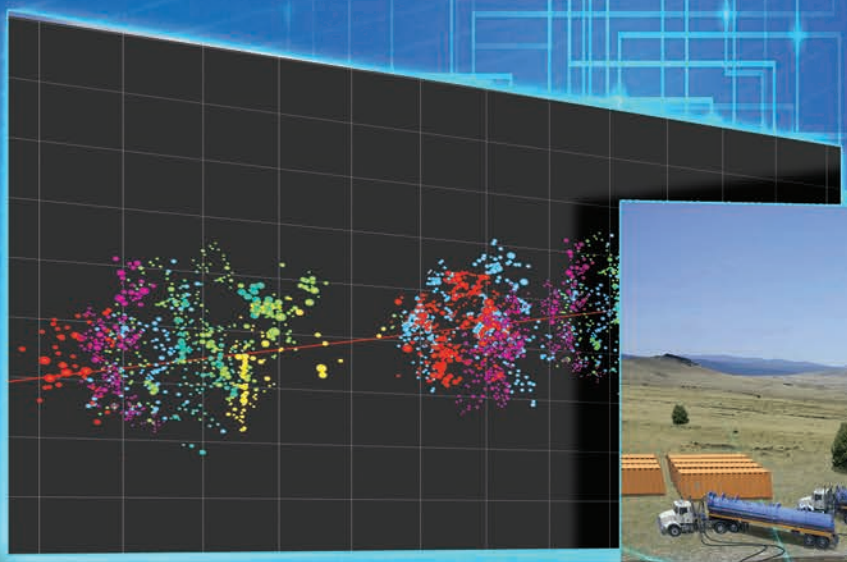
MicroSeismic

Passive Monitoring, *Active Listening*



MicroSeismic.com

Corporate Overview

Surface Monitoring—Accurate Results in Real-Time

Since 2003, MicroSeismic, Inc. has quickly grown to become the technology leader in surface microseismic monitoring across the world. Our services help customers:

- Optimize well completions
- Plan field development through well spacing and orientation
- Improve estimates of reserves and ultimate recovery

Our Mission

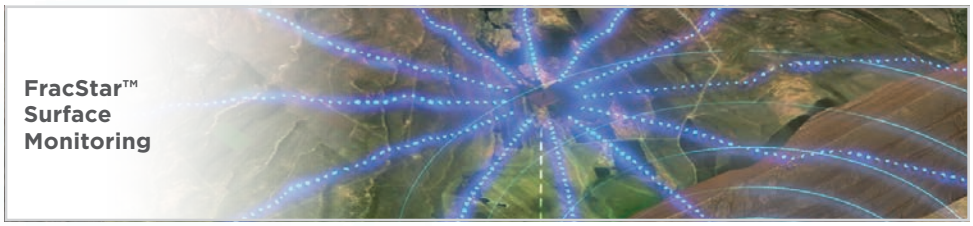
To deliver reliable and consistent completion optimization solutions that help customers understand the interaction between the reservoir, the stimulation treatment, and its impact on economics.

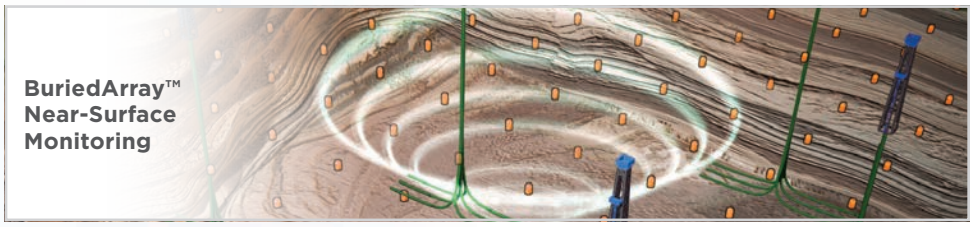
Groundbreaking Technology. Proven Expertise.

