Delivering Real Results

Clarion™ permanent optical in-well seismic system

Seismic imaging from wells while producing for life-of-well reservoir monitoring

Production optimization

- Artificial lift
  - Controllers
  - Downhole pressure & temperature sensors
  - Variable-speed drives
  - Well surveillance & analysis software

- Control systems
  - Control panels
  - Pilots
  - Safety shutdown systems
  - Safety-system field instruments
  - Workover control systems

- Flow measurement
  - Custom measurement solutions
  - Multiphase water-cut meter
  - Real-time well testing systems
  - Water-cut meters
  - Wet-gas, modular multiphase meters

- Reservoir monitoring
  - Flowmeters
  - Pressure/temperature gauges
  - In-well, seismic sensor systems
  - Temperature measurement systems

- Software
  - Artificial-lift analysis
  - Asset management
  - Flow assurance
  - Production engineering
  - Real-time monitoring
  - Well design and diagnostics

- Subsea production
  - Communication controllers
  - Control systems
  - Topside information & control systems

Weatherford
Delivering Real Results

Weatherford’s Clarion™ permanent optical in-well seismic system has delivered seismic imaging and monitoring in production and injection wells worldwide.

Onshore France

Long-term monitoring of CO₂ injection well

Results
Weatherford’s Clarion seismic system was installed in combination with multiple optical pressure/temperature gauges in France to permanently monitor the injected CO₂. The system will provide life-of-well microseismic and pressure monitoring, assuring long-term, continued safe storage.

Offshore Gulf of Mexico

Permanent seismic monitoring and 4D imaging while producing

Project details
• 12-station single and 3-component seismic array
• 13,900 ft (4,237 m), 7,100 psi (49 MPa), 175°F (79°C)
• 3 1/2-in. tubing, 7-in. casing
• Oil-producing well

Results
Weatherford’s Clarion multistation, optical seismic array and optical pressure/temperature gauge were successfully installed in a production well in the Gulf’s Mars field. Deployed on the production tubing using a single cable, the array was comprised of 3C and 1C seismic sensors and was interfaced to an existing permanent ocean-bottom cable system. The 12-station, in-well seismic system continues to date to reliably record seismic signals including 3D vertical seismic profiling (VSP) in tandem with conventional seismic surveys while the well is under full-production flowing conditions.
Continuous high-resolution monitoring of microseismic events from remote operations

Project details
• 8-station × 3-component seismic array
• Variable array spacing
• 13,238 ft (4,035 m), 12,000 psi (83 MPa), 230°F (110°C)
• 3 1/2-in. tubing, 7 3/8-in. casing
• Observation well

Results
We successfully installed our Clarion multistation, optical seismic array in a deep-monitor well in Kazakhstan, providing continuous high-resolution microseismic data. Deployed on the production tubing, the array was comprised of 3C seismic sensors with variable spacing. The Clarion system is interfaced to a third-party processing system, and microseismic data related to production is captured and mapped for events up to 5 mi (8 km) from the monitoring wellbore.

Reliable, large-volume data recording
In early 2006, the Clarion™ sensor was installed in a water-injection well. Since that date, the system has continuously monitored the subsurface for passive seismic information from production and injection-related activities. Reliably recording background seismic signals—including 3D ocean-bottom seismic (OBS) surveys and 3D VSPs during quieter shut-in periods—from the five stations of three component accelerometers has led to the collection of large volumes of downhole data, surpassing the accumulated 6-TB data-volume milestone. The data stream acts as a long-term track record of acoustic events for the field.
Weatherford’s Clarion™ permanent optical in-well seismic system delivers reliable, high-resolution, on-demand in-well seismic data. Based on well-established fiber-optic telecommunication technology, our innovative optical accelerometers and hydrophones are designed to withstand hostile well environments. Permanently installed in the well, the Clarion systems can be used for various applications, including:

- VSP reservoir imaging
- Surface seismic calibration
- Microseismic monitoring
- Crosswell seismic
- Seismic while drilling

The all-optical system contains no in-well electronics, and the simplicity of the component parts provide life-of-well seismic monitoring and imaging even under extreme conditions.

For more information about the Clarion in-well seismic system, contact your local Weatherford representative, or visit weatherford.com.