the temporary blocking failed, adjust the fracturing program immediately.
4. Fracturing effect evaluation. The fracturing effect is evaluated according to the fracture energy of each cluster, the total volume of fluid injected into each cluster, and the temperature falling after fracturing ending.
5. Combined with the later production situation, the relationship between yield and fracturing effect was analyzed, and the subsequent fracturing scheme was optimized.



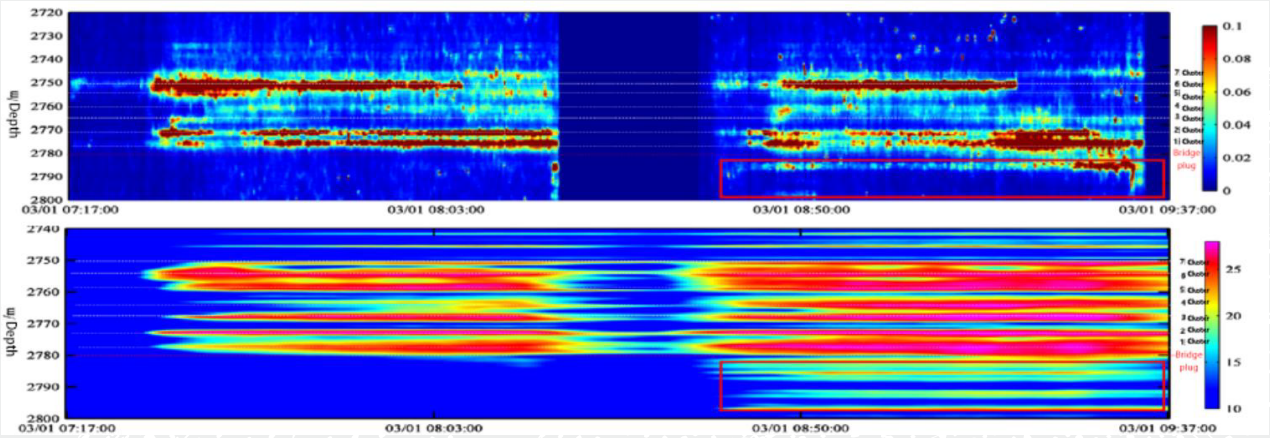
1-5 is the slip occlusion process, 6 is the blasting and losing hand process;
Monitor pitch seat position during fracking pitching to verify bridge plug seal depth.



Fracking pitching monitoring

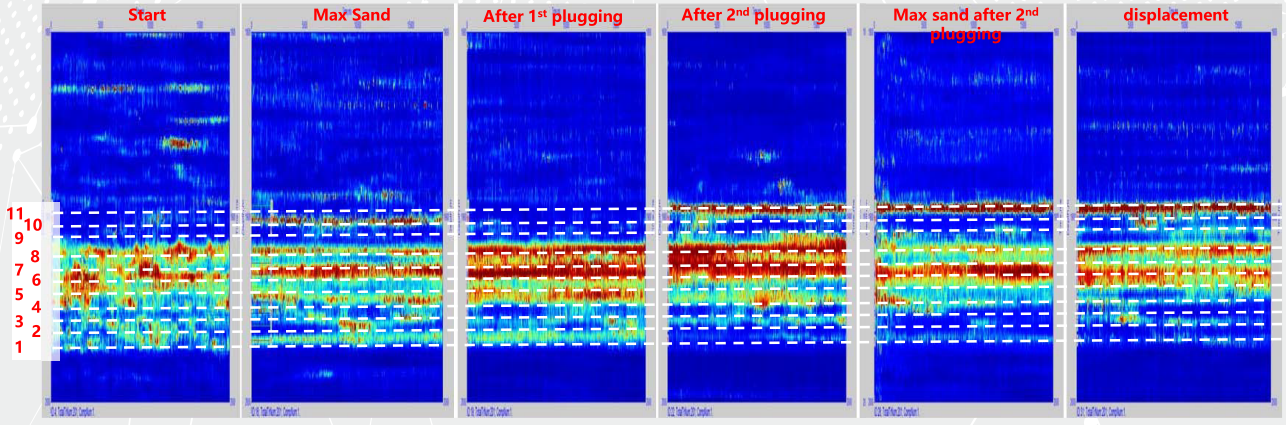
Unconventional oilfield reservoir stimulation
- Optical fiber sensing monitoring in the same wellbore

- DAS+DTS Monitoring the sealing effect of the bridge plug and judge the real-time status of the bridge plug.



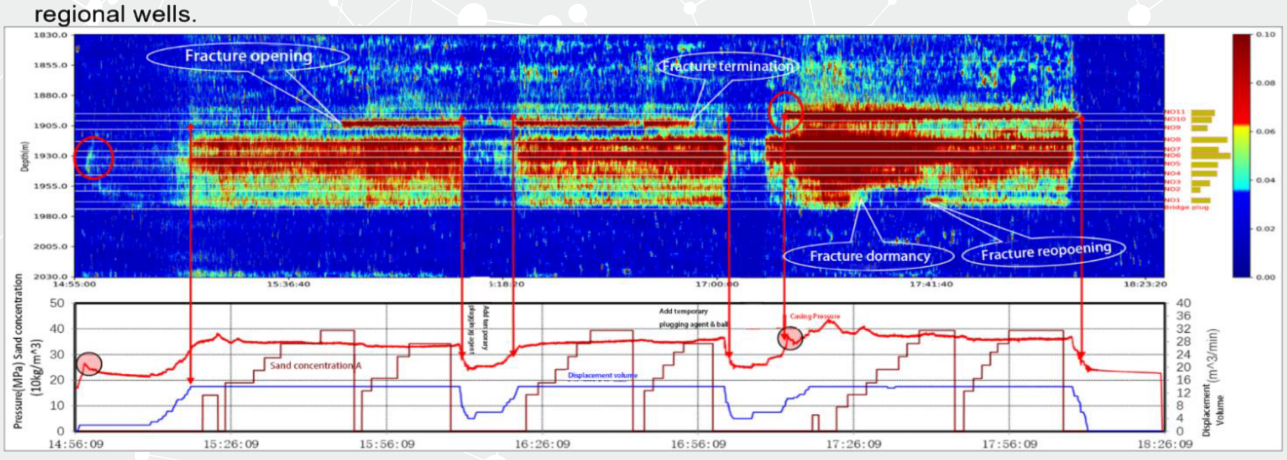
Status of bridge plug （Leak / Slide）

- Fracturing inlet monitoring can realize real-time display of clusters, effectively judge the injection of each cluster of formation under different fracturing operation systems, and provide guidance for the adjustment of on-site fracturing schemes.



Real-time monitoring of the injection of each cluster at different fracturing stages

- DAS combined with fracturing curve to evaluate the fracturing effect and optimize the fracturing scheme of regional wells.