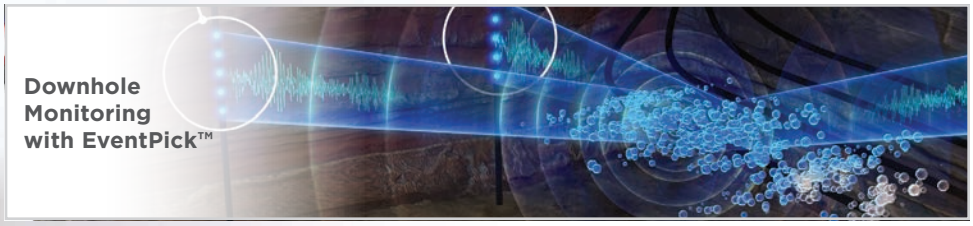
With 20,000 stages monitored, 800 square miles of permanently deployed BuriedArray™ microseismic data acquisition arrays, and work spanning 17 countries, MicroSeismic, Inc. has both pioneered and proven the successful application of surface microseismic monitoring across the world. From hydraulic fracture mapping to seismicity and reservoir monitoring, our passive monitoring services and advanced analysis products are unmatched in the marketplace.

ANALYSIS	
Fracture Mapping	✓
Stimulated Rock Volume	✓
Geohazard Mitigation	✓
Pressure Pumping Analysis	✓
Fracture Geomodeling	✓
Source Mechanism Analysis	✓
Propped Fracture Estimation	✓
Reservoir Changes Over Time	✓

SERVICE	
Real-Time Detection	✓
Field Wide Monitoring	✓
No Need for Monitor Wells When Using Surface Monitoring	✓
No Direction or Distance Bias When Using Surface Monitoring	✓
Final Analysis in < 1 Month	✓
Auto Alert on Key Events	✓
Surface & Downhole Monitoring	✓
Proven Expertise	✓







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FracStar™

Real-Time Surface Monitoring

MicroSeismic's FracStar Surface Monitoring uses an easily deployed, retrievable, surface-located, radial geophone array to effectively monitor long laterals and pad drilling over large geographic areas. Each array design is customized for the operator's specific area of interest, ensuring the highest quality dataset is obtained.

The combined effect of the FracStar array's wide aperture and PSET™-based microseismic data processing provides vital information about how the stimulation-induced fractures interact with the reservoir's natural fracture networks. This insight allows operators to reduce their completion costs quickly, while increasing their per-well recovery from subsequent wells in the area.

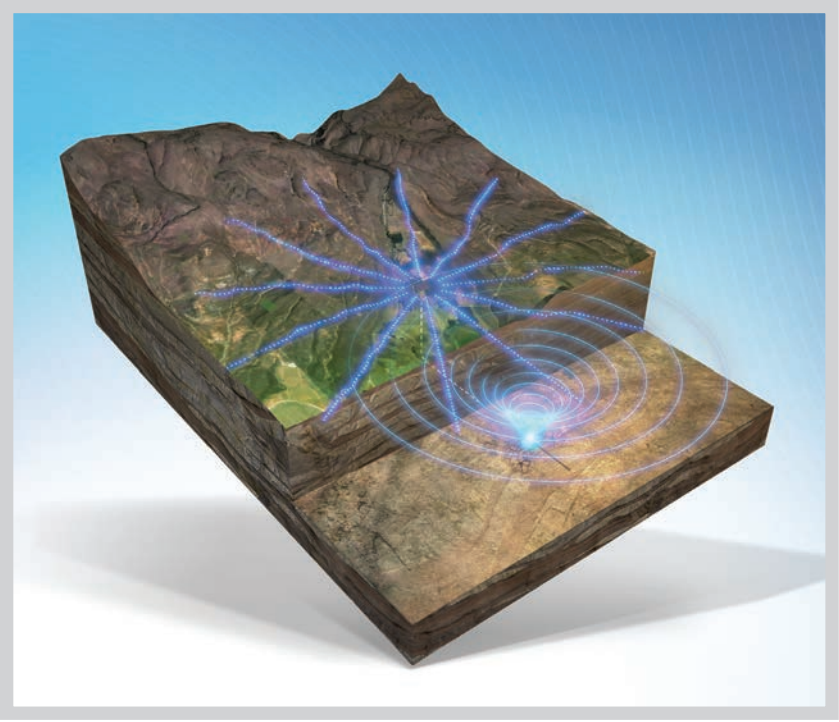
Array Design

The FracStar retrievable array typically consists of 10 to 12 arms arranged radially around the wellbore, and covers 5-15 square miles (12-40 square km) delivering full event imaging throughout the well site and beyond. Geophones are spaced throughout the stations on these arms and can number in the 1000s. Arm placement does not need to be linear and will often deviate to meet permitting requirements or geographic constraints. Stations can be deployed using standard cable technology or wirelessly to minimize field operation time, reducing cost. A powerful processing unit is deployed on-site in the MicroSTAR recording acquisition truck to process the data in real-time.

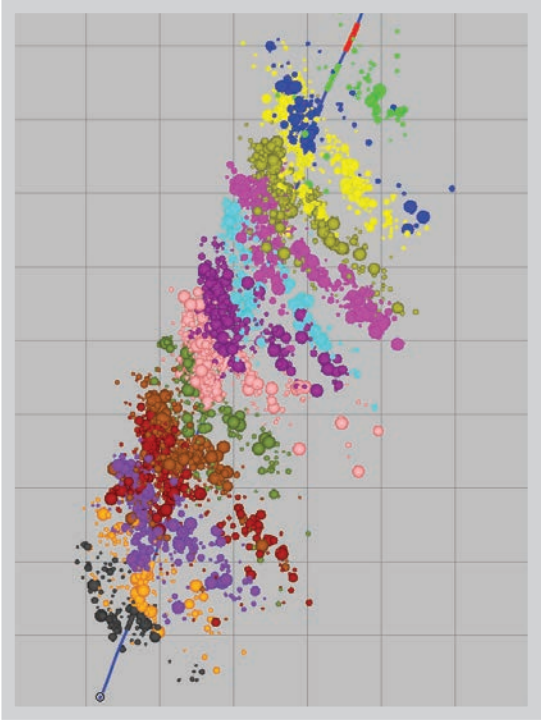
Arrays are capable of imaging events to about -3.0 moment magnitude. MicroSeismic's proprietary processing techniques make our solutions highly resilient to surface noise sources such as: pumping operations, ground traffic, rain, and high winds.

Key Benefits:

- Saves money by eliminating costly monitoring wells
- Consistently delivers high-accuracy event location in X, Y, and Z over the entire monitored volume
- Fracture orientations are revealed by source mechanisms through PSET processing
- Real-time monitoring available
- Utilizes PSET unique beamforming processing technology
- Directly maps local stress orientations
- Rapid array deployment with minimal surface and environmental disturbance during acquisition



The FracStar array is a cost effective means to monitor your well treatment and observe reservoir stimulation.



Event trends from a stimulation reveal fracture trends and optimum wellbore orientation.

BuriedArray™

Permanent & Real-Time Shallow Subsurface Monitoring

MicroSeismic's BuriedArray data acquisition product deploys a permanent array of MicroSeismic designed geophone strings installed in the near surface to monitor an area of any size, in some cases exceeding more than 500 sq. miles (1,300 sq. km). BuriedArray Shallow Subsurface Monitoring uses PSET technology to provide results that show how fractures are propagating during the well treatment. By determining source mechanisms, PSET processing provides a greater understanding of the effectiveness of the stimulation treatment.

A BuriedArray is ideal for operators who need to monitor multiple wells or require monitoring through the life-of-field. The wide area coverage provides economies of scale. As more wells are monitored under the same array, costs decline dramatically relative to any other microseismic acquisition technique. The ability to monitor large areas repeatedly with the same equipment leads to more strategic field planning and development, and the ability to monitor refracs as well as life-of-field monitoring applications.

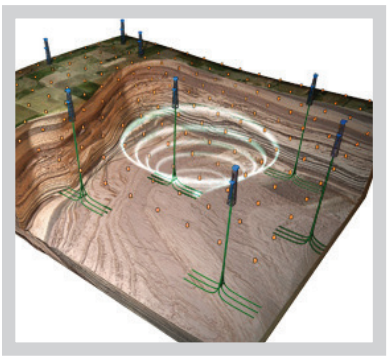
Data acquisition for hydraulic fracture stimulation monitoring is accomplished using an autonomous wireless recording system. Autonomous digitizer/recording systems are installed at each location with a battery and memory sufficient to provide several days of recording. The autonomous recording system allow for wireless data downloading within 100' (30m) of the recorder. In addition, the BuriedArray can include a Wireless Data Acquisition (WDA) system option which allows for 24/7 data acquisition as well as Real Time on demand processing. Long term production monitoring can be accomplished through the use of autonomous digitizing/storage equipment at each geophone location with internal storage capable of recording up to four weeks of data before requiring a data download.