Unconventional oilfield reservoir stimulation
- Adjacent-well optical fiber sensing monitoring

Challenges

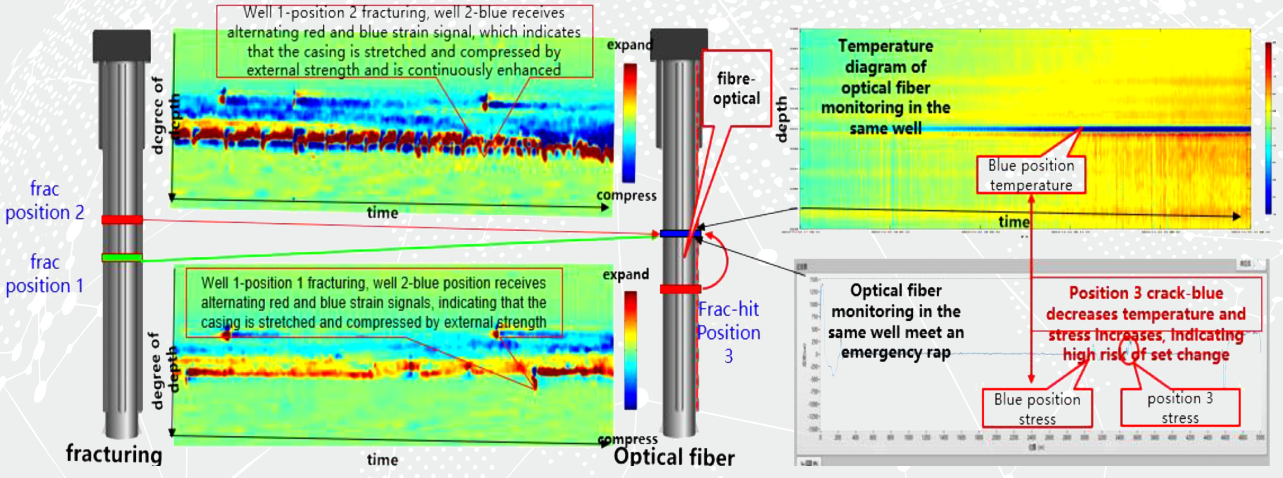
1. Enrich fracturing monitoring methods and deepen the understanding of fracturing networks.
2. Early warning and treatment of casing deformation and damage.

Solution

1. when the adjacent well is in the process of fracturing, the fracture will be extended, leading to the strain field change in the reservoir, formation migration and deformation of optical fiber.

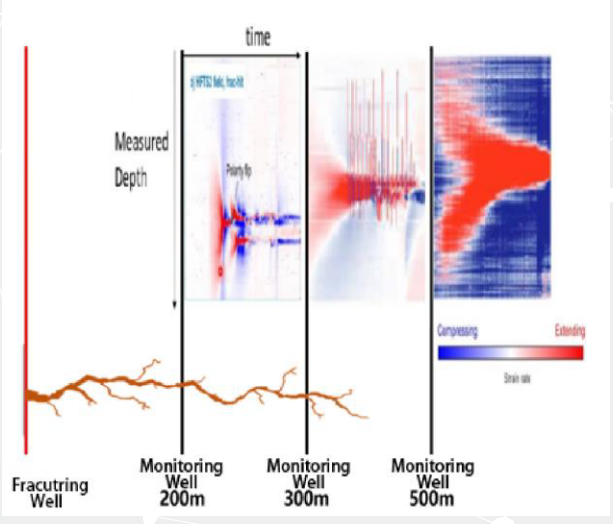
Results

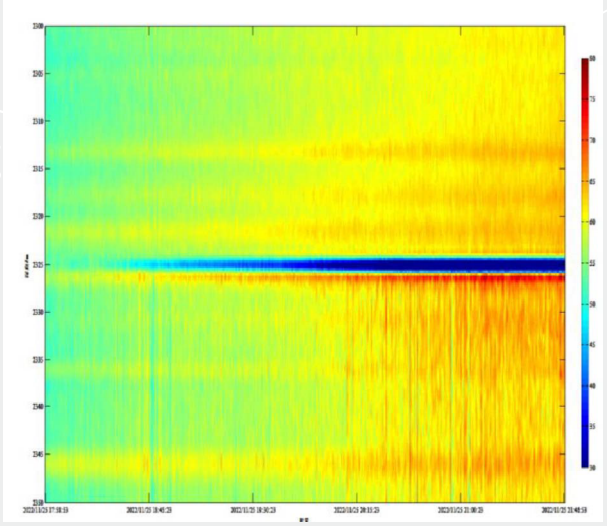
1. Low-frequency strain can predict the set changes accurately and predict casing deformation & damage.



2. Prediction of casing deformation & damage

Through the ultra-low frequency DAS strain monitoring in the well, the effects of fracture expansion, length, closure and pressure channeling were effectively evaluated. Ultra-low frequency strain enables accurate arbitrage prediction.





Unconventional oilfield development
- Fluid production monitoring using optical fiber sensing

Challenges

With the continuous development of unconventional oil and gas, how to evaluate production, how to improve efficiency, prolong the life cycle and enhance ultimate recoverable reservoir (EUR), how to identify the location of water/sand, how to prevent sand plugging or gas well flooding are current urgent problems need to be solved.

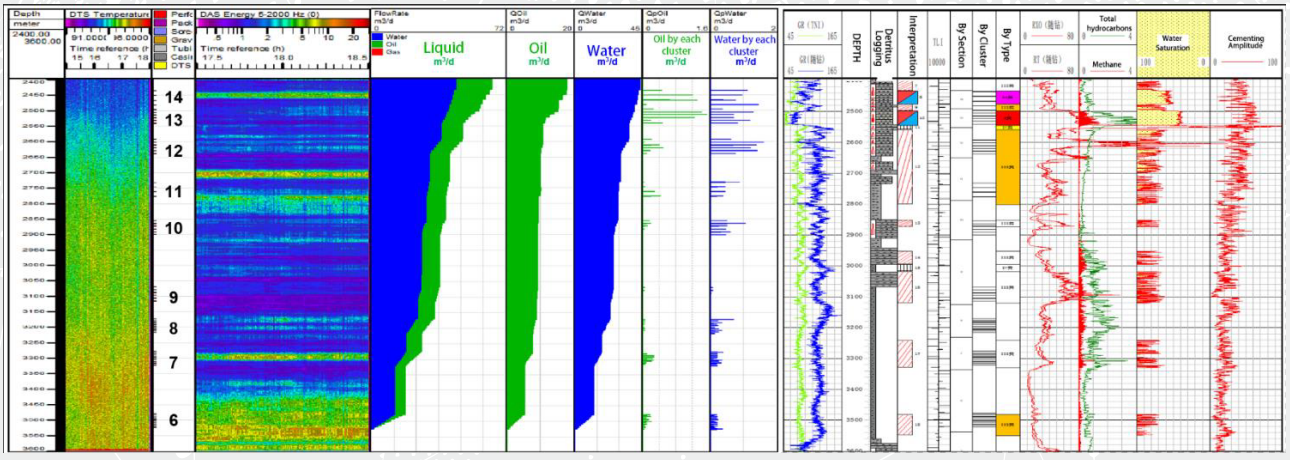
Solution

Monitor and display the fluid production profiling and DAS acoustic energy under different production systems in real time, and choose the best production system; Identify the water outlet area according to the temperature change of the whole wellbore, and identify the sand production position according to the change of acoustic energy.