Array Design

The BuriedArray installs include multiple level combinations of 1C and 3C phones at depths varying according to the established noise profile. The density of stations will also vary based on event detectability; from two to eight stations deployed per square mile. Shallow burial of phones typically reduces surface noise more than 20 dB allowing sparser station spacing, thus reducing cost. BuriedArray stations can be live 24/7 as they are powered by battery, solar, and wind sources. Data can be recorded locally or transmitted wirelessly back to the main processing unit.

Key Benefits:

- Directly map local stress orientations
- Observe field-wide well stimulation
- Map individual and multiple well drainage areas with long-term production monitoring
- Monitor multi-zones and multi-wells simultaneously
- Optimize infill well spacing and lateral length for increased production efficiency
- Permanent array provides refrac monitoring capability
- Ideal for 24/7 time lapse monitoring applications
- On demand Real Time processing if the Wireless Data Acquisition system is included



Our BuriedArray product offers a long term solution to monitoring over the life-of-field.

Downhole Monitoring with EventPick™

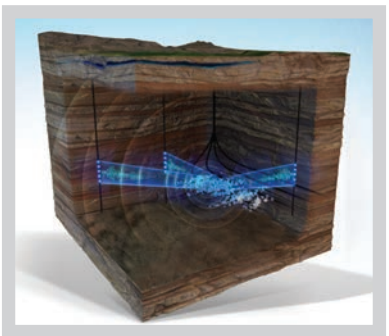
P- And S-Wave Arrival Picking

Real-time MicroSeismic Downhole Monitoring with EventPick™ Technology provides an independent evaluation of well stimulation results in areas less suitable for surface-based microseismic acquisition. Initial results, using the proprietary EventPick processing technology, are delivered within a month. The solution provides operators with the fracture geometry and azimuth, discrete fracture network characterization, estimations of propped stimulated reservoir volume, and recommendations for completions optimization.

Acquisition is performed using 15Hz 3C geophones, usually placed on 10 to 20 levels, spaced 20-50 feet apart. MicroSeismic uses the earthquake seismology derived technique of p-wave and s-wave first arrival picking for processing microseismic events acquired via downhole geophone arrays.

Where the monitoring well location is sub-optimally located, detectability can be improved through the use of multi-well downhole acquisition. A further refinement can be made through the combination of surface and downhole acquisition to provide a more comprehensive view of the fracture network.

MicroSeismic has been in operation since 2003 and has performed downhole microseismic processing work since 2008, spanning three countries and fifteen different target formations. Our downhole processors have over 50 years of geophysical experience, located in both our Houston headquarters and our Calgary office. We have processed, reprocessed and interpreted downhole data for hydraulic fracture mapping services as well as reservoir monitoring services such as steam injection monitoring and casing failure monitoring.



Multi-well downhole acquisition provides superior azimuthal sampling.

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Hydraulic Fracture Mapping (HFM)

MicroSeismic Hydraulic Fracture Mapping services assist our clients in improving their well completions through better understanding of fracture size, geometry, and complexity. Our unique passive seismic acquisition technique provides a wealth of information such as wide area monitoring and focal mechanism detection when using surface acquisition or multi-well downhole techniques. In addition, the large aperture, high fold, wide azimuth surface data acquisition approach eliminates monitoring well proximity that can affect event quality. Patented PSET technology, successfully used in hundreds of wells, ensures high quality depth imaging and resolution, even in low signal areas.