Results

1. Evaluate production and optimize production parameters

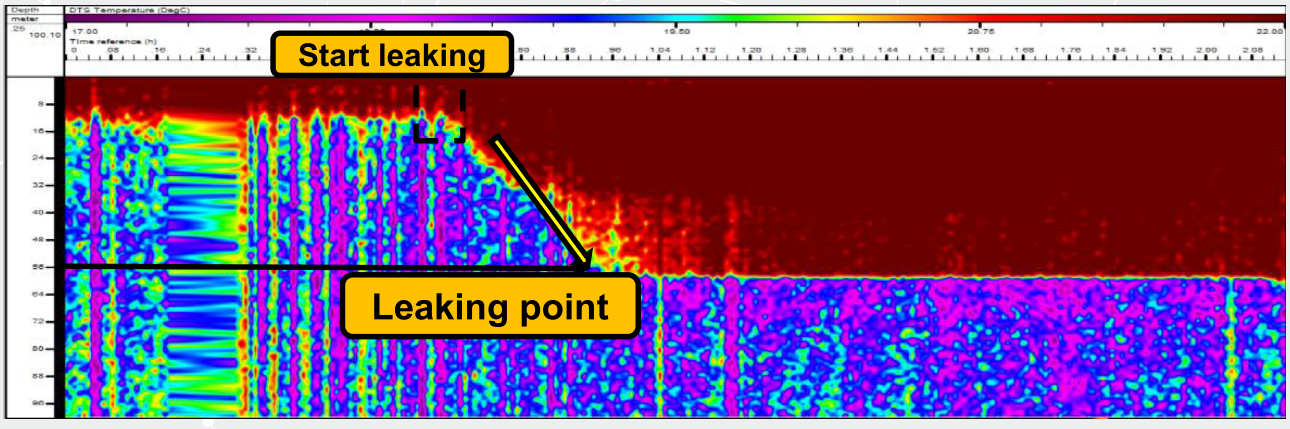
Using DTS to test the fluid production profiling with different production systems, combined with DAS, analyze and verify the acoustic energy of each cluster, and choose the best production system.



Fluid production profiling chart

2. Water outlet and sand production position monitoring

By analyzing the temperature change of the whole wellbore, the water outlet point is identified, which can provide accurate position for oil&gas well to block water; The sand production position can be indentified by analyzing the whole wellbore acoustic energy changing. The positioning error is less than 3m.



Reservoir dynamic monitoring
- Time-lapse DAS walkaway VSP

Challenges

During oilfield development, it is necessary to monitor reservoir and fluid changes, find and exploit the remaining oil to enhance oil recovery. For oil and gas storage, it is necessary to monitor the status of oil/ gas migration and storage.

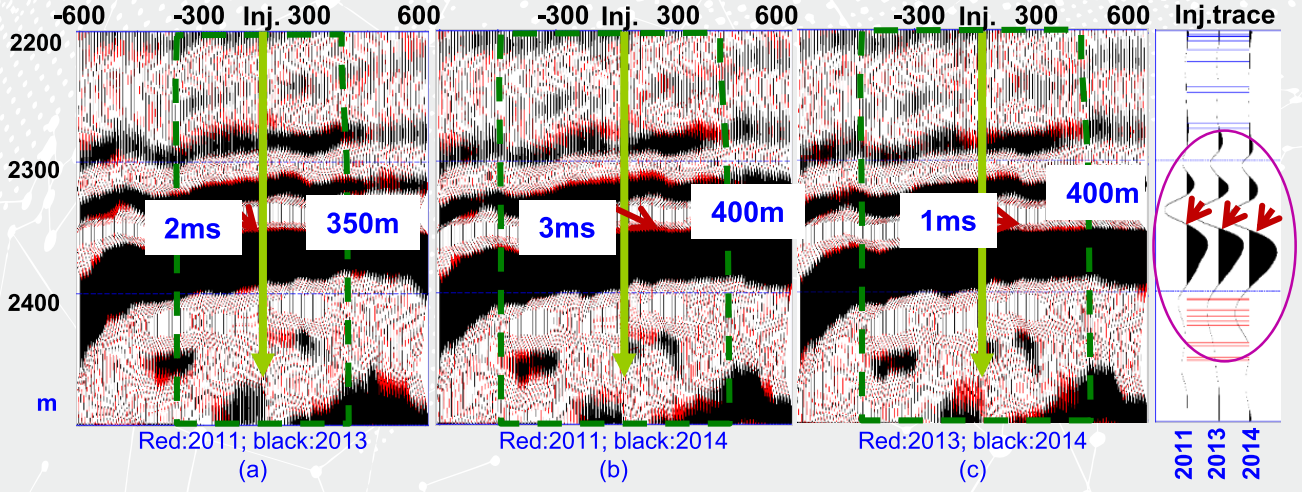
Solution

Time-lapse DAS walkway VSP is designed using uDAS system. It has advantages in consistency and high precision. The difference analysis of attribute parameters, such as seismic wave velocity, travel time, amplitude, frequency and wave impedance between different stage data, is used to study the change of fluid status of reservoir near wellbore.

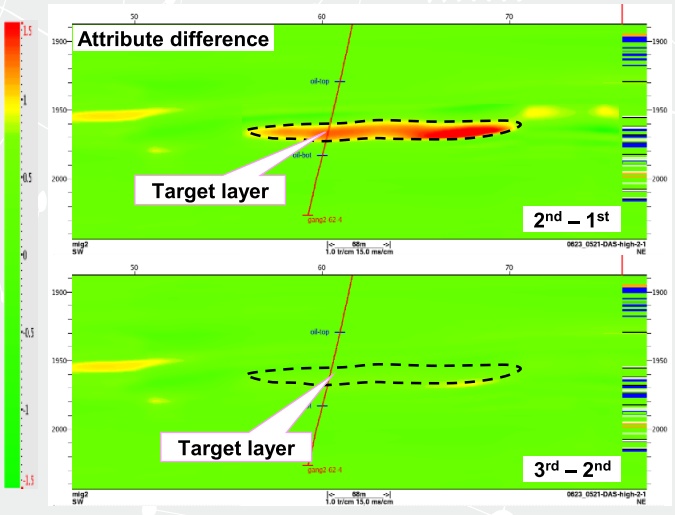
Comparing the differences of acquired data in different stages, it reflects the reservoir changes in a certain range around the observation wellbore, which is very important for gas reservoir monitoring, remaining oil finding and recovery improvement. Especially, the application of uDAS with optical fiber cemented outside the case makes this method more reliable.