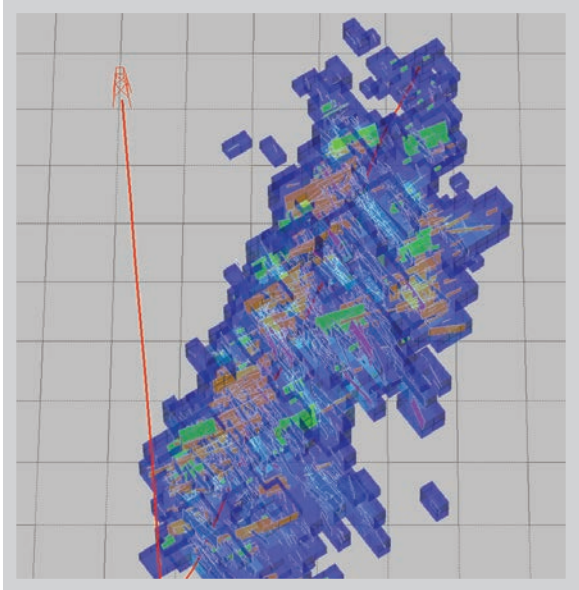
Array calibration is conducted by monitoring a string shot or perforation shot performed by the operator. Since the time and location for the shot is known, the imaged event hypocenters can be migrated to the known location. PSET's VTI (Vertical Transverse Isotropy) algorithms account for velocity variations due to anisotropy. Processing result in X, Y, and Z errors ranging between +/- 10' – 50' depending on signal quality and event magnitude.

HFM Service—Results

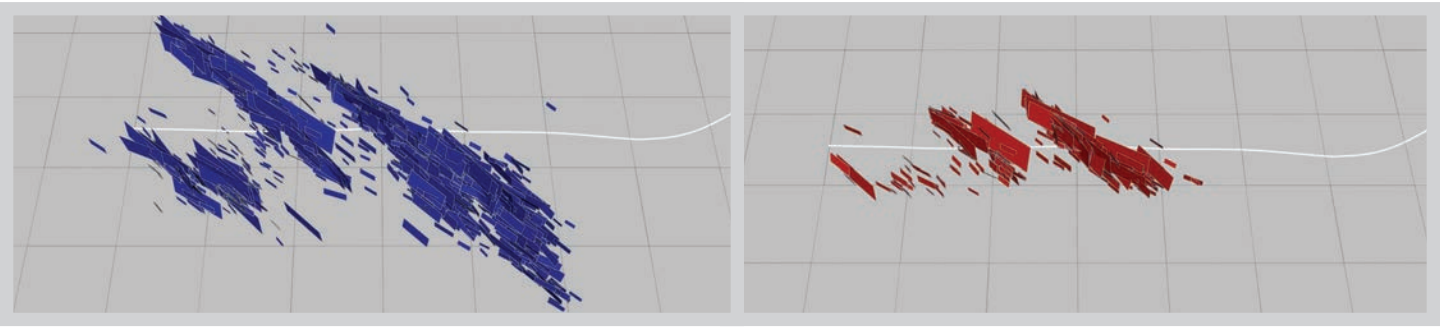
A team of experienced geoscientists and engineers work with our customers to provide interpretation of the results, and recommendations for optimizing future completions. Real-time results can help optimize a frac program during the job. Full analysis is delivered within a month, including; fracture mapping, geomechanical analysis, geocellular modeling, discrete fracture network creation, and an estimation of propped fractures to calculate productive stimulated rock volume (Productive-SRV™).

HFM Benefits:

- Optimize completions by understanding how the reservoir responds to stimulation
- Determine where to drill next by determining well spacing and well bore orientation
- Improve recovery through better determination of well landing zone and more productive stage placement



Experienced interpreters develop geologically constrained discrete fracture networks (DFNs) to provide estimated stimulated rock volume calculations.



Total fracture network

Estimate of propped fractures

MicroSeismic HFM Services

ANALYSIS

Fracture Mapping
- Hypocenter Location
- Fracture Geometry

Hazard Mitigation
- Fault Identification
- Deviation from Target Zone

Geomechanical Analysis
- Source Mechanisms
- Local Stress Orientation

Fracture Geomodeling
- Discrete Fracture Network
- Stimulated Rock Volume

RECOMMENDATIONS

Well Spacing
- Drainage Estimation
- Field Optimization

Frac Design
- Pumping Pressure Impact
- Fluid Effectiveness

Completion Techniques
- Perforation Design
- Fracture Styles

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Seismicity Monitoring (SM)

Seismicity Monitoring allows the operator to establish a baseline for naturally occurring seismicity prior to the startup of injection activities. Monitoring over the life of the asset helps to demonstrate proactive stewardship of field operations.