Results

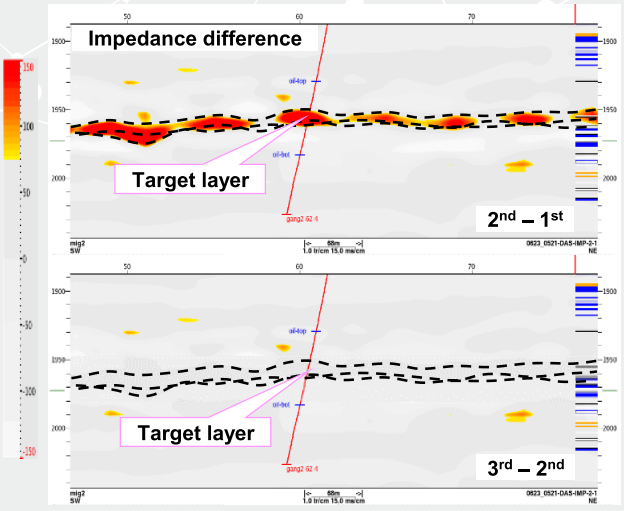
The time-lapse VSP method is firstly applied to the monitoring of reservoir. Through the comparative analysis of multi-stage seismic attributes and wave impedance inversion profiles, the dynamic characteristics of reservoir fluid are finely described and the shifting direction of reservoir fluid is predicted.



VSP image comparison among different stages



Amplitude attribute differences between different stages



Impedance inversion differences between different stages

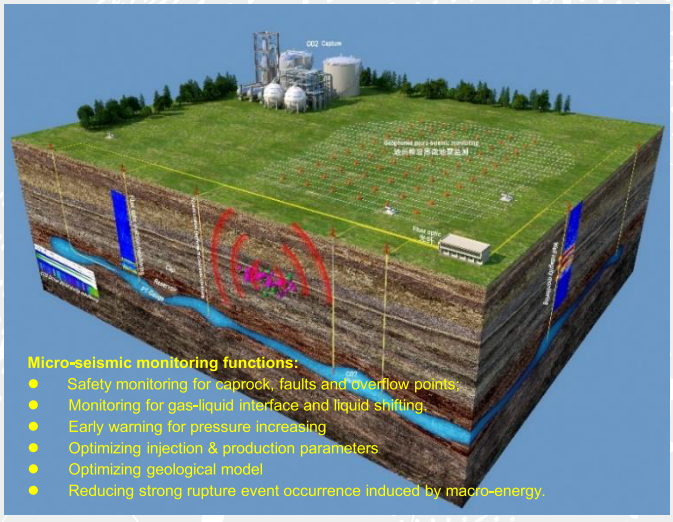
Underground Gas Storage operation
- Microseismic and DAS joint monitoring

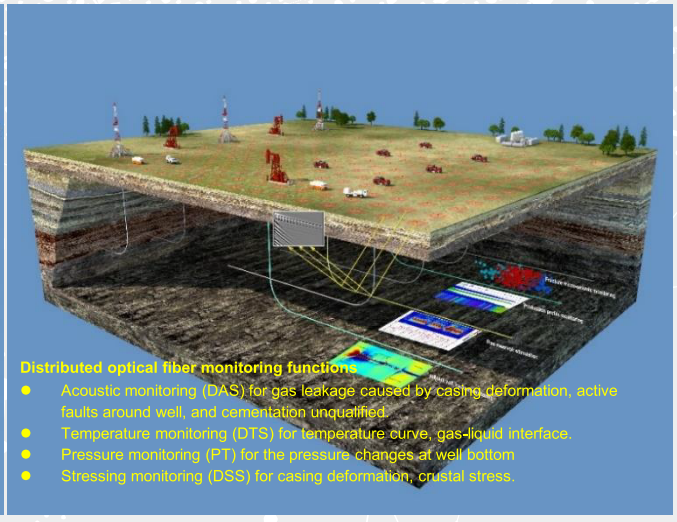
Challenges

Underground Gas Storage (UGS) accidents is mainly caused by the integrity of geological body and wellhole losing efficacy. During long-term operation, high-pressure reciprocating injection and production leads to periodic disturbances in the in-situ stress field, and then the caprock and wellbore integrity may lose efficacy.

Solutions

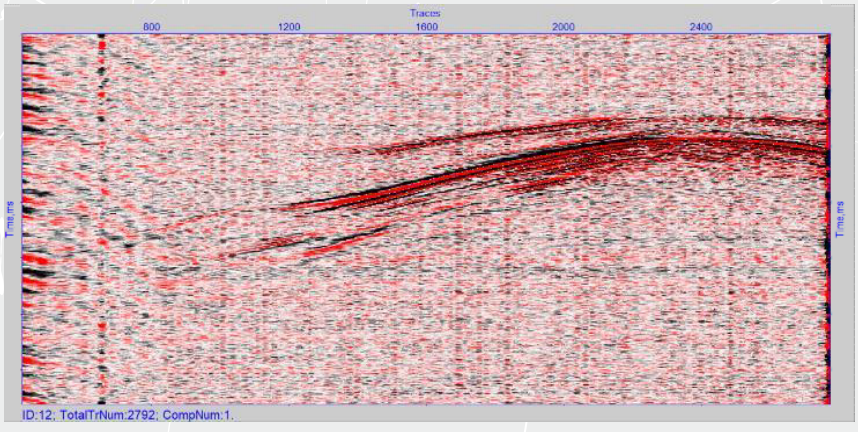
The establishment of a safety early warning system provides a solid guarantee for the pressure increasing of UGS. According to UGS characteristics, micro-seismic and optical fiber joint monitoring is adopted. Microseismic monitoring system is deployed to conduct real-time monitoring of the integrity of geological bodies, and optical fibers are deployed in observation and injection-production well to conduct real-time monitoring of wellbore integrity.



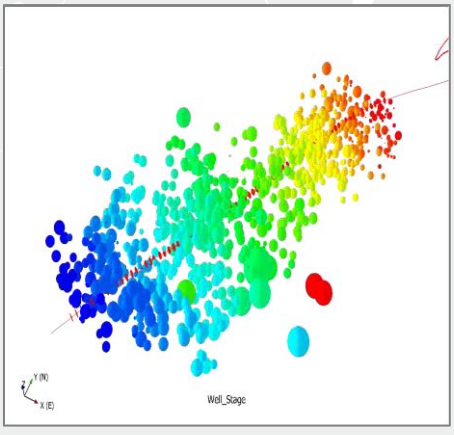


Case study

1. Distributed optical fiber acoustic sensing (DAS) monitoring, receiving fracture signal to analyze the location, strength and other information, provide early warning for UGS operation.