CAPABILITY	High Resolution	Intermediate Resolution	Coarse Resolution	USGS Resolution*
Township (<50 sq. miles)	±50'	±300'		±5 mi
Extended (<500 sq. miles)		±150'	±600'	±5 mi
Regional (>500 sq. miles)			±2000'	±5 mi

Monitoring can be based on an existing standard BuriedArray design (for smaller operations), or deployed using a custom designed sparse array over areas of >10,000 sq. miles. Event resolution from this service can be 10x better than measurements available from public networks such as USGS and NRCan; helping to accurately pinpoint and demonstrate the safety of subsurface treatment activities. This service also includes real-time event alerts sent directly to your smartphone, as well as weekly reporting of activities.

Reservoir Monitoring (RM)

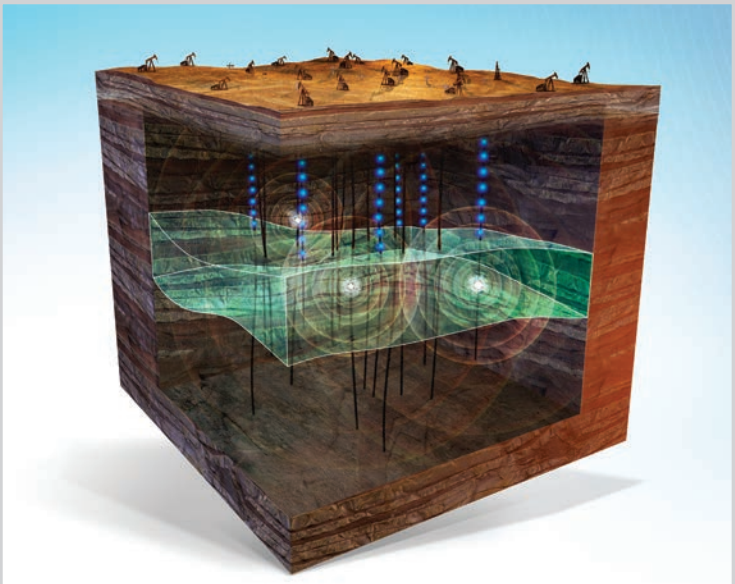
World Leader in Life-of-Field Microseismic Monitoring Installations | Traditional tools for understanding reservoir geometry and texture such as well logs, pressure transient testing, and 4D seismic imaging give only a partial, static view of reservoir complexity. Life-of-field microseismic monitoring maps the dynamic interaction of injected/produced fluids with the complex reservoir geology, providing direct measurement of hydrocarbon recovery efficiency.

Individual Well Drainage Area Mapping | Depletion of hydrocarbons from hydraulically stimulated shale generates significant stress changes during the first few months of production, which produce detectable microseisms. These stress changes will cause compaction of propped fractures and reactivation of connected or nearby natural fractures.

Fluid Injection Monitoring | The injection of water, steam and CO_2 into a reservoir for pressure support or oil mobilization will, in most cases, provide sufficient change in the natural fracture confining stresses to initiate movement and create mappable microseismic energy. Mapping these microseismic events over time allows the operator to identify areas that are not swept due to reservoir heterogeneity or structural complexity.

Cap-Rock Integrity and Casing Failure Monitoring | Thermal operations used to produce heavy oil generate considerable stress on both the production casing and the reservoir cap-rock or overburden. Failure of the casing or cementing can produce larger amplitude microseismic events. Monitoring for these can immediately alert operators to the failure and determine the specific location.

PHASE OF DEVELOPMENT			
Monitoring Activity	**Primary**	**Secondary**	**Tertiary**
Production-Related Natural Fracture Reactivation	●		
Drilling Waste Injection Containment	●		
CO_2 Sequestration Fluid Migration	●		
Reservoir Compaction & Overburden Subsidence	●	●	●
Real-Time Cap-Rock Integrity	●	●	●
Casing Failure	●	●	●
Variance in Reservoir Properties Across a Field	●	●	●
High Accuracy Regional Earthquake Location	●	●	●
CSS In-Reservoir Stream Conformance		●	
SAGD Stream Chest Growth		●	
Water Injection Pattern		●	●
CO_2 Microbial Flood Pattern Conformance		●	●



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Technology — PSET™ 4.0

Multi-Patented Surface Microseismic Processing

PSET Monitoring

MicroSeismic offers its Passive Seismic Emission Tomography (PSET) technology to precisely locate microseismic events. This patented microseismic monitoring, mapping, and analysis process employs beam steering to gather and sum the output detecting event hypocenters with high accuracy.