Raw data with micro-seismic events

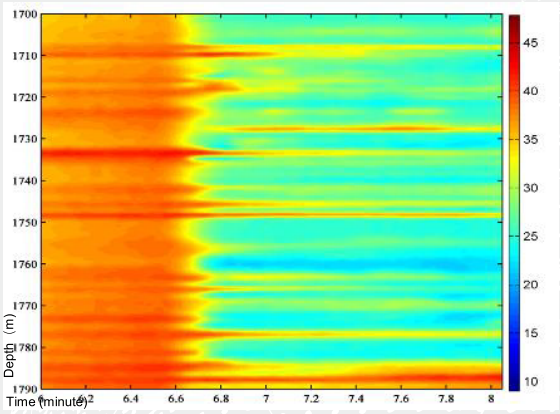


Micro-seismic events

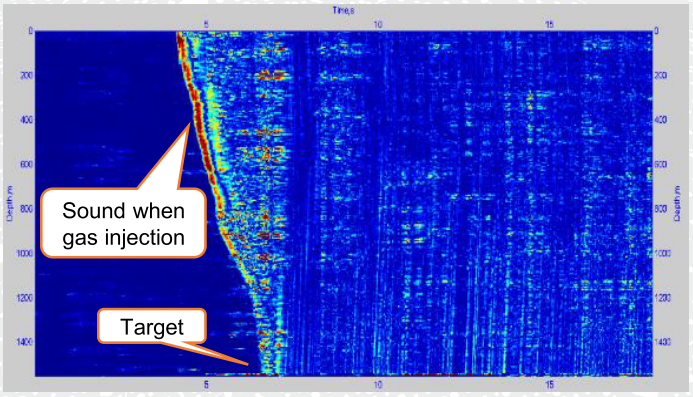
Underground Gas Storage operation
- Microseismic and DAS joint monitoring

Case study

2. Distributed temperature sensing (DTS) monitoring, to analyze the gas-liquid interface, the temperature before injection and after, the seal performance of packer and optimize injection & production parameters.



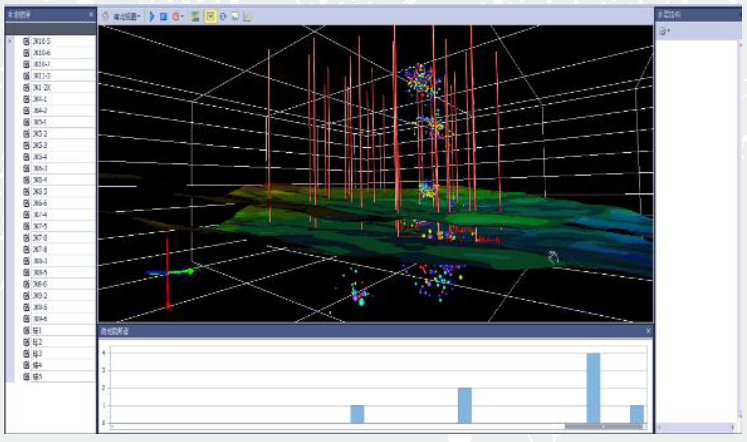
DTS monitoring (gas injection duration)



DAS monitoring (Gas injection duration)

3. Pressure and temperature (PT) monitoring

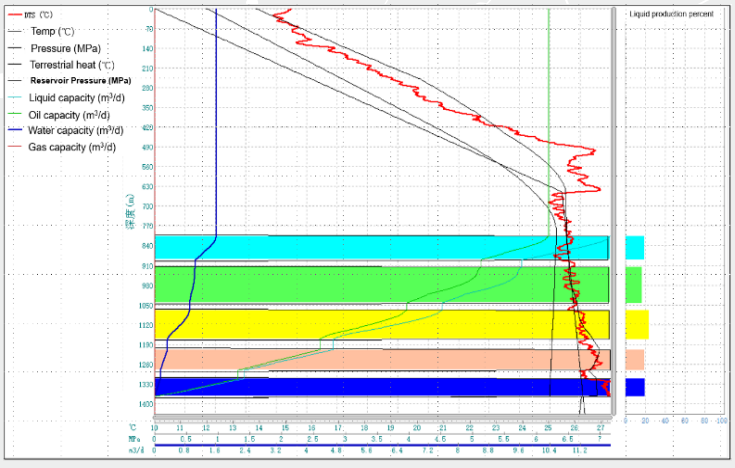
According to the pressure change of each well after gas injection & production, judge the connection of each well, evaluate the gas diffusion and the secondary gas accumulated pattern.



Wellhole pressure and micro-seismic comprehensively analyze sketch map

4. Distributed stress sensing (DSS) monitoring for formation strain from multi-well, to analyze stress change in work area, provide early warning.

5. DTS+ DAS+ PT injection & production section, comprehensively analyze gas-liquid interface, and optimize injection & production parameters.



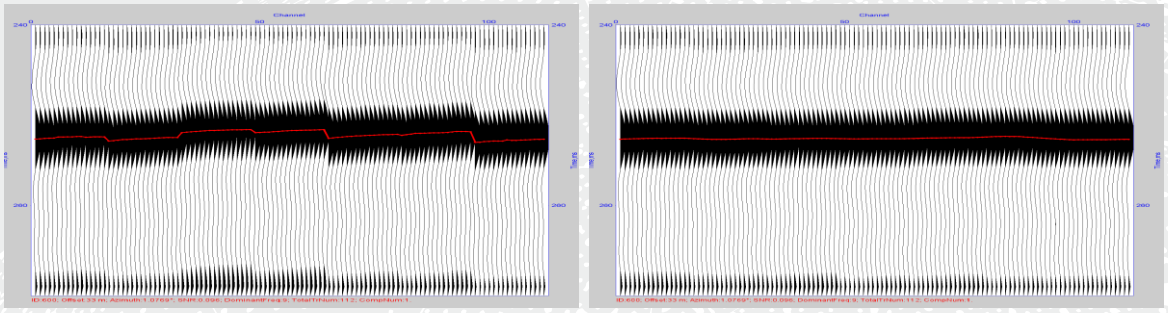
Pressure, temperature and injection & production parameters sketch map

CCS/CCUS Time
-lapsed DAS Monitoring

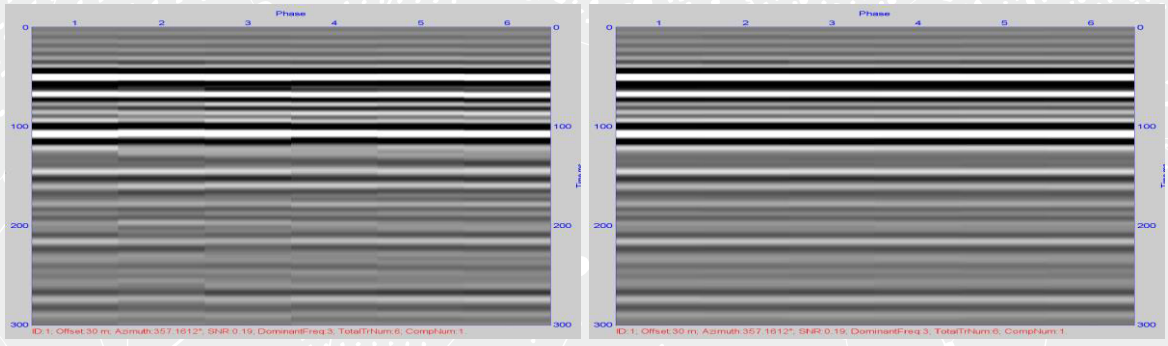
Case study

6. Distributed acoustic sensing (DAS) monitoring, to use in CCS/CCUS VSP monitoring experiments to understand the geophysical response after CO_2 injection, which can be used to guide the evaluation and adjustment of the injection plan. At present, the pre-stack consistency processing and post-stack time-shift analysis schemes have been formed.