All collected microseismic data is transmitted to a central recording and processing facility. Our analysis provides an accurate understanding of the reservoir's heterogeneity and the geologic conditions from which hydrocarbons are being extracted. Our technology also allows geologists to integrate microseismic data with other sub-surface data to better understand the reservoir.

Our technology differentiator comes from our depth migration algorithms which calculate a more complete picture and precise view of the reservoir in real-time. Downhole monitoring methods are unable to offer this level of investigation due to their limited aperture.

PSET monitoring has been successfully employed on 20,000 stages globally.

PSET Alerting

In addition to PSET monitoring capabilities, the technology also includes the ability to automatically alert in real-time, on user selected event types. For example, when monitoring for cap rock integrity during steam injection, PSET Alerting can trigger immediate notifications when out-of-zone steam migration causes a seismic event of a set threshold value. Similarly, when used for seismicity monitoring, PSET Alerting can provide instant and unassisted notice of larger than expected magnitude events.

PSET Uncertainty Estimation

Customers can evaluate hypocenter uncertainty using the PSET Uncertainty attribute. Uncertainty is computed using a patent pending, Maximum Likelihood Estimation (MLE) statistical technique that uses Fisher Information Matrix co-variances to understand the information content of the possible parameter values. The attribute helps customers understand the location uncertainty in a more quantitative way, and gain more confidence in the results.

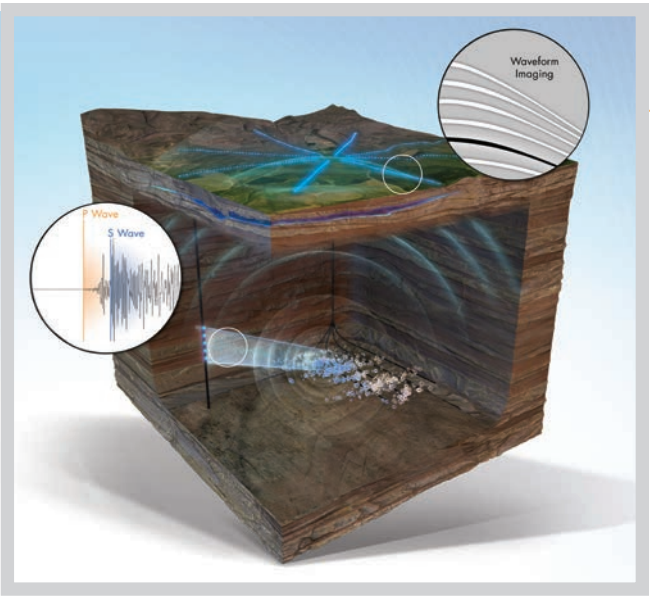
PSET VTI

PSET VTI (Vertical Transverse Isotropy) is an interactive calibration tool used to characterize anisotropic velocity models. This provides a clearer, more precise image of microseismic event locations. Using PSET VTI reduces vertical event position error. PSET algorithms, taken as a whole, limit errors in X, Y, and Z directions between +/- 10' to 50', varying by signal quality and event magnitude.

EventPick™

Downhole First Arrival Processing

MicroSeismic uses the earthquake seismology derived technique of p-wave and s-wave first arrival picking for processing microseismic events acquired via downhole geophone arrays. The proprietary EventPick processing software is used to provide automated triggering on microseismic events. A team of experienced processors manually validates each trigger to identify the events of interest and separate them from false positives like tube waves, electrical spikes and pumping noise. Where multiple wells are available, the technology can be used to calculate source mechanisms to characterize how the rock was broken. The raw results and microseismic viewer are provided on every job for quality control.



Combined surface FracStar™ and Downhole Monitoring with EventPick™ Acquisition.

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Passive Monitoring, *Active Listening*

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