Consistency Processing

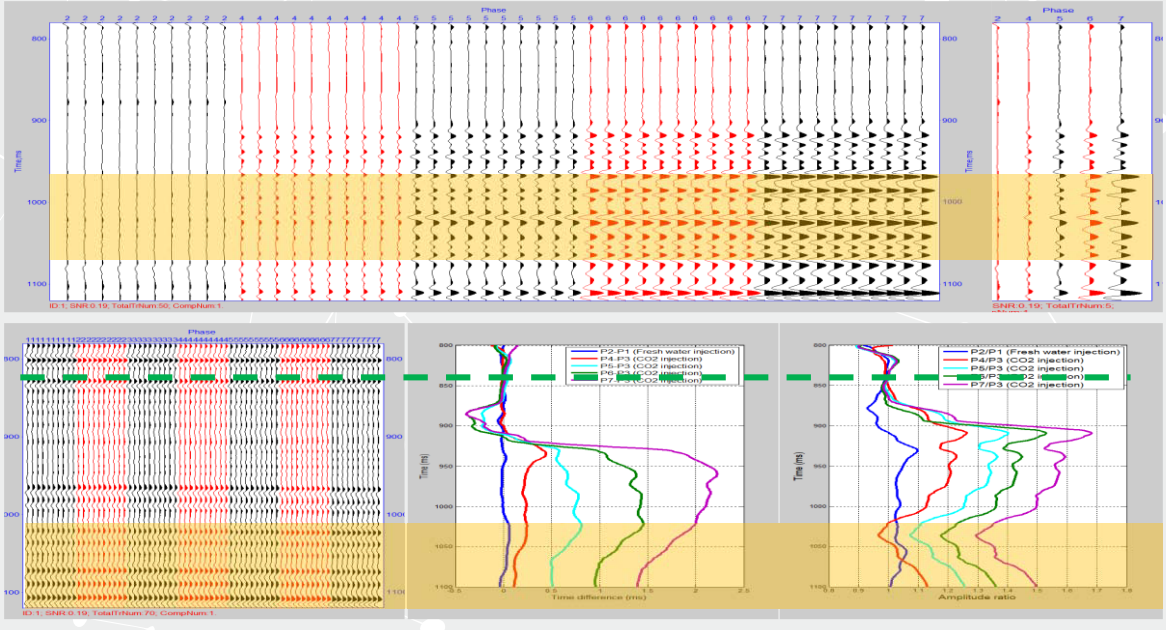


Before Correction　　After Correction



Before Wavelet Correction　　After Wavelet Correction

Time-lapsed Analysis



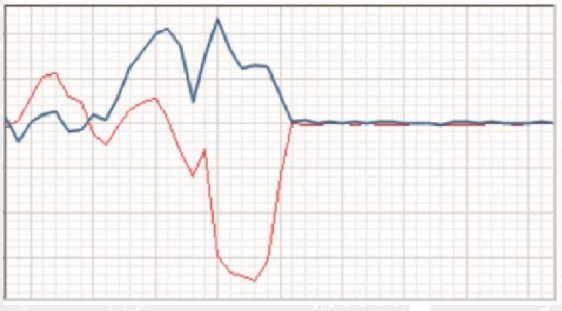
Pipeline Security DAS Monitoring

Challenges

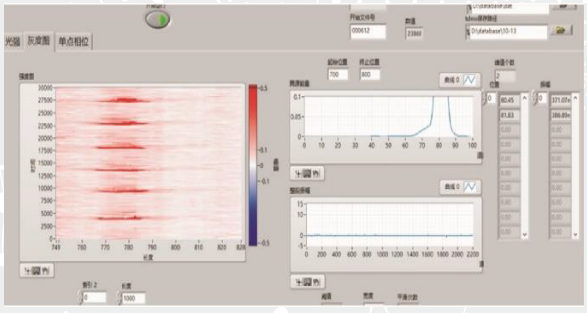
In terms of pipeline security monitoring, through the DAS system deployed in the valve chamber, AI pattern recognition technology is used to extract features of various signals, set different strategies and response times according to different event types, and cooperate with UAV inspection technology to establish a pipeline optical fiber safety early warning system, reduce the false alarm rate, and realize real-time monitoring of pipeline safety.

Solutions

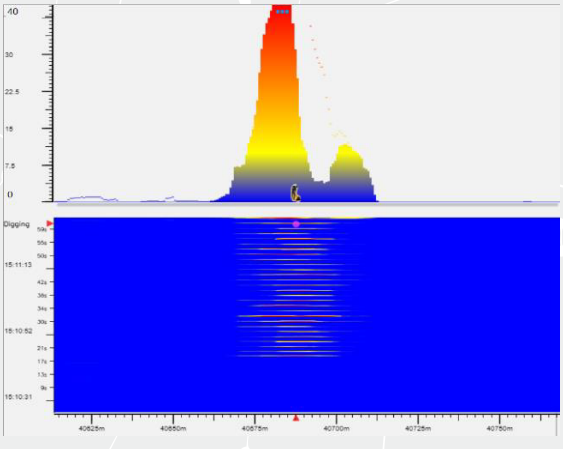
Using the high-precision DAS intelligent pipeline monitoring station, combined with the optimal acquisition technology of geophysical exploration, the optical fiber sensing technology has the advantages of high precision, small excavation surface and high success rate in the identification and positioning of abnormal events.



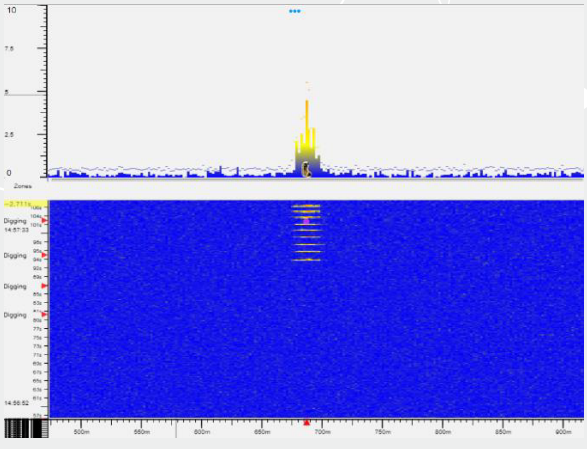
Breakpoint Position



Vibration Specturm Analysis



Excavate Event



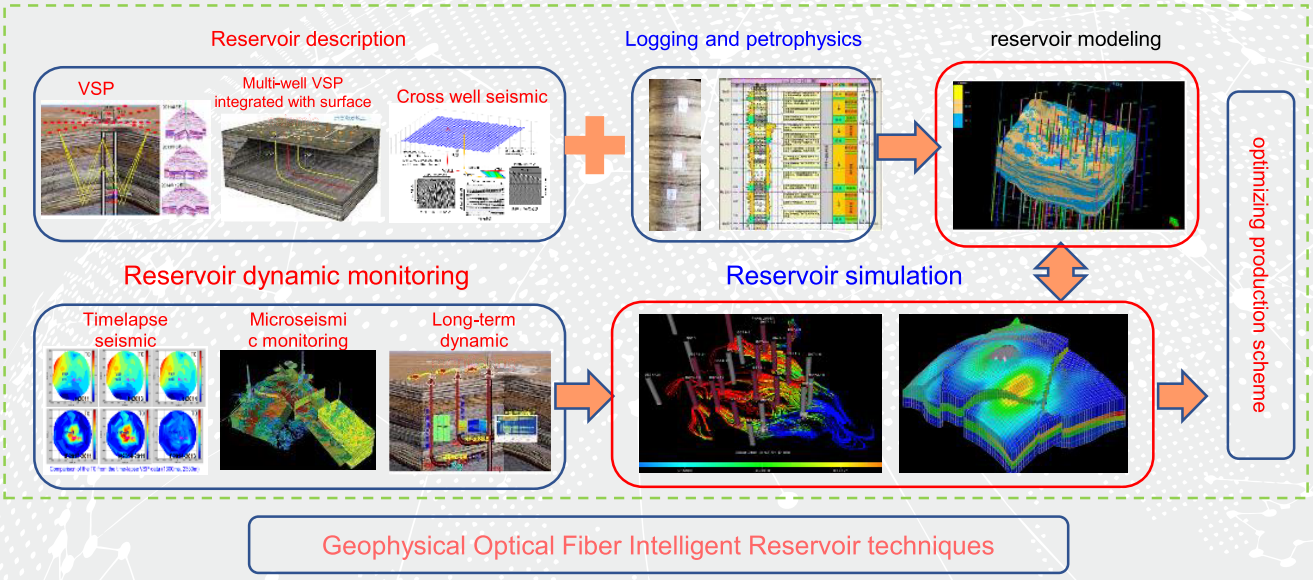
Weight Dropper Event

Introduction to Company's borehole seismic integration technique services

1 Research & development

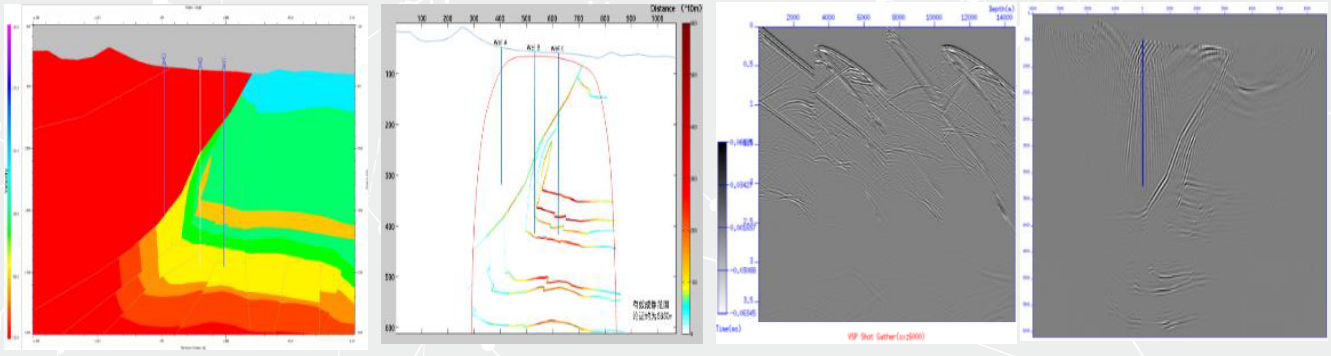
1.1 Techniques

Company's borehole seismic integration service utilizes static description and dynamic monitoring, integrates logging, petrophysics and reservoir modeling, to achieve reservoir simulation, and it provides basis for finding remaining oil, enhancing oil recovery and optimizing production scheme.



1.2 Modeling demostration

Optimizing geometry of VSP(DAS & conventional geophone), micro-seismic monitoring and DAS dynamic monitoring based on parameters demonstration through modeling, ray-tracing and inverting.



Geological model with weathered layer | Image range and fold times | Modeling | Inversion RTM image

Introduction to Company's borehole seismic integration technique services

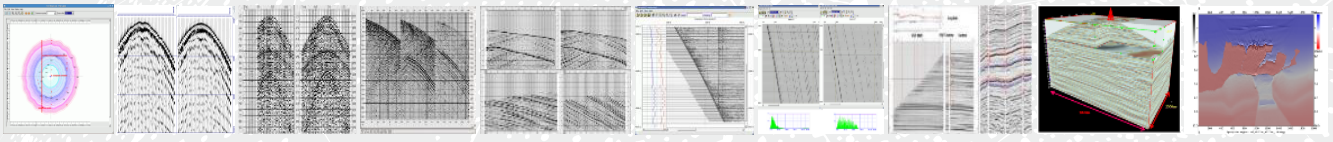
1 Research & development

1.3 Software development

Company developed GeoEast VSP and GeoEast ESP software with independent intellectual property rights which is professional at VSP and micro-seismic monitoring data processing and interpretation.

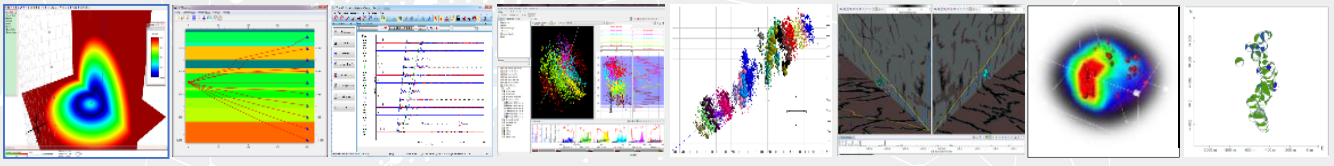
Integrated VSP data processing & interpretation system

GeoEast-VSP



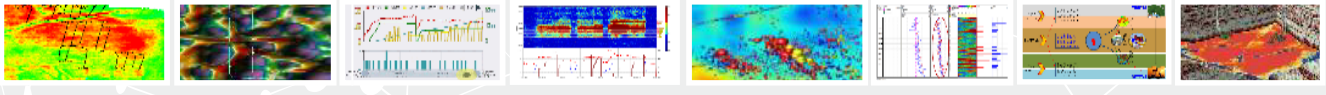
Integrated micro-seismic data processing & interpretation system

GeoEast-ESP



Optical fiber-based integration of seismic geology & engineering

GeoEast-SGE



Introduction to Company's borehole seismic integration technique services

2 Equipment capability

Company has successfully developed the 3rd generation advanced distributed optical fiber series instruments.

uDAS-2.3 Conventional

uDAS-3.0

uDAS-LF

Company possess 3C conventional downhole tools which can adapt to different downhole pressures and temperatures.

Model: MaxiWave (3-Component)
Pressure rating: 1200 bars (17400psi)
Temperature rating: 135℃(275℉)operating

Model: Geochain SlimTM (3-Component)
Max outside diameter: 43mm (1"11/16)

GeoWave 3C down-hole receivers 32 levels
20,000psi, 180 ℃

Company possess different seismic sources, such as vibrator, air gun, and weight drop which can satisfy different surface conditions. Company also have logging unit wich is designed for VSP services.

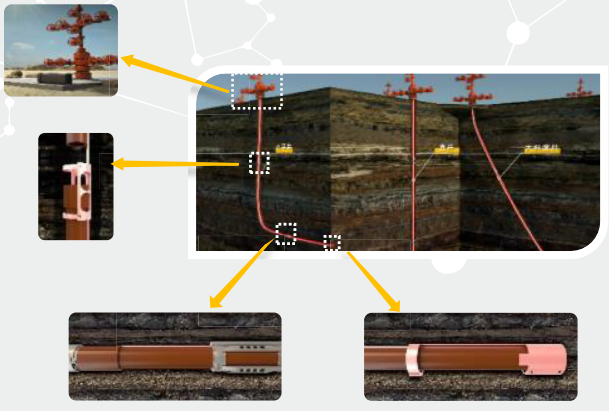
Vibrator

Air gun

Weight drop

Logging unit

Company provides cable deployment and cable mapping services. We have recorded the deepest vertical well (5800 meters) and horizontal well (3630 meters) cable deployment in China, and 21 wells have been successfully installed.



Optical cable deployment (wellhead protection, device passing through the tubing collar, customized centralizer, cable tail end)

Introduction to Company's borehole seismic integration technique services

3 Operation experiences

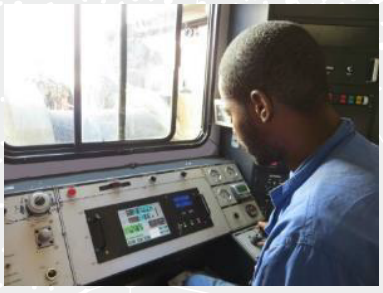
Company has provided integrated borehole seismic services for about 30 oil companies in China, and some overseas oil companies, such as PERTAMINA EP (Indonesia national oil corporation), CNPC INTERNATIONAL (Turkmenistan) LTD, CNPC INTERNATIONAL (CHAD) CO. LTD, CNPC NIGER PETROLEUM S.A. We have performed about 4000 well projects of VSP & micro-seismic monitoring, and accumulated abundant operation experiences. Company has sufficient personnel and equipment to perform multiple projects at the same time.

3C geophone routine maintenance

VSP tool deployment

DAS VSP Worksite

Fracturing microseismic monitoring

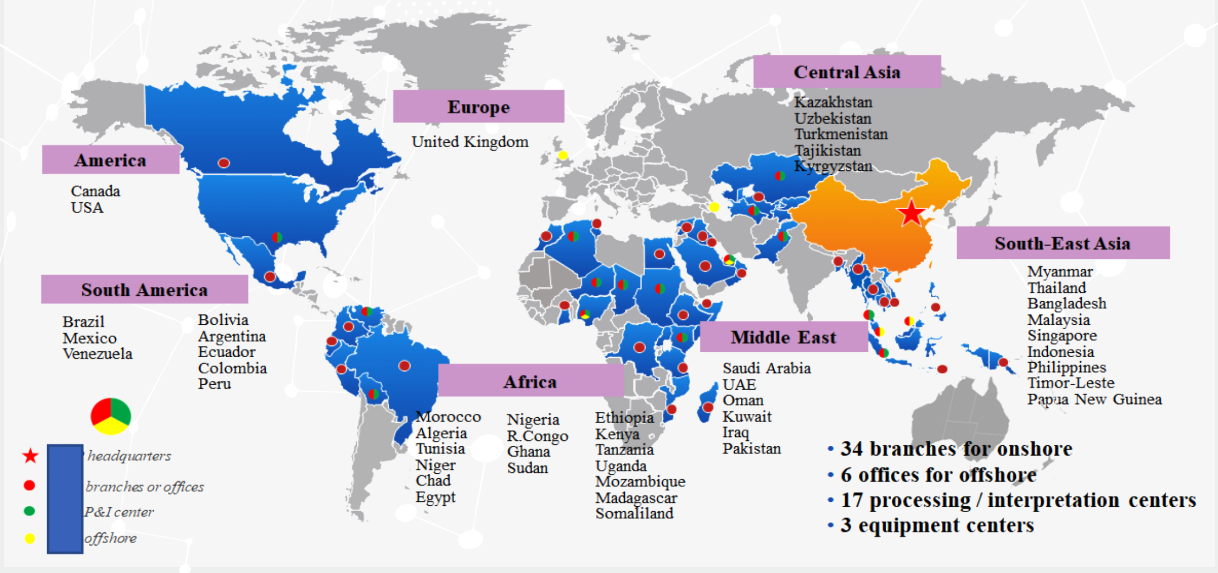


Winch truck operation

Walkaway VSP source drilling

Company overseas operations

Company has forty (40) overseas branches which provides over 300 clients with onshore and offshore integration seismic services, such as acquisition, processing & interpretation, GME services. Company's overseas branches can provide personnel, equipment and other local resources support for VSP operation, to make the VSP operation successful with high efficiency and low cost.



Introduction to Company's borehole seismic integration technique services

4 QHSE management

Company has been always adhering to "Safety is our core value". Company's HSE Management System has been established since the early 1990 based on relevant standards and IAGC guidelines. The HSE Management System is updated annually to include best practices of the seismic industry.

According to the ISO9001 standard, Company has established a quality management system which consists of operation standards and work procedures for borehole seismic service.

H_2S leakage drill

Medvac drill

Security training

Operation at wellsite

5 Contact us

For more information and further contact please contact by e-mail:

international@zyaobo.